

## CHAPTER XXXIV

## THE PROSTATE AND SEMINAL VESICLES

HAMILTON BAILEY

**Embryology.**—The prostate arises from the primitive urethra as a series of solid buds (fig. 1103); in a matter of weeks these become canalised. Budding takes place into the surrounding mesenchyme, which becomes differentiated into the muscular and connective tissue of the gland. In man, the buds arise from all sides of the urethra, and can be arranged into five groups—anterior, middle, posterior, and two lateral. These are the forerunners of the lobes of the prostate. The buds which go to form the anterior commissure (it is hardly worthy of being designated as a lobe) are formed only in man and the great anthropoids.

Skene's tubules that open into the female urethra are the homologues of the prostate.

**Surgical Anatomy.**—As can be seen in transverse section (fig. 1104), embedded in a dense fibromuscular stroma lie the glandular elements of the prostate and their ducts which, for the most part, open into the posterolateral grooves on either side of the verumontanum. The epithelium of the whole of the glandular system is columnar. Commencing peripherally, and passing centralwards, beneath the anatomical capsule lie the long branched **prostatic glands proper**. From accumulated experience this region is named the **carcinomatous zone**. Beneath this thick envelope, and separated from it by an indefinite capsule, lies another mass of secreting elements, also

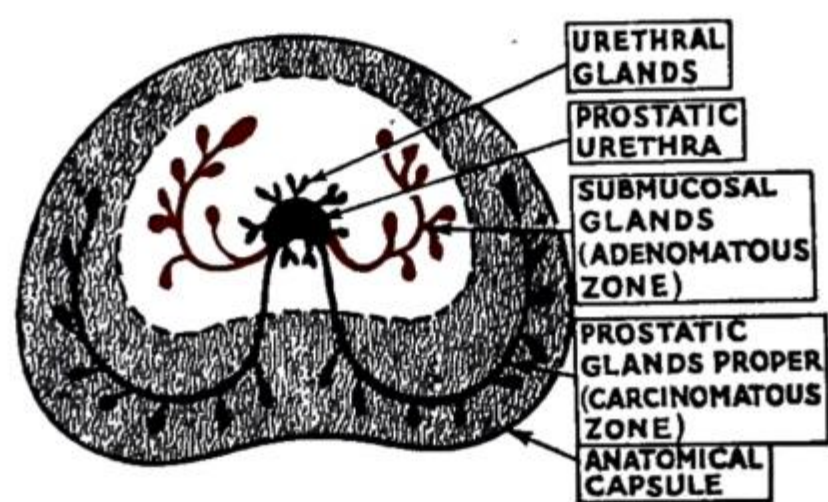


FIG. 1104.—Distribution of the normal glands of the prostate, transverse section. (After J. C. B. Grant.)

branched. These are the **submucosal glands**—and the zone that they occupy is known as the **adenomatous zone**. Still nearer the urethra are the unbranched **mucosal glands** whose mouths open directly into the urethra.

Into the prostatic urethra, therefore, open the prostatic ducts proper, the ducts of the submucosal and mucosal glands, as well as common ejaculatory ducts and the prostatic utricle (see fig. 955, p. 716). No wonder that chronic infection of the prostatic urethra is difficult to eradicate!

Turning now to the macroscopical arrangement as seen in sagittal section, it is essential to appreciate clearly certain relationships and divisions of the prostate set out in fig. 1105. The middle lobe is that part of the prostate included between the common ejaculatory ducts and the prostatic urethra. This middle lobe contains more secretory

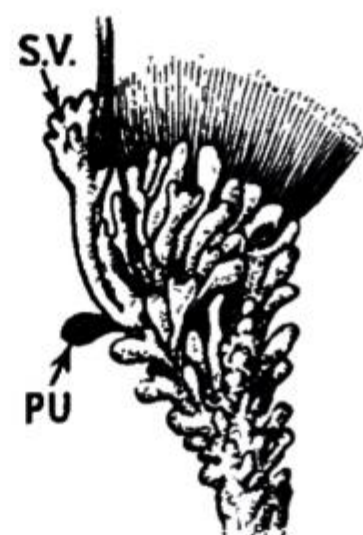


FIG. 1103.—The prostate towards the end of the fourth month of intra-uterine life. SV = seminal vesicle, PU = prostatic utricle. (After E. J. Evatt.)

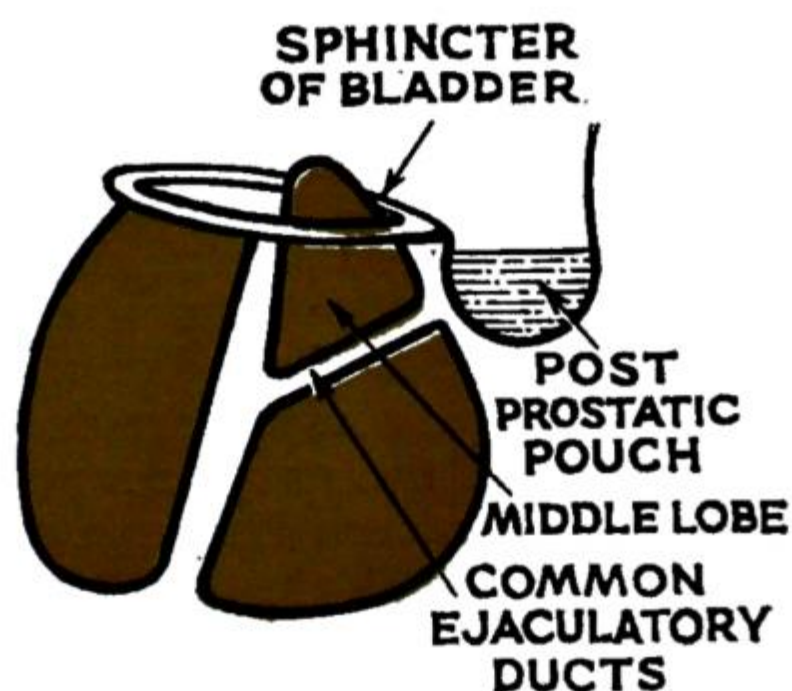


FIG. 1105.—The surgical subdivisions and relationships of the prostate.

Alexander J. C. Skene, 1838–1900. Surgeon, Long Island College Hospital, New York.



glandular element (as opposed to muscle and fibrous tissue) than the lateral lobes.

Touching now on a prostate the seat of adenomatous hyperplasia, from what has been said it can now be appreciated that an enlarged prostate is invested with three capsules: (1) The compressed outer zone = *the false capsule*; (2) The anatomical capsule = *the true capsule*; and external to this (3) *The prostatic sheath of pelvic fascia*.



FIG. 1106.—The prostatic venous plexus.

Between the anatomical capsule and the prostatic sheath lies the prostatic venous plexus (plexus of Santorini) (fig. 1106). The prostatic sheath is contiguous with the strong fascia of Denonvilliers that separates the prostate and its coverings from the rectum.

**Physiology.**—At first sight it seems difficult to assign a specific function to the prostate, an organ which is present in all male animals. That the prostate is purely a genital organ is evinced by the fact that in such animals as manifest a seasonal sexual life, the organ is rudimentary except during the rutting season.

Evidence that normal adult prostatic epithelium undergoes atrophy secondary to castration was known to John Hunter, and subsequently this has been proved many times in animals and man.

**Hormonic Influences.**—Experimental work suggests that the prostate is governed by two testicular hormones, one male (androgenic) and the other female (œstrogenic). Normally the preponderant testicular hormone is androgen, which is supplemented by androgens secreted by the adrenal glands (fig. 1107).

Knowledge of the counter effects of œstrogen on the prostate are of more recent origin. It has been proved, both in animals and man, that œstrogens cause retrogressive changes in the testes and prostate gland. For example, at the present time, most capons are produced by implanting œstrogen pellets into the neck of the bird rather than by castration. That the prostate is under the influence of hormonal influences is also borne out by animal experiments, which show that as a result of fairly prolonged administration of œstrogens the middle zone of the prostate (see fig. 1104) alone becomes hyperplastic.

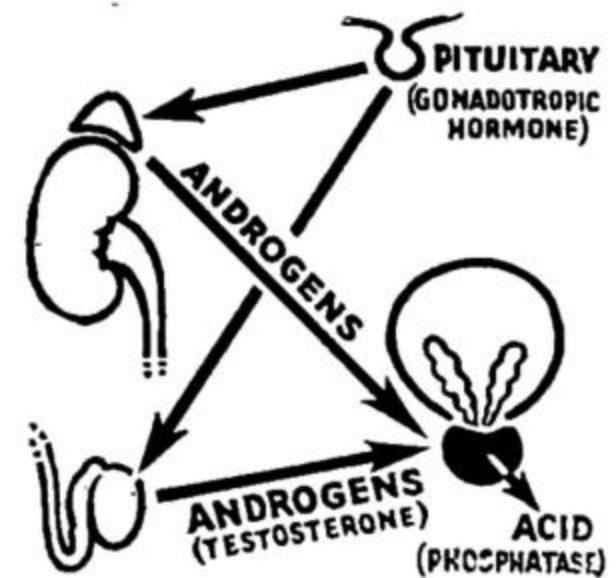


FIG. 1107.—Preponderant hormonal control of the prostate. (After L. N. Pyrah.)

**Elaboration and Secretion of Acid Phosphatases.**—Enzymes that split organic phosphates and are most active about pH 5, to wit acid phosphatases, are present in many human tissues, but their concentration in the adult prostate is several hundred times greater than in any other organ or tissue. This high level is not achieved until after puberty. The secretion of acid phosphatases is therefore a secondary male sexual characteristic of a chemical nature. While the function of this enzyme is speculative, it is highly suggestive that the acidity which is most favourable for its action corresponds to that of the vagina at the time of ovulation. Most of the acid phosphate secreted by the prostate drains along the prostatic ducts into the urethra, so that the blood level of this enzyme remains low. When for some reason the cells producing this enzyme cannot discharge their products externally, the serum acid phosphatase rises.

Acid phosphatase activity has also been demonstrated in Cowper's glands.

**Acid phosphatase estimations** are made on plasma or serum free from hæmolysis. The blood sample must be taken in the morning before breakfast, and on no account after a heavy meal, since lipid-rich serum gives inaccurate estimations. For forty-eight hours prior to taking the sample of blood for phosphatase determination, rectal examination must be avoided since digital palpation of the prostate is liable to produce a transient rise in the serum acid phosphatase level. The amount

Giovanni Domenico Santorini, 1681-1737. Professor of Anatomy, Venice.  
Charles Pierre Denonvilliers, 1808-1872. Professor of Anatomy, Paris.  
John Hunter, 1728-1793. Surgeon to St. George's Hospital, London.



of enzyme is determined by assaying the end products of its catalytic activity (under prescribed conditions) on a known concentration of an organic substrate, usually a phenyl phosphate. This is the basis of the King-Armstrong method. The normal range of findings is 0-5 K-A units per 100 ml. of serum. Modifications of this test are required to distinguish between acid phosphatase elaborated by the adult prostatic epithelium and similar enzymes derived from other sources, especially red cells. The latter are eliminated by the formalin inactivation technique, and with this modification readings of over 3.0 units suggest abnormal prostatic activity, such as occurs in those cases of prostatic carcinoma in which the malignant cells exhibit a pronounced capacity for enzyme production (see p. 853).

Whereas it is quite usual for this estimation to be raised in cases of carcinoma of the prostate *with metastases*, seldom is it above normal limits when the carcinoma is confined to the gland, and almost never in benign enlargement of the organ. On the other hand, slightly increased values are not uncommon (1) after prostatic massage, and in cases of (2) Paget's disease of bone; (3) hepatic cirrhosis and (4) retention of urine.

#### BENIGN ENLARGEMENT OF THE PROSTATE

*"When hair becomes grey and thin, when atheromatous deposits invade the arterial walls, when there has formed a white zone about the cornea, at the same time, ordinarily—I dare say invariably—the prostate increases in volume."* (SIR BENJAMIN BRODIE.)

Benign enlargement of the prostate occurs in men over fifty years of age; most often between sixty and seventy. In isolated instances the patient is under the age of fifty. These facts refer to white races, in whom the condition is very common. In Indians prostatic enlargement is less frequent, and occurs more often in the younger age-group; in Negroes it is rare, while in Asiatics it is exceptional. The reason for these discrepancies is unknown.

**Ætiology.**—The cause of this condition is open to discussion. It is interesting to note that the ageing house-trained dog is prone to prostatic hyperplasia but, unlike his master, does not often develop retention of urine. Due, however, to the bulging upwards<sup>1</sup> of the enlarged prostate the dog's rectum is compressed. This engenders a feeling of continuous fullness in the rectum, and so induces straining as if to pass fæces (J. McCunn). Prostatic hyperplasia does not occur in kennel dogs, or, indeed, in any other animal. Perhaps more enlightening is the fact that the prostates of eunuchs are small and completely under-developed. It is said that in these individuals benign enlargement of the prostate is unknown.

#### Theories of causation of benign enlargement of the prostate:

**The Hormonic Theory.**—As age advances the male hormone diminishes while the quantity of the œstrogenic hormone is not decreased equally. According to this theory the prostate enlarges because of predominance of the œstrogenic hormone. To regard prostatic enlargement as involutionary hyperplasia akin to fibro-adenosis of the breast, due to a disturbance of the ratio and quantity of the circulating androgens and œstrogens, is to be in an unassailable position.

**The Neoplastic Theory** postulates that the enlargement is a benign neoplasm. As the prostate is composed essentially of fibrous tissue, muscle tissue, and glandular tissue, the neoplasm is a *fibromyo-adenoma*. It follows that should the glandular element (adenoma) predominate, that part of the gland which is richest in secretory glandular tissue, to wit the middle lobe, will be maximally affected. When the fibrous element is most in evidence, the small, hard fibrous prostate is produced.

**Pathology.**—There is hyperplasia of the submucous glands beneath the apex of the trigone (the subcervical glands) as well as those of the prostate. There is also hyperplasia of the connective-tissue stroma. Often the disease commences in the subcervical glands, in which event the middle lobe of the prostate becomes enlarged. If the submucous glands of the prostate itself

<sup>1</sup> An enlarged prostate bulges *upwards* in a quadruped.

Earl J. King and Arthur Riley Armstrong, *Contemporaries*. Co-workers at the Department of Medical Research, Banting Institute, University of Toronto.  
Sir Benjamin Brodie, 1783-1862. Surgeon, St. George's Hospital, London.  
James McCunn, *Contemporary*. Professor of Veterinary Anatomy, Royal Veterinary College, London.



are involved, the lateral lobes enlarge. In 40 per cent. of cases the enlargement remains confined to the middle lobe. It is also common for the lateral lobes and the middle lobe to become enlarged (fig. 1108). More rarely,

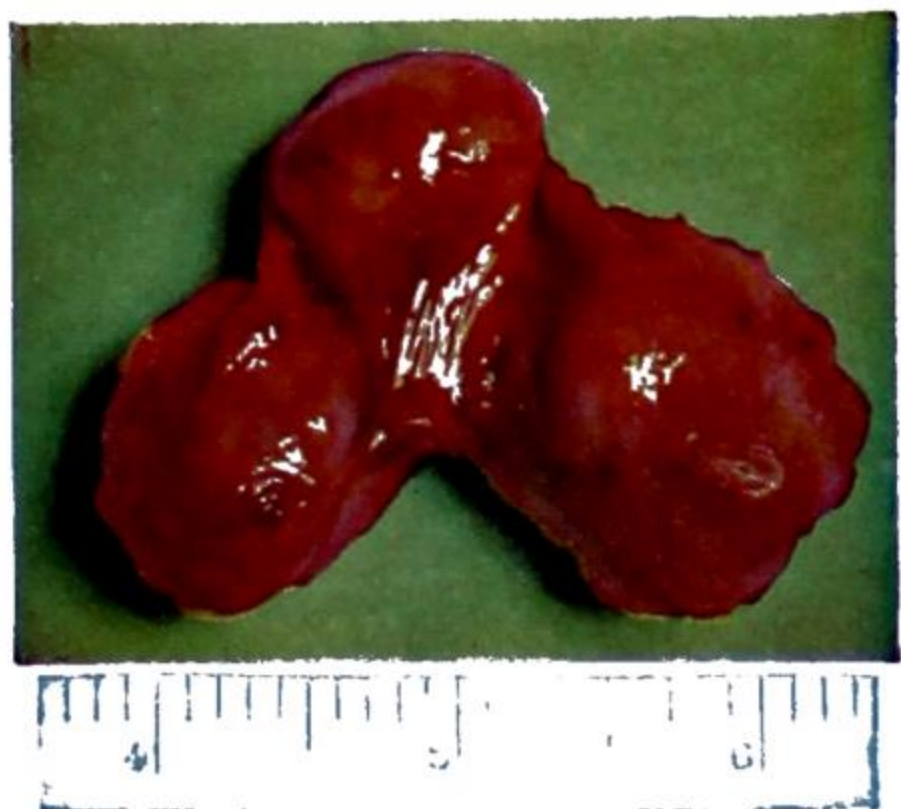


FIG. 1108.—Trilobed enlargement of the prostate. Specimen enucleated by suprapubic prostatectomy.

the lateral lobes enlarge and the middle lobe is unaffected. Occasionally one lateral lobe is enlarged and the other macroscopically normal, but in this instance it is usual for the middle lobe to participate. The anterior lobe or isthmus of the prostate is involved in only 1 per cent. of cases. The so-called posterior lobe (the outer zone (see fig. 1104)) does not take part in benign enlargement. As the prostate enlarges extravasically, it tends to displace the seminal vesicles, so that instead of lying on the base of the bladder, these structures become a direct posterior relation of the upper limit of the prostate. Intravesically an enlarged middle lobe insinuates itself within the cervical sphincter (see fig. 1105). Sometimes both lateral lobes also project into the bladder, so that when viewed from within, the sides and back of the internal urinary meatus are surrounded by an intravesical prostatic collar. The ratio of fibrous tissue overgrowth to glandular hyperplasia varies considerably. When the hyperplasia is mainly glandular (so-called adenoma) the prostate may become two or three times its normal size, sometimes larger. In prostates with considerable fibrous hyperplasia the enlargement is not so much in evidence, and the term fibroadenoma is descriptive.

#### SECONDARY EFFECTS OF PROSTATIC ENLARGEMENT

**On the Urethra.**—That portion of the urethra lying above the verumontanum becomes elongated, sometimes to as much as twice its normal length. The canal is compressed laterally, so that it tends to become an antero-posterior slit. The normal posterior curve often becomes so exaggerated that it requires a coudé, bi-coudé, or even a fully curved metal catheter to negotiate it. When one lateral lobe becomes enlarged predominantly, lateral distortion of the prostatic urethra occurs.

**On the Bladder.**—The musculature of the bladder hypertrophies to overcome the obstruction. When viewed from within, bands of muscle fibres can be seen standing out—*trabeculation* (fig. 1109). Between these



FIG. 1109.—Trabeculation of the bladder from prostatic obstruction. (The late Professor K. A. L. Aschoff, Freiburg.)

As the prostate enlarges extravasically, it tends to displace the seminal vesicles, so that instead of lying on the base of the bladder, these structures become a direct posterior relation of the upper limit of the



hypertrophied bundles there are shallow depressions—potential diverticula—but because they are shallow the process is termed *sacculation*. Occasionally one of the saccules (rarely two or more) continues to enlarge, and forms a true diverticulum.

When the middle lobe projects upwards into the bladder it acts as a dam to the last ounce or more of urine, which remains in the post-prostatic pouch (see fig. 1105). Calculi (fig. 1110) are prone to form in this stagnant pool of residual urine.

The enlarged prostate may compress the prostatic venous plexus: the resulting congested veins (vesical ‘piles’) at the base of the bladder are apt to cause hæmaturia.

Unless the obstruction is relieved a time is reached when the tone of the vesical musculature wanes; muscular hypertrophy dwindles, and eventually gives place to atony, the tired muscle making no attempt to overcome the obstruction.

**On the Ureters and Kidneys.**—Increasing intravesical pressure, or perhaps in some cases direct pressure of the intravesical portion of the prostate on the ureteric orifices, causes gradual dilatation of the ureters, and hydro-ureters are followed by some degree of bilateral hydro-nephrosis. When decompensation of the bladder hypertrophy occurs, the sphincter mechanism around the ureteric orifices ceases to function, permitting reflux of urine from the bladder into the dilated ureters. Chronic interstitial nephritis with increasing damage to the renal parenchyma is a frequent accompaniment of the back-pressure effects of prostatic obstruction. As a result of ascending infection from the bladder, or more rarely from the bloodstream, acute or chronic pyelonephritis supervenes.

**On the Sexual Organs.**—In the early stages of prostatic enlargement there is increased libido. Later, impotence is the rule.

**Clinical Features.**—*Increased frequency* is the earliest symptom of an enlarged prostate. At first it is nocturnal, the patient being obliged to get up to micturate twice or more often during the night, usually commencing at 2 or 3 a.m. Frequent micturition at this stage is probably due to vesical introversion of the sensitive prostatic mucous membrane by the intravesical enlargement of the prostate. The frequency becomes progressive, and is then present both by night and by day. When the vesical sphincter becomes stretched a little urine escapes into the normally empty prostatic urethra, causing an intense reflex desire to void, and *urgency* is added to the frequent necessity to micturate. Later, as residual urine increases, increased frequency becomes more and more in evidence, and there is terminal dribbling.

**Dysuria.**—The patient finds it useless to strain (cf. urethral stricture and fibrous prostate (pp. 876 and 846)). Rather, he must wait patiently,



FIG. 1110.—Calculi in a post-prostatic pouch behind the hypertrophied middle lobe of the prostate as viewed through the cystoscope. (After H. H. Young.)



with a relaxed abdomen, for the stream to start. When it does start, the stream, instead of being projected, tends to fall vertically.

*Pain* is absent, unless cystitis or acute retention of urine supervenes. When hydronephrosis commences there may be a dull pain in the loins. A feeling of weight in the perineum, or a fullness in the rectum, are occasional complaints.

*Acute retention of urine* is sometimes the first symptom to impel the patient to seek relief because of the intense pain it produces. The postponement of micturition is a common precipitating cause, as also is indulgence in alcoholic liquors, particularly when he goes out of doors on a cold night; as congestion of internal organs then tends to occur. Confinement to bed on account of some intercurrent illness is also a cause of acute retention of urine.



FIG. 1111.—Retention with overflow. The patient's only complaint was that he 'wet his trousers.' Note the overfull bladder.

*Retention with Overflow.*—The patient comes complaining that urine is constantly dribbling away. It is exceptional for him to have noticed the swelling caused by the distended bladder and he experiences no pain (fig. 1111).

*Hæmaturia.*—A drop of blood at the beginning or end of micturition is not unusual in this condition. Occasionally alarming hæmaturia occurs from a ruptured varicose vein at the base of the bladder or from an erosion on the enlarged prostate itself. Incrimination of an enlarged prostate as the source of the bleeding before excluding other causes has resulted in the term 'decoy' prostate.

*Renal Insufficiency.*—The patient presents himself with one or more of the signs of renal failure (see p. 718).

*Examination.*—When possible, the act of micturition should be watched. Loss of projectile power is significant. The urine is passed into two glasses; mere inspection of it is of some service. It is later

examined chemically, and if not crystal clear, a mid-stream specimen is sent for bacteriological examination.

The patient then lies on a couch and the abdomen is examined. In patients with a long history, varying degrees of chronic retention of urine will be found on palpation, percussion, and sometimes on inspection. The renal areas are palpated for tenderness and possible enlargement of the kidneys. The state of the tongue is noted; a dry brown tongue and a urine of low specific gravity is indicative of a considerable degree of renal insufficiency. The external urinary meatus is examined to exclude atresia meati, and the epididymes are palpated for signs of recent or remote inflammation.

*Rectal examination* is carried out in the knee-elbow position and, in the



absence of a full bladder, bimanually in the dorsal position. In benign enlargement affecting the lateral lobes, increase in their size is evident. They are smooth, convex, and typically elastic, but because all grades of fibroadenomatosis occur, the fibrous element may give the prostate a firm consistency. The rectal wall can be made to move over the prostate. On bimanual palpation an intravesical lobe can sometimes be felt. By exerting pressure on the apex of the prostate by the finger in the rectum, it will be found that a gland which is the seat of benign enlargement possesses a limited degree of mobility. Residual urine in a post-prostatic pouch can sometimes be felt as a fluctuating swelling above the prostate. It should be noted that if there is a considerable amount of residual urine present, it pushes the prostate downwards and vitiates an estimation of the size of the organ, making it appear larger than it is.

*The nervous system* is examined by testing the reflexes and reactions of the pupils, to eliminate a neurogenic lesion. Tabes and disseminated sclerosis give symptoms similar to those of prostatic obstruction.

*The cardiovascular system* should be investigated by a physician before operative treatment is undertaken. At the preliminary examination the blood pressure is measured.

*Examination of the Blood.*—A blood urea estimation, a blood count, and a Wassermann reaction are all important, the first two being essential.

*Excretory pyelography* is omitted only if the patient shows clinical signs of renal failure, or if the blood urea estimation is high. It affords a great deal of information without resorting to instrumentation. It is an excellent test of renal function; it will exclude or confirm the presence of hydro-ureters and hydronephroses; a vesical diverticulum, if present, may be shown; if a film is taken after micturition, residual urine will be revealed. Sometimes an intravesical enlargement of the prostate is outlined by the medium. Nevertheless, complete reliance must not be placed on radiological evidence of residual urine—the patient quite frequently has difficulty in passing urine in the radiological department, especially if a female radiographer is nearby—this point must be ascertained and allowance made for it, if necessary.

A preliminary radiograph may show a renal calculus, or a stone in the bladder, or in a diverticulum thereof. Stones in a post-prostatic pouch are sometimes not evident until cystoscopy has been performed.

*Cysto-urethroscopy.*—When the rectal findings are negative, when a differential diagnosis must be made between urethral stricture and a fibrous prostate, or when there is a history of hæmaturia, urethroscopy and/or cysto-urethroscopy must be performed in order to make the diagnosis. When the diagnosis of prostatic enlargement can be established on clinical and radiological grounds, the investigation is unnecessary. Instrumentation should be avoided when the bladder is palpable above the pubes, and when there is considerable urinary infection which persists in spite of sulphonamide and antibiotic therapy. If cysto-urethroscopy is necessary to make or confirm the diagnosis, and there is no contraindication to instrumentation, it is best performed as an immediate preliminary to operation, if operation is found advisable.



The patient having been instructed to empty his bladder just prior to the examination, the amount of residual urine present in the bladder is measured

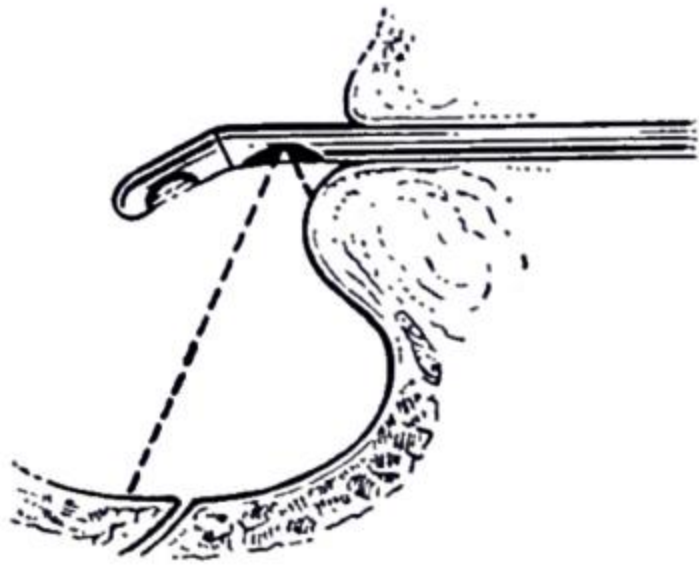


FIG. 1112.—Marion's sign.

after the instrument has been passed and its obturator withdrawn. After irrigation, if necessary, the bladder is distended. The bladder is first examined. Trabeculation and sacculation is the significant finding. The presence of cystitis will have been anticipated by the examination of the urine. Normally the posterior edge of the internal urinary meatus and a ureteric orifice cannot both be seen in the same cystoscopic field. In cases of moderate enlargement of the

middle lobe this becomes possible (Marion's sign, fig. 1112). Should the intravesical projection be considerable the ureteric orifices and the inter-ureteric bar are hidden completely beneath the prostatic shelf.

#### HORMONE TREATMENT

Although contrary to accepted theory, treatment with female hormones has given good results in comparatively early cases. Employing diethylstilbœstrol, two 0.5 mg. tablets t.d.s., 50 per cent. of patients show decreased residual urine within a month. In 35 per cent. of cases cystitis disappears without other treatment.

#### INDICATIONS AND PREPARATION FOR PROSTATECTOMY

When increased frequency seriously interferes with sleep and rectal examination reveals an enlarged prostate, and/or should cystoscopy be indicated (e.g. middle lobe enlargement only) 3 or more ounces of residual urine is recovered; if there are no contraindications, prostatectomy is usually advised. Acute and acute-on-chronic retention of urine, or retention-with-overflow, are frequent reasons for surgical intervention.

*In cases of acute retention of urine*, a few surgeons carry out prostatectomy within six hours of admission, provided the general condition is good, the blood urea estimation does not exceed 60 or at the most 70 mg. per cent., and there is no obvious urinary infection. In order to relieve the pain and to obtain the necessary information concerning the state of the urine, a urethral catheter must be passed or, as some prefer, suprapubic puncture with a hollow needle is performed. A much larger number of surgeons, having relieved the acute retention by catheterisation, postpone the operation for at least forty-eight hours; indeed, in some cases after the retention has been relieved spontaneous micturition recommences, perhaps rendering operation in the near future unnecessary.

*In cases of chronic retention of urine and retention-with-overflow.* So vulnerable are the urinary passages to infection that in these conditions the aim is to avoid urethral catheterisation altogether. If the renal function tests are satisfactory, which is sometimes the case in the first of the groups under consideration, operation can be undertaken without decompressing the bladder. In other circumstances the bladder should be decompressed slowly, as described on p. 795, either suprapubically or via a perineal ure-



throstomy, which minimises urethritis from an indwelling catheter and leaves the suprapubic region unscarred for prostatectomy (J. G. Sandrey).

*In patients unfit for prostatectomy* on account of persistent urinary infection, affections of the myocardium, or considerable hyperpiesis, it may be advisable to perform suprapubic catheterisation in order to help to improve the general condition by circumventing the effects of prostatic obstruction.

After decompression has been carried out the suprapubic or perineal catheter is connected to a sterile bottle until the general condition has improved and renal function tests are satisfactory. During this interval the patient should receive a high fluid intake (6 pints (3.5 litres) per diem), an alkaline mixture and, when necessary, a course of sulphonamide or antibiotic therapy. Many patients can be rendered fit for prostatectomy within fourteen days; others require a longer period. If, after three weeks, the tests are still unsatisfactory, the patient can be fitted with a suprapubic belt, the catheter of which is changed at fortnightly intervals until he is deemed fit to undergo prostatectomy.

**Special complications:** (a) *Severe hæmaturia or clot retention* calls for suprapubic cystostomy. It happens rarely that the bleeding continues at the time of the cystostomy, when immediate prostatectomy is the best means of controlling the hæmorrhage. In most cases the bleeding ceases after the bladder has been drained, and this affords time to get the patient into the best possible condition for removal of the prostate.

(b) *When an infected vesical diverticulum is also present* diverticulectomy (see p. 809) should be performed. Only after the infection has been controlled completely should prostatectomy be carried out.

#### OPERATIVE TREATMENT

Until the commencement of the present century the accepted treatment of prostatic obstruction was a catheter-life. The patient passed the instrument himself, often lubricating it with saliva. The more affluent sufferers carried their catheter in their top hat. Nearly 20 per cent. of all sufferers died within three months. Some of the remainder acquired partial immunity to recurring bouts of infection.

**Preliminary Vasectomy.**—In all the operations about to be described, bilateral vasectomy (dividing the vasa deferentia) is advisable. It prevents infection from the prostatic bed spreading to the seminal vesicles and the epididymes. This minor additional procedure can be undertaken as a preliminary step, or at the conclusion of prostatectomy.

**Technique.**—Through a small incision over each superficial abdominal ring the vasa deferens is isolated from the spermatic cord, and divided. The lower (testicular) end is allowed to drop back into the wound. The upper (vesicular) end is brought through the skin, and fixed there by a stitch, and the edges of the wound are approximated.

Exteriorisation of the vesicular end avoids the formation of a subcutaneous abscess should vesiculitis supervene.

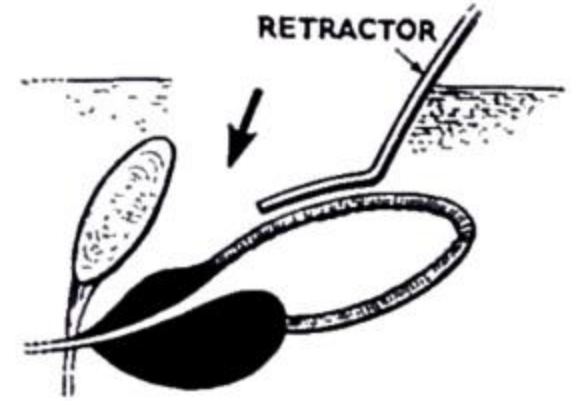
**Freyer's operation** is still employed, usually in cases where preliminary suprapubic drainage has been necessary and a patient with an enlarged prostate is unfit for a more prolonged operation. The operation is carried out blindly through a 2-inch (5-cm.) suprapubic incision. The adenomatous tissue is enucleated with the finger. All operations of digital enucleation of the prostate should commence from below upwards at the apices of the lateral lobes, continue from above downwards behind the middle lobe, and finish in front of the anterior commissure. As a rule hæmorrhage is not as copious as that encountered during a one-stage operation

*John Gordon Sandrey, Contemporary. Surgeon, St. Peter's Hospital for Stone, London.*  
*Sir Peter Freyer, 1889-1921. Indian Medical Service, Later Surgeon, St. Peter's Hospital, London.*



because, as a result of draining the bladder, periprostatic congestion is diminished, and warm irrigations are sufficient to arrest the bleeding. When considerable hæmorrhage persists the prostatic cavity is packed, preferably with gelfoam or oxycel. The bladder and the abdominal wall are closed around a large rubber tube, and a drain is placed in the prevesical space. After five days the tube is removed and some form of suprapubic box is worn until the wound heals, which takes about sixteen days.

**Retropubic Prostatectomy (Millin).**—A transverse incision is made through the skin a finger's breadth above the pubic bones. The aponeurosis is incised in the line of the skin incision and the underlying recti abdominis muscles are separated in the middle line, exposing the prevesical fat, which is displaced upwards with the finger. A self-retaining retractor is introduced, the upper blade of which depresses the bladder, thus bringing the prostate into view, viz. —————→



Any large veins that are seen traversing the anterior surface of the gland are divided between hæmostats and sealed by touching the hæmostat with a diathermy needle. Using a boomerang needle (fig. 1113) and a ligature carrier (fig. 1114), two stay sutures are passed through the capsule of the prostate above and below the proposed

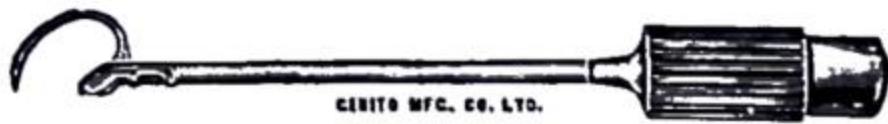


FIG. 1113.—A boomerang needle.

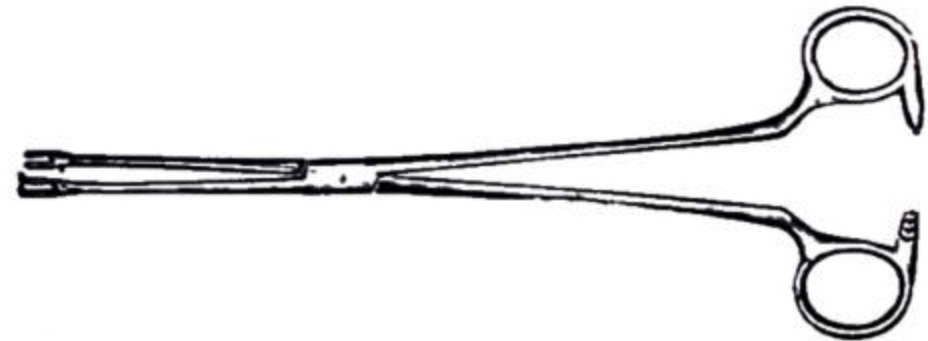


FIG. 1114.—Harris's ligature carrier.

line of incision. Holding these stay sutures taut, a transverse incision is made through the prostatic capsule (fig. 1115A), displaying the pearly white enlarged

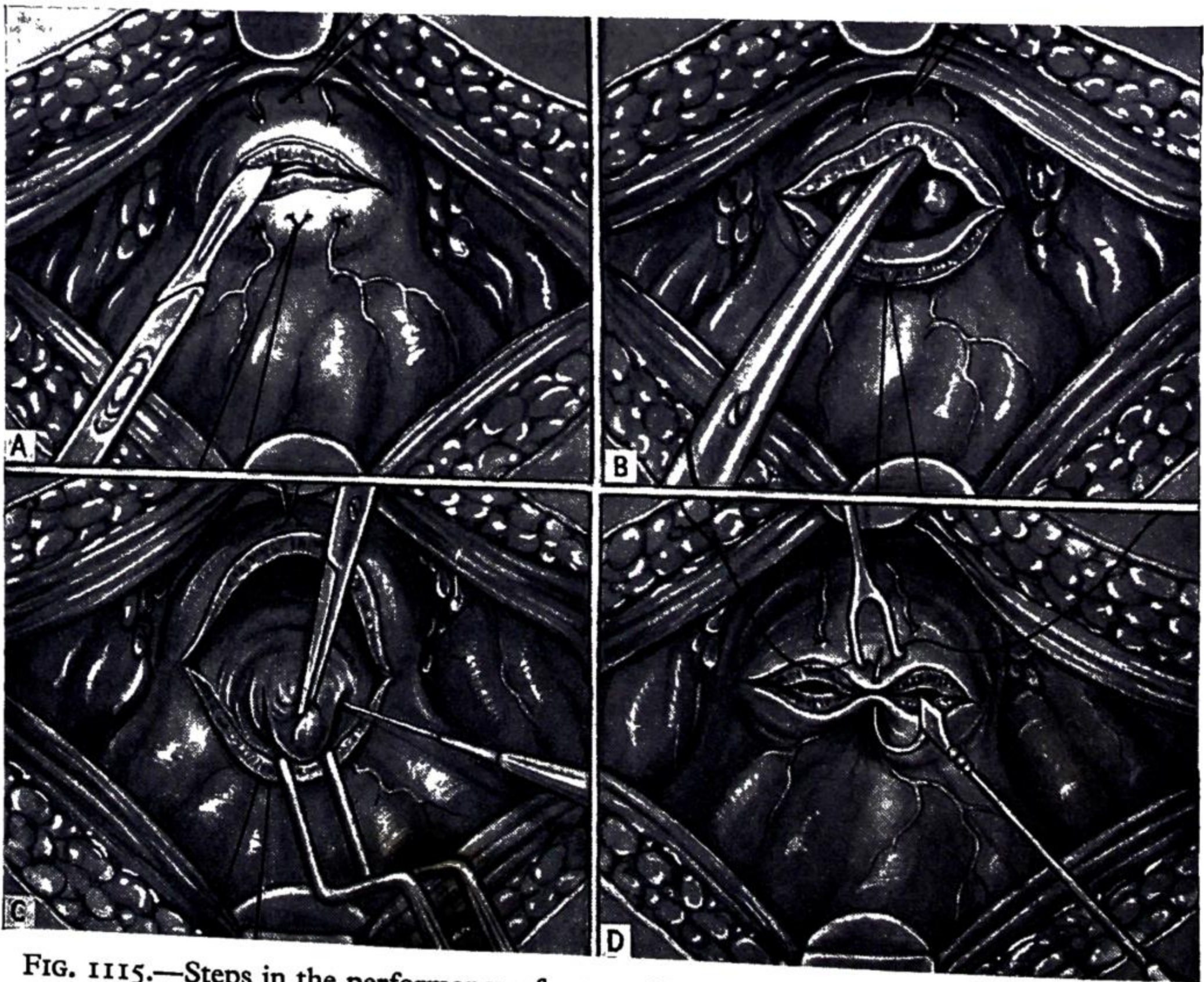


FIG. 1115.—Steps in the performance of retropubic prostatectomy. (After J. D. Fergusson.)

Terence Millin, *Contemporary Surgeon, All Saints Hospital, London.*  
S. Harry Harris, 1881-1937. *Urologist, Lewisham Hospital, Sydney, Australia.*



gland. After freeing the amalgamated true and false capsules (see p. 834) from the contained adenomatous tissue with blunt-pointed scissors (fig. 1115 B), the retractor is removed temporarily, and the adenomatous mass is enucleated with the finger. Profuse bleeding ensues. The cavity is packed with gauze, after which the retractor is replaced. The pack having been removed, the assistant introduces the nozzle of a sucker into the cavity to keep the field free from blood, while bleeding vessels are secured in hæmostats. Touching these with the diathermy needle soon stays the hæmorrhage. The prostatic bed is inspected carefully for loose tags which, if present, are removed with scissors. Next a deep wedge of the anterior lip of the internal urinary meatus is excised (fig. 1115 C), with the object of preventing post-prostatic stricture, which otherwise is liable to occur. This completed, a Foley's catheter is passed along the urethra and its tip guided into the bladder. Employing a boomerang needle, after inserting a central fixation stitch (fig. 1115 D), the edges of the whole thickness of the opening in the prostatic capsule are approximated with a continuous suture of No. 1 plain catgut. At this juncture the balloon of the Foley's catheter is distended. A small stab incision is made in the lower skin flap through which a rubber tube is directed into the prevesical space. The abdominal wall is then repaired. Before the patient leaves the operating theatre the interior of the bladder is irrigated with warm normal saline solution until all clots have been evacuated and bleeding has ceased. The catheter is then spigoted. On return to bed, the end of the catheter is connected by means of tubing to a sterile water-sealed bottle.

**Wilson Hey's Operation.**—The bladder is opened by an ample suprapubic incision. A Tiemann's catheter is passed from the bladder to the external urinary meatus, where the tip is clipped in a hæmostat by an assistant; retrograde catheterisation avoids introducing infection from the urethra. A mechanical retractor having been inserted, the mucous membrane over the vesical aspect of the prostate is incised with a diathermy needle around the proposed line of enucleation. The prostate is then enucleated as in Freyer's operation. The enucleated portions of the prostate are picked up with sponge-holding forceps, and if one or more remains attached to the urethra, the connecting tissue is severed with the diathermy needle. Cuts are made through the mucosa of the bladder at 3 and 9 o'clock, on the rim of the prostatic cavity, viz. —————→ the better to display the circular muscle of the internal sphincter, which is divided delicately. (The rationale of dividing the sphincter in two places is to prevent post-operative contracture of the bladder neck.) The posterior part of the rim falls back, and the whole of the cavity can be seen clearly. Up



FIG. 1116.—Insulated hæmostat (Riches' pattern).

to this stage visible bleeding vessels are sealed by applying forcipressure with an insulated hæmostat (fig. 1116) connected to a diathermy. Sealing of blood-vessels is continued until the prostatic bed is dry. Loose tags are removed with scissors. The butt end of a Harris's catheter is

attached inside the bell of the Tiemann's catheter by a stitch, and an assistant draws the Tiemann's catheter out until the Harris's catheter appears at the meatus. The prostatic cavity is packed with gelfoam, reinforced with a piece of oxycel. The bladder and the abdominal wall are closed with drainage of the prevesical space, and the remaining steps are similar to that of the retropubic operation.

**Transurethral resection of the prostate** is indicated particularly in obstruction due to an enlarged middle lobe, a fibrous prostate, or a median bar. Preliminary drainage by an indwelling catheter or a suprapubic tube may be required, and the adequacy of renal function and freedom from gross infection is just as necessary in this form of operation as in the open method.

**McCarthy's resectoscope** (fig. 1117) is the instrument most often employed. The operation is preceded by cystoscopy, unless this has been performed already, and it is often the cystoscopic findings that deter-



FIG. 1117.—McCarthy's endoscopic prostatic resector.

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Sir Eric Riches, Contemporary. Surgeon and Urologist, The Middlesex Hospital, London.  
Joseph F. McCarthy, Contemporary. Urologist, Post-graduate Hospital, New York.*



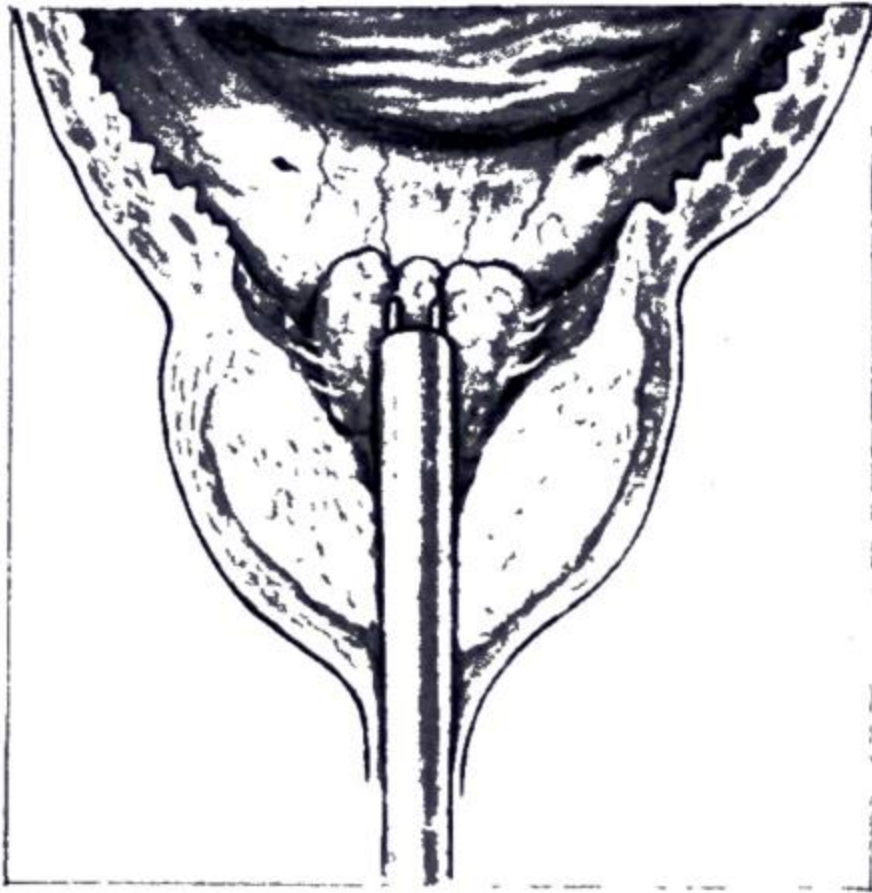


FIG. 1118.—Transurethral resection showing the loop commencing to remove a strip from the middle lobe of the prostate. (After R. M. Nesbit.)

mine whether resection or open operation is the more desirable procedure. The resectoscope is passed with the patient in the lithotomy position. The larger of the two sheaths, with its obturator, is introduced into the urethra. If it fails to pass easily, the smaller is substituted. When the anterior urethra is narrow or strictured, perineal urethrostomy is sometimes required in order to admit the instrument. The obturator is removed and the bladder is irrigated with sterile water. The carrier, with its telescope lamp and electrode, is passed down the sheath, the cutting loop being in the retracted position. The irrigation inlet is connected to a reservoir of sterile water, and the outlet with a pail. The obstructing area of prostate having been located, the loop is advanced beyond it into the cavity of the distended bladder. With the cutting current switched on, the loop is slowly withdrawn through the obstructing tissue (fig. 1118) by rotating the pinion handle. On

completing the cut, the current is switched off and the inlet is closed. The carrier is removed and the contents of the bladder received into a kidney dish. The strip of tissue excised will either be adherent to the end of the loop, or it will be swept out in the water. The process is repeated (fig. 1119) until sufficient prostatic tissue has been removed, or bleeding becomes troublesome. Each strip must be retrieved and accounted for. Hæmostasis is effected, after substituting a ball electrode for the cutting loop and a coagulating for a cutting current, by touching bleeding-points with the ball. When sufficient of the middle lobe has been removed, the operator should be able to look into the bladder when the telescope in the posterior urethra is at the level of the verumontanum. When necessary, strips are cut from the lateral lobes, but here the cutting loop should not transgress the margin of the bladder outlet. After sufficient tissue has been resected the bladder is inspected for fragments of prostatic tissue which, when present, can be removed by means of a Bigelow's evacuator or a special similar type of instrument that can be fitted to the sheath of the resectoscope. The operation is concluded by inserting a Foley's catheter which has the advantage that it is self-retaining and, if gentle traction is exerted on the catheter, the balloon is of some hæmostatic value. The post-operative treatment resembles that of other operations upon the prostate which rely entirely upon a urethral catheter for drainage. The catheter is removed about the fourth day.

**Punch Prostatectomy.**—The Thompson punch is a direct-vision cystourethroscope containing a tubular knife which can be moved back and forth, the sheath having a fenestrum near the distal end of the opposite side of the beak. When the tubular knife is in the forward position it closes the fenestrum. The instrument is passed and the bladder neck and the prostatic urethra are examined. When the tubular knife is drawn back, obstructing tissue at the bladder neck or in the prostatic urethra will project into the fenestrum (fig. 1120). The knife is advanced and the

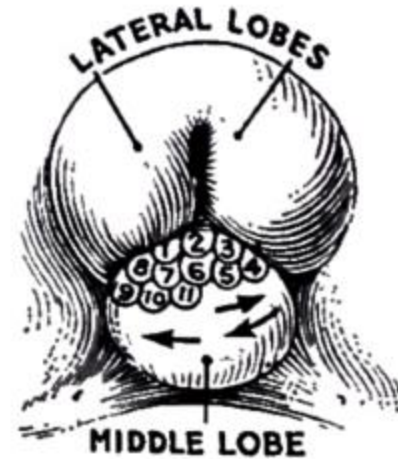


FIG. 1119.—Transvesical view showing the order in which strips are removed (middle lobe). (After R. W. Barnes.)



FIG. 1120.—Punch prostatectomy. The fenestrum engaging the tissue of the middle lobe.

tissue engaged is cut from before backwards. This cylinder of prostatic tissue is washed into the bladder, and from thence out of the wide irrigation outlet. Bleeding is controlled by introducing a diathermy electrode along the channel for it contained

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Gershom Joseph Thompson, Contemporary. Head of Urology Section, Mayo Clinic, Rochester, U.S.A.



in the sheath of the instrument. An advantage of this method is that there is less necrotic tissue left behind than when the excavation is performed by a cutting current.

**After-treatment** in all operations of prostatectomy includes a high fluid intake and a course of alkalis, sulphonamide, and, if necessary, an antibiotic.

#### COMPLICATIONS OF PROSTATECTOMY

**Hæmorrhage.**—The loss of blood during and in the immediate post-operative period may be considerable; consequently the blood of all patients about to undergo prostatectomy should be grouped and arrangements made whereby suitable donor blood is available. When there has been sufficient loss of blood to cause a considerable fall in blood pressure, either during the operation or later, blood transfusion should be carried out. If secondary hæmorrhage due to infection of the prostatic bed occurs, it usually does so between the sixth and twelfth post-operative days, and may also call for blood transfusion. The local management of post-operative hæmorrhage differs in the various operations. In all, the foot of the bed is raised and an injection of morphia or omnopon is given. In operations which depend entirely on a urethral catheter for drainage, irrigations of 3·8 per cent. sodium citrate solution by means of a 2-oz. (60-ml.) rubber bulb syringe are undertaken should the catheter become blocked with clot. If this does not dislodge the clot, injection of the solution with, and suction by, a more powerful bladder syringe is employed. Should these means fail, the patient must be taken to the operating theatre, where, under anæsthesia, after removing the urethral catheter, all clots can be cleared from the bladder by means of a Bigelow's evacuator (see p. 805). In a few cases where the patient's general condition is poor, it is more expeditious to perform suprapubic cystostomy. After clots have been evacuated, bleeding usually ceases with irrigation. If, however, the bladder washes remain highly blood-stained, the prostatic cavity must be packed, preferably with gelfoam, followed by a piece of oxycel. In the more persistent, but less precipitant, forms of hæmorrhage, the passage of a Foley's catheter, which is strapped to the thigh after the balloon has been inflated, often effects hæmostasis by pressure on the prostatic bed. Irrigations of warm saline solution should be continued until they are returned almost clear.

When hæmorrhage is considerable after transurethral resection of the prostate and the bladder becomes full of clots that cannot be dislodged by a syringe, the patient is anæsthetised in the operating theatre, and after removing clots with an evacuator the resectoscope, furnished with its electrode, can be inserted and bleeding-points in the prostatic bed coagulated.

**Infection.**—The routine employment of sulphonamide and appropriate antibiotic therapy before operation and during the post-operative treatment has considerably reduced complications consequent upon infection of the prostatic bed, although they still occur, especially if blood-clot is permitted to collect there.

**Epididymitis.**—Division of the vasa deferentia at prostatectomy almost eliminates post-operative epididymitis, but a localised inflammation of the spermatic cord or a small abscess at the site of the division sometimes occurs.

**Acute Pyelonephritis.**—Ascending pyelonephritis can often be combated by streptomycin, but bilateral infection occurring in the presence of kidneys already the seat of some degree of hydronephrosis is always most serious.

**Renal Failure.**—Oliguria or anuria which does not respond to treatment, detailed in Chapter xxxi, is the most lethal complication of prostatectomy.

**Extraperitoneal perforation of the bladder** is an occasional accident during transurethral prostatectomy. The perforation occurs at the neck of the bladder, usually posteriorly on one or other side of the middle line, where the wall of the bladder is thin; the prostatic capsule, being tough, resists too deep resection. When the patient is under low spinal anæsthesia, immediately the perforation occurs he complains of great suprapubic pain, often radiating towards the epigastrium. Such symptoms appearing after the patient has regained consciousness from a general anæsthetic are more difficult to interpret. When perforation of the bladder is suspected, immediate suprapubic cystostomy and drainage of the prevesical space should be carried out. If this operation is delayed more than twelve hours, the prognosis becomes grave, except in a few instances when extravasation occurs slowly with the formation of an abscess in one inguinal region.

**Thrombosis and pulmonary embolism** are complications that merit most



serious consideration. If merely sitting out of bed is interpreted as 'early rising,' the disturbing frequency of these disappointing aftermaths are unlikely to diminish. Another problem is that anticoagulant therapy cannot be administered with safety until all danger of hæmorrhage from the prostatic bed has passed.

**Cardiac and respiratory complications** are prevented by suitable pre- and post-operative treatment, but they occur more frequently than in most other operations owing to the advanced age of many of the patients.

#### LATER COMPLICATIONS

**Osteitis pubis**, although rare, is a relatively frequent complication of retropubic prostatectomy; it also occurs occasionally after intrapelvic rupture of the urethra and after inguinal herniorrhaphy. It is probably due to pricking of the periosteum during the operation,<sup>1</sup> or to a spread of infection from the prevesical space. The



FIG. 1121.—Radiograph showing osteitis pubis following retropubic prostatectomy. (Mr. N. M. Matheson, Ashford, Middlesex.)

symptoms do not appear until two or more weeks after the operation. There is great pain over the pubes, radiating to the buttocks and down the inner side of the thighs, with inability to walk more than a few steps owing to agonising spasmodic contractions of the adductor muscles. Tenderness is present over the pubic bones, and often over the tubera ischii. Radiography shows irregular rarefaction of the ischio-pubic rami (fig. 1121) and widening of the symphysis; these changes appear only after the symptoms have persisted for about three weeks. This exceedingly painful state continues for many weeks.

Spontaneous cure with recalcification of the rarefied bone and bony ankylosis of the symphysis occurs after several months. Vitamin B in large doses hastens resolution, and cortisone 50 mg. for two days and then 25 mg. for twelve days relieves the pain in some cases; X-ray therapy is beneficial.

**Post-operative stricture** of the prostatic bed is a troublesome complication that is less frequent after modern operation than it was when Freyer's operation was practised widely. Dilatation must be carried out regularly. More common now are strictures of the anterior urethra following the passage of a wide-bore resectoscope or punch.

#### CONTRACTURE OF THE BLADDER NECK

Several names have been given to this condition—median bar obstruction, fibrous prostate, *prostatisme sans prostate*, and Marion's disease are all in current use. Because the condition occurs in children of both sexes, and in women as well as men, the term contracture of the bladder neck is all-embracing.

**Ætiology.**—While there is a comparatively rare congenital form that produces symptoms in childhood and youth, the great majority of cases are an aftermath of chronic prostatitis in men and urethro-trigonitis in women. At least 25 per cent. of cases of prostatic obstruction are due to this cause.

**Pathology.**—The glandular and muscular tissues of the prostate become infiltrated with fibrous tissue, which ultimately replaces them, the sphincter vesicæ being involved in the process. In a few cases the middle lobe of the prostate is especially affected, and stretching across the dorsal aspect of the internal urinary meatus, and obstructing it, there is a bar or dam composed

<sup>1</sup> A number of examples of osteitis pubis following inguinal herniorrhaphy have been reported recently.



of fibrous tissue covered by the epithelial lining of the bladder. As a rule, in either sex contracture of the bladder neck (fig. 1122) is circumferential. The musculature of the trigone is much hypertrophied from endeavouring to open the vesical orifice and often there is a deep pouch behind the inter-ureteric ridge. Atony of the vesical musculature as a result of chronic distension of the bladder is commonplace in long-standing cases.

**Clinical Features.**—The symptoms are similar to those of prostatic enlargement, and often by the time the patient presents there is a large amount of residual urine. Points of dissimilarity are (a) there is sometimes a history of prostatitis for which the patient has received treatment; (b) straining helps to expel the urine, and as a consequence an inguinal hernia of recent origin is sometimes an additional or even the main complaint; (c) hæmaturia is rare.

Patients with an acquired contracture of the bladder neck are on an average somewhat younger than those with benign prostatic enlargement, for the symptoms date back before the fiftieth year.

**Rectal Examination.**—The prostate is either normal in size or smaller than normal. In an average case it is distinctly harder than normal, and more fixed. When, as is sometimes the case, the prostate feels very hard, the differential diagnosis between a fibrous prostate and carcinoma is impossible without several of the aids described under carcinoma of the prostate. Tuberculosis of the prostate must also be ruled out, especially in patients between the ages of twenty and forty years.

**Cysto-urethroscopy** is essential in order to confirm the diagnosis and distinguish the condition from stricture of the urethra. It may be necessary to dilate the urethra with metal bougies before the cysto-urethroscope can be passed. The changes in the bladder wall are in all respects similar to those seen in prostatic enlargement. The walls of the prostatic urethra do not fall apart when the irrigation is turned on, and the internal urinary meatus does not expand. *Contracture of the bladder neck is the most common cause of a diverticulum of the bladder* (see p. 807).

#### **Treatment:**

**Dilatation.**—Minor degrees of the condition sometimes respond satisfactorily to intermittent dilatation by bougies and treatment of the chronic prostatitis, if it is still active. With this exception, operation is always needed.

**Transurethral resection** is practised widely for this condition. The immediate results are brilliant, but early relapses so often follow, especially

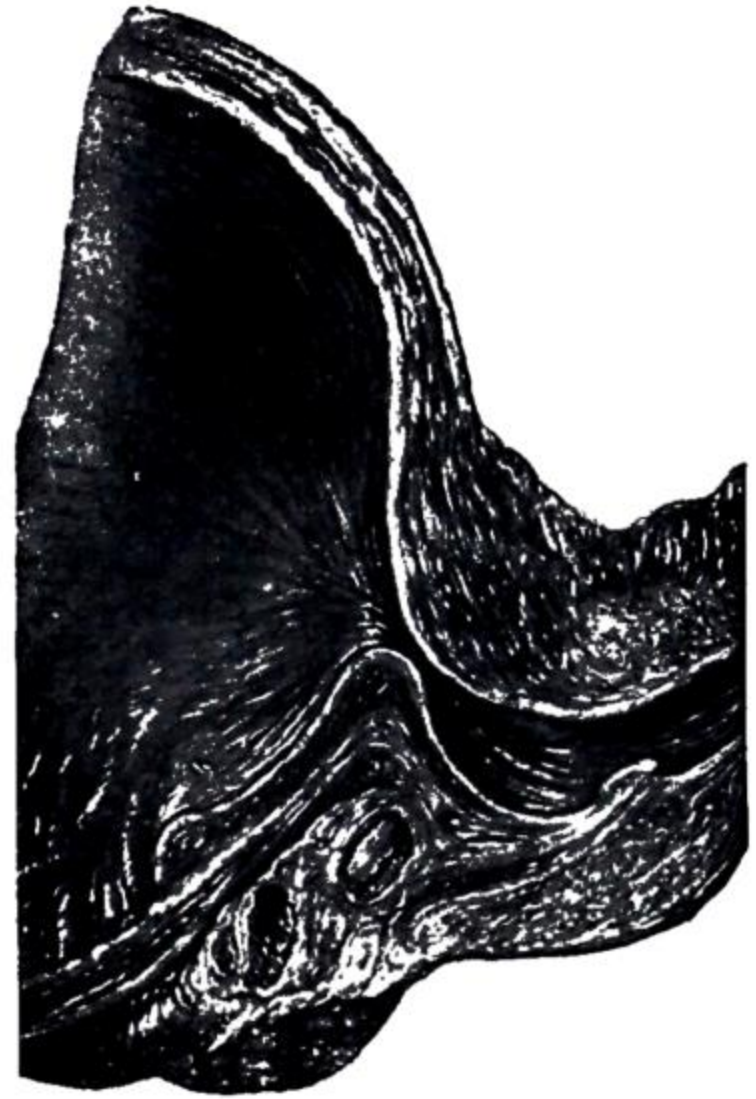


FIG. 1122.—Contracture of the bladder neck causing 'prostatic' obstruction. (After H. H. Young.)



in women, that opinion is veering to open operation unless the patient's general condition is parlous.

*Open Operation.*—The principle of open operative treatment, like that of Johanson's operation for urethral stricture (see p. 880), is to establish in the strictured portion of the canal one part of the circumference that is non-fibrotic and pliant.

*Sphincteroplasty* is conducted through a retropubic incision.

**Bonnin's operation** is suitable for adult male patients. A V-shaped flap in the bladder (muscle and mucosa) is introduced into the anterior aspect of the vesical outlet, and the steps of the operation are shown in fig. 1123. When severe vesical

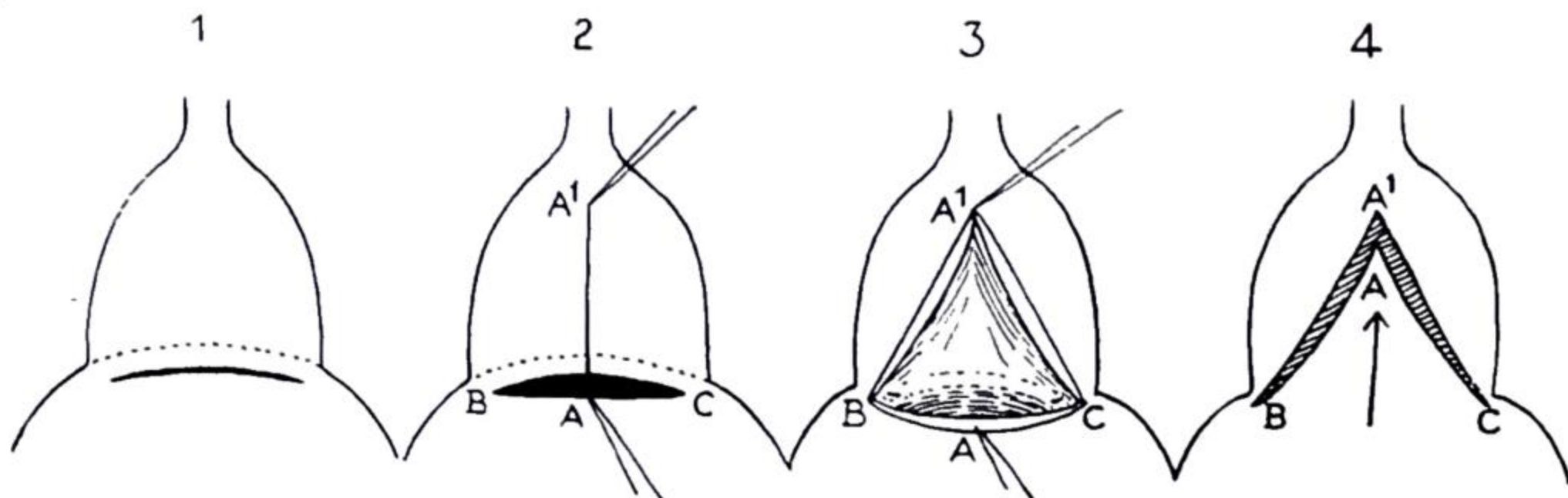


FIG. 1123.—Bonnin's operation for contracture of the bladder neck in the male.

atony is present, which is usual in cases of some standing, it is desirable to resect a large portion of the bladder. This is accomplished by mobilising the antero-superior aspect of the bladder before incising it. To have the viscus well distended is most important. The transverse incision shown in fig. 1123 (1) is extended upwards and outwards on each side to effect resection of as much of the antero-superior wall of the bladder as is deemed necessary, viz. —————→

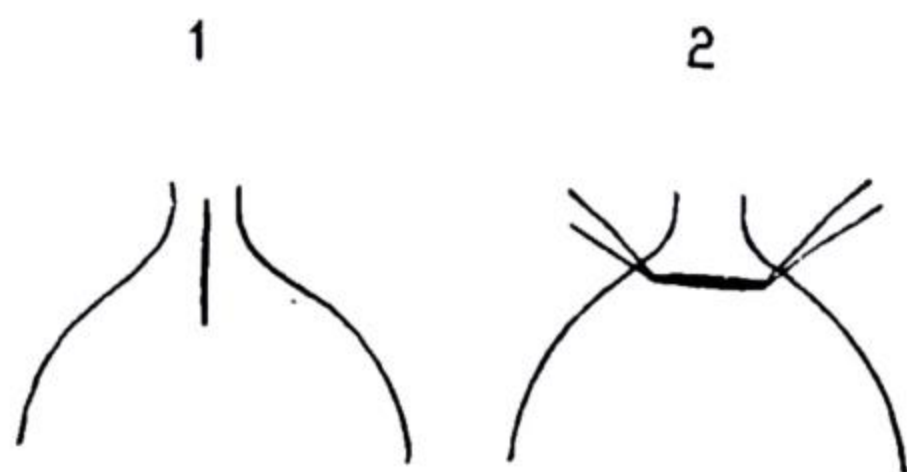


FIG. 1124.—Vesical sphincteroplasty in the female.

urethra, which is sewn up transversely (fig. 1124), gives excellent results.

**In children** of both sexes the same operation as in women gives good results, and allows excision of obstructing valves, if such be present.

**Congenital Valves of the Prostatic Urethra** (see p. 866).

PROSTATIC CALCULI < Endogenous  
Exogenous

**Corpora amylacea** are found in the prostates of elderly men and apes, but not in the prostates of animals lower in the phylogenetic scale than anthropoids. Corpora amylacea occur also in the homologue of the prostate—the tubules of the bladder neck of women (Skene's tubules). So common in the prostates of dissecting-room subjects are corpora amylacea that they are described in most works on human anatomy. In spite of this, they should be looked upon as pathological. These bodies consist of amorphous debris and desquamated epithelium. Often an intact epithelial wall of a prostatic duct forms their outer coat. They are always deeply pigmented, and are variously described as like poppy seeds, black pepper, or coal dust. Neither the composition nor the origin of the pigment is known. Probably corpora amylacea are the forerunners of endogenous prostatic calculi.

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Prostatic calculi are of two varieties—endogenous, which are fairly common, and exogenous, which are comparatively rare.

*Endogenous* prostatic calculi (they are always multiple) are those formed within the prostate. An *exogenous* prostatic calculus (always single) is a urinary (commonly ureteric) calculus that becomes arrested in the prostatic urethra. The latter is considered on p. 883.

Endogenous prostatic calculi, which are usually composed of calcium phosphate combined with about 20 per cent. of organic material, cast a well-defined radiological shadow (fig. 1125). Various clinical types are encountered:

1. **Symptomless.**—Calcified corpora amyloacea occur in an otherwise normal prostate, and are common in men over forty years of age. The stones, which are small and not, as a rule, very numerous, are discovered on radiography, often for a non-urological condition.

2. **Incidental.**—Small prostatic calculi are sometimes encountered during prostatectomy for an enlarged prostate. Usually, but not invariably, they can be seen in a preliminary radiograph. Such calculi are situated between the surgical capsule and the pseudo-adenomatous portion that is enucleated.

3. **Associated with Chronic Prostatitis** (*syn.* Calculous Prostatitis).—The severity of the symptoms varies greatly. At first they are those of chronic prostatitis. The stones are small and impalpable. Rarely they are seen in one or more of the mouths of the prostatic ducts during urethroscopy, or grating is experienced during the passage of a metal bougie.

4. **As a cause of Prostatic Obstruction.**—When the stones are numerous and larger they often replace the major part of the prostatic gland, which is the seat of fibrosis. The symptoms are then those of prostatic obstruction, and the patient is usually over fifty years of age. On rectal examination the stones are often felt as irregular, intensely hard nodules which are difficult to distinguish from carcinoma of the prostate, although in the latter condition the organ is likely to feel more fixed. On rare occasions crepitus makes the diagnosis certain at the clinical examination. On radiography these stones often form a horseshoe (see fig. 1125) or a circle. Calcification in a healed tuberculous prostate can simulate prostatic calculi. The past history with signs of treated epididymitis will eliminate the former. Occasionally a large solitary stone occurs, often at a comparatively early age, when it is the sequel of a cavity in the prostate produced by a prostatic abscess.

5. **Associated with Carcinoma of the Prostate.**—In 20 per cent. of cases prostatic calculi are associated with carcinoma of the prostate.

#### **Treatment of Prostatic Calculi:**

**Conservative Measures.**—When the calculi are small and the symptoms are mild, the treatment of chronic prostatitis by prostatic massage and a course

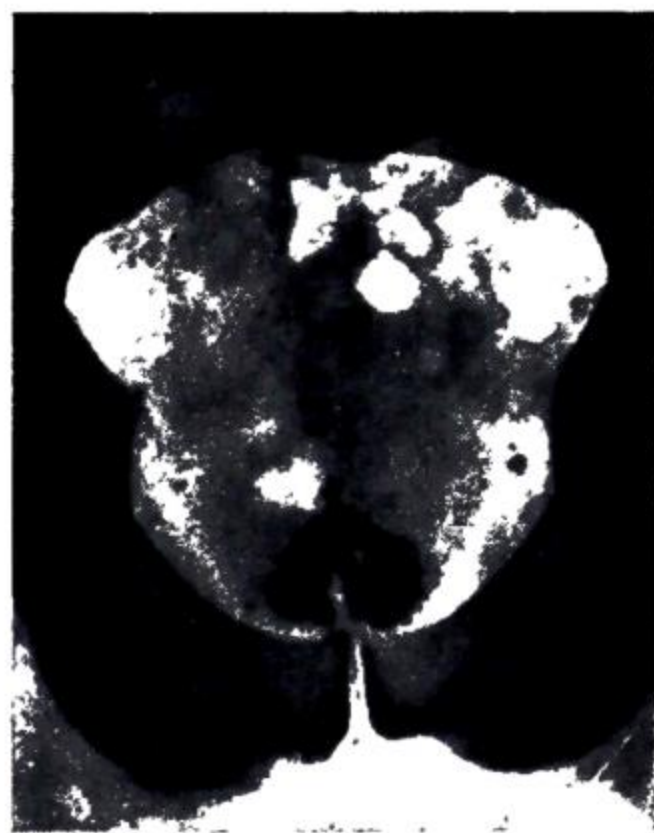


FIG. 1125. — Radiograph showing endogenous prostatic calculi.



of sulphonamide often keeps the patient free from symptoms for months at a time.

**Transurethral resection** of the fibrous prostate will release multiple small calculi as the strips of prostatic tissue are excised, and many more of them are removed by the irrigation inseparable from transurethral resection. Still others are passed per urethram at a later date.

When symptoms of prostatic obstruction are present, and a radiograph shows the prostate is riddled with stones, they can be removed either by the retropubic or the perineal route.

**Retropubic Prostate-lithotomy.**—After incising the capsule of the prostate longitudinally, the incision is deepened until the prostatic urethra is opened. The urethral catheter, previously inserted, is withdrawn until its tip lies in the membranous urethra. Using a sharp curette, all the calculi and as much as possible of the infected prostatic tissue is removed. The bladder neck is then exposed, and a generous wedge of the posterior lip is resected with curved scissors. The operation is concluded in a manner similar to that of retropubic prostatectomy.

#### CARCINOMA OF THE PROSTATE

About 20 per cent. of cases of prostatic obstruction prove to be due to carcinoma, to which must be added a substantial number in whom the first and main symptoms are due to metastases. So it comes about that among white races the prostate as a site of primary carcinoma in the male is rivalled only by that of the alimentary canal and the lungs. During the past twenty years the incidence of carcinoma of the prostate has been increasing, which can be accounted for by the ageing population as well as by improved methods of diagnosis. Carcinoma of the prostate commences in one of the following ways :

- (a) In the posterior zone of the normal gland (see fig. 1104) ;
- (b) Diffusely in one or other normal lateral lobes ;
- (c) In association with benign enlargement.

Prostatectomy for benign enlargement of the gland confers little immunity to the subsequent development of carcinoma (see fig. 1104).

#### Pathology :

**Latent Carcinoma of the Prostate.**—Routine necropsy supplemented by serial sections of the prostate has revealed carcinoma in that organ in no less than 15 per cent. of men over fifty years of age. True, many of these neoplasms are tiny and (if life had continued) might have remained dormant for years. This astounding revelation is not the published work of one observer, but the result of repeated investigations on both sides of the Atlantic. In a series of subjects over ninety years of age, three-quarters of the prostates were thus involved (L. M. Franks). It seems, therefore, that not infrequently a seedling carcinoma is present in the prostate of an elderly man, awaiting favourable conditions to become active.

**Non-latent Carcinoma of the Prostate.**—Most often the carcinoma is spheroidal celled, with a varying degree of tubule formation, in which case the tumour is a slowly growing one. Greater malignancy is attributed to the anaplastic type of carcinoma, which manifests itself more aggressively than an adenocarcinoma. An adenocarcinoma, however, can change to the undifferentiated type (A. de la Peña).

**Local Spread.**—Commonly a growth commencing in the posterior zone of

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*Alfonso de la Peña, Contemporary. Professor of Urology, Madrid.*



*the gland* breaks through the anatomical prostatic capsule and is prevented (at least temporarily) from extending backwards by the strong fascia of Denonvilliers. Consequently it tends to grow upwards to involve the seminal vesicles. Further upward extension causes compression on the lower end of one (fig. 1126) or both ureters, the latter terminating in anuria. Carcinoma commencing in a lateral lobe involves the prostatic urethra early: in advanced cases the base of the bladder is invaded. In 11 per cent. of cases a carcinoma of the prostate implicates the rectum (C. C. Winter).

In some instances distant metastases occur while the primary growth is quite small.

**Spread by the blood-stream** occurs particularly to bones; indeed, the prostate is the most common site of origin for skeletal metastases, being followed in turn by the breasts, the thyroid gland, and the bronchial tree. The bones involved most frequently by metastases of carcinoma of the prostate are shown in fig. 1127. It should be noted that the rami of the pubis, the ischium, the ilium, the sacrum, and the lower lumbar vertebræ are particularly common sites. The frequent proximity of skeletal metastases to the primary growth

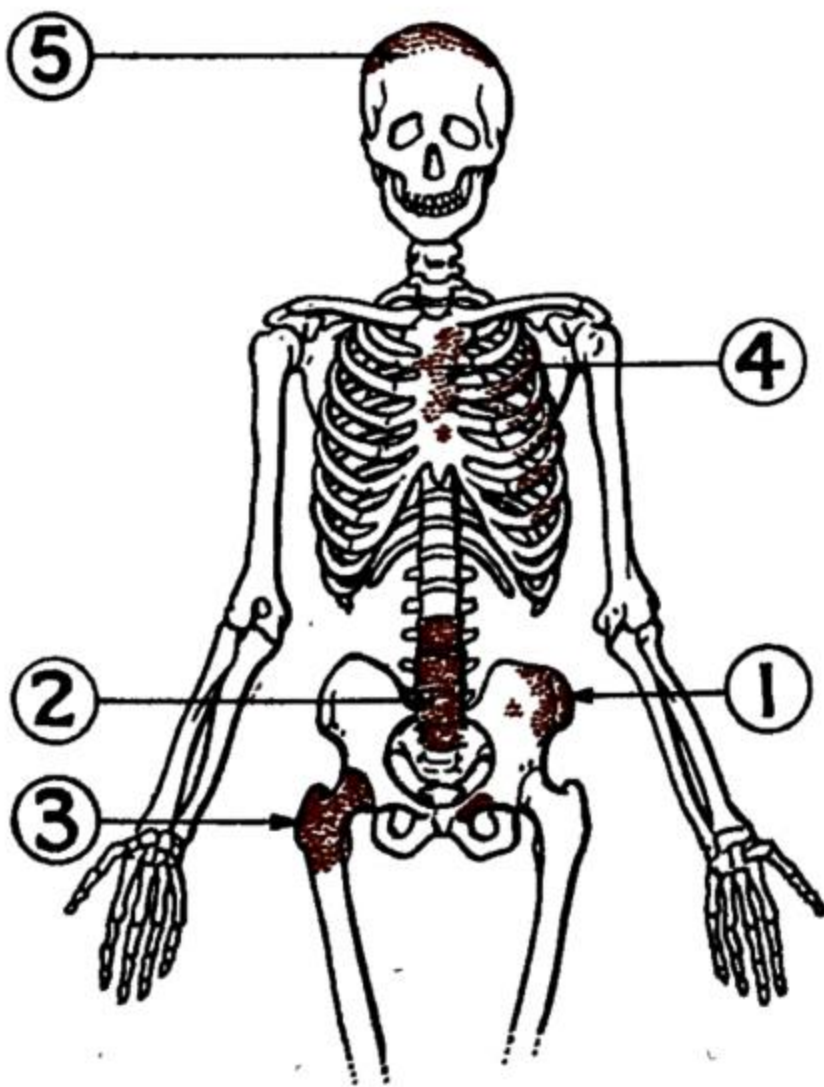


FIG. 1127.—Sites of location, in order of frequency, of metastases from carcinoma of the prostate in bones. (After Swift Joly.)

has been attributed to reversed flow from the vesical venous plexus to the emissary veins of the pelvic bones during coughing, sneezing, etc.

Occasionally prostatic carcinoma gives rise to metastases in the skin (see fig. 1134). In late cases the lungs, the liver, the kidneys, and the brain are involved, in that order of frequency.

**Lymphatic Spread.**—(a) *Via* lymphatic vessels passing along the sides of the rectum to the lymph nodes along the internal iliac vein and in the hollow of the sacrum. These nodes lie in close association with the sacral nerve plexuses. (b) *Via* lymphatics which pass over the seminal vesicles and follow the vas deferens for a short distance to drain into the nodes along

the external iliac vein. From both these situations the retroperitoneal nodes, and later the mediastinal nodes, and occasionally the supraclavicular nodes, become implicated. Only rarely are the inguinal nodes involved.

It is probable that metastases in the lumbar vertebræ are sometimes swept thither along the perineural lymphatic vessels.



FIG. 1126.—Carcinoma of the prostate implicating the right ureteric orifice. (W. A. T. Robb and P. M. Roemmele.) (British Journal of Urology.)



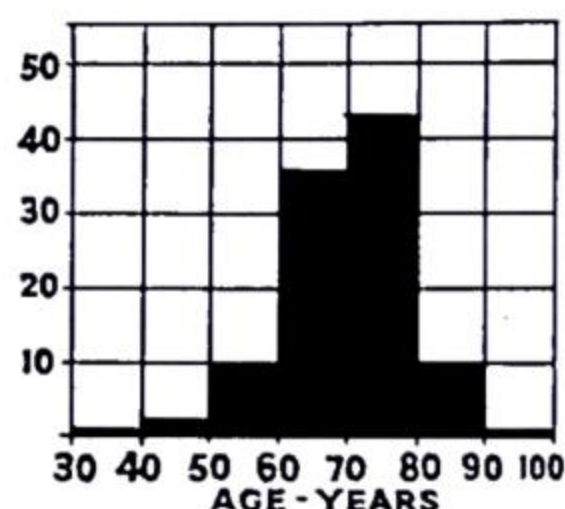


FIG. 1128.— Age incidence of patients with carcinoma of the prostate diagnosed clinically. (After L. M. Franks.)

**Clinical Features.**—In the majority of cases the patient is over fifty-five years of age (fig. 1128). More than half the patients present with acute or chronic retention of urine.

**Type 1. The Pathological.**—The symptoms and signs are identical with those of benign enlargement. At histological examination 2 to 5 per cent. of prostates removed in the belief that they were benign prove to contain one or more areas of carcinoma.

**Type 2. The Clinically Doubtful.**—In a number of instances the symptoms and signs are similar to those of benign enlargement or fibrous prostate, but as a rule the history is comparatively short (weeks not months). A hard nodule or increased fixation of the gland favours the diagnosis of carcinoma.

**Type 3. The Clinically Certain.**—The patient complains of pain in the perineum or suprapubic region, in addition to symptoms of prostatic obstruction. On rectal examination (see below) the findings may leave no doubt as to the diagnosis.

**Type 4. The Occult.**—Urinary symptoms are absent or slight. Pain in the back, or sciatica, is the main symptom. Bilateral sciatica in an elderly man is most often due to metastases from carcinoma of the prostate. Œdema of one or both legs, paraplegia, or a spontaneous fracture are occasionally due to metastases from a carcinoma of the prostate.

On account of destruction of bone marrow, bone metastases from carcinoma of the prostate can give rise to a hæmorrhagic diathesis, and the patient suffers hæmorrhage, often severe, not necessarily from the urinary tract.

**Rectal Examination.**—The only way to make an early diagnosis of carcinoma of the prostate is by a rectal examination. Irregular induration, characteristically stony hard, in a part or the whole of the gland with decreased mobility suggests carcinoma. Obliteration of the notch between the seminal vesicles, or of the groove between the lateral lobes, adds to the suspicion. If, in addition, the induration extends to one or more of the following situations, (a) beyond the lateral limits of the gland, causing obliteration of the lateral sulci, (b) to the lymphatics above and lateral to the seminal vesicles, or (c) to the membranous urethra, the diagnosis is certain. Prostatic calculi and calcareous changes secondary to tuberculosis of the seminal vesicles present the greatest difficulties in the diagnosis of prostatic carcinoma by rectal palpation alone.

**Radiological examination** to exclude or confirm the presence of prostatic calculi or pelvic and lumbar skeletal metastasis is always necessary. Whereas osseous metastases from carcinoma of other organs are usually osteolytic, producing a rarefied 'moth-eaten' appearance, those in the lower lumbar vertebræ and pelvic bones from a carcinoma of the prostate are typically osteoblastic, resulting in increased density of the bone (fig. 1129). However, osteolytic prostatic metastases do occur from time to time, and




must be distinguished from Paget's disease of bone (see Chap. xlvii). It is most unlikely that the two conditions will be confused unless a rectal examination has been omitted.

**Additional Aids to Diagnosis in Doubtful Cases.**—One or more of the following procedures are often required to confirm or disprove a doubtful lesion :

**Serum Acid Phosphatase.**—In only about 40 per cent. of patients suffering from carcinoma of the prostate is the formol-stable acid phosphatase estimation raised above normal (1 to 3 King-Armstrong units). A reading between 3 and 5 units is suspicious of carcinoma of the prostate, and above 5 units practically diagnostic. In patients with metastases 10 K-A units per 100 ml. of serum is not uncommon. See also p. 834.

**Exfoliate Cytology.**—Provided prostatic massage is conducted in a systematic manner and the ensuing secretion is collected so that a selective examination of it is possible, pathologists with special experience can state whether or not the specimen contains carcinoma cells. The patient should stand with the legs apart, leaning forward and steadying himself with one hand resting upon the examination couch ; with the other hand he retracts his prepuce, if such is present. Four slides, duly numbered, are placed in readiness on the couch.

Prostatic massage is conducted in such a way as to avoid compressing the seminal vesicles, viz.  4 drops being obtained and collected separately. In this way contamination with seminal fluid is likely to be avoided (J. D. Fergusson). The massage concluded, each slide is covered with another, similarly numbered. Each pair is slid apart, leaving a film of secretion upon it. All are placed in fixative fluid in such a way as they cannot touch one another.

Procuring a prostatic smear for cytological examination should not be conducted within three days of a diagnostic rectal examination of the prostate.

**Biopsy.**—Needle, open, and transurethral biopsy are practised.



FIG. 1130.—Obtaining a specimen of prostatic tissue by means of Turkel's needle.

**Needle Biopsy.**—Turkel's or a similar instrument is passed as shown in fig. 1130. The cannula is removed and the trephine is passed through the needle and directed to a suspicious nodule. Histological examination of the fragment obtained by a skilled pathologist gives accurate information.

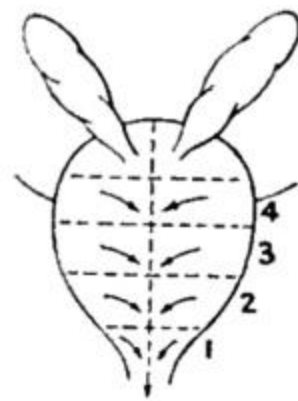
**Open Biopsy.**—Many are convinced that a formal biopsy through a  $\cap$ -shaped perineal incision is the method of choice, because the margin of error (by which is meant that a biopsy needle fails to engage neoplastic tissue, in spite of the fact that such is present) is high ; possibly as high as 50 per cent. Obviously a wedge of tissue obtained by the open method gives the pathologist more scope in doubtful cases.

**Transurethral Biopsy** (see below).

**Cysto-urethroscopy.**—When there is a history of hæmaturia, this examination is essential. There is often a grating sensation as the prostatic urethra is traversed. With the instrument in place, deep induration in the prostate is more readily appre-



FIG. 1129.—Osseous metastases of the pelvic bones in a case of carcinoma of the prostate. (L. N. Pyrah.) (*British Journal of Surgery.*)





ciated by a finger in the rectum, and fixation of the gland becomes more evident. Puckering of the apex of the trigone, submucous nodes in the base of the bladder, or ulceration of an intravesical projection are late manifestations. In earlier cases there are no pathognomonic visible signs.

*Transurethral Biopsy.*—Transurethral resection of the prostate has the advantage of removing the obstruction and providing large pieces of tissue, but it may not reach the posterior zone of the prostate, which is commonly the seat of early carcinoma.

**Vesiculography** has been found to be helpful in confirming the diagnosis of carcinoma of the prostate by Continental, especially Belgian, surgeons. In comparatively early cases distortion of the topography of the ampullæ of the seminal vesicles is extremely suggestive of carcinomatous infiltration.

**Bone marrow aspiration** (sternum and ilium) reveals metastatic carcinoma cells in a surprisingly high percentage of those cases where radiological examination revealed no evidence of secondary deposits. This investigation should be carried out in every case before radical prostatectomy is even considered.

In spite of endeavour, the diagnosis of carcinoma of the prostate usually is made late in the course of the disease, as the following statistics of the condition at the time of diagnosis testify :

Neoplasm confined within the anatomical capsule of the prostate	5 per cent.
Local spread ... ..	55 per cent.
Metastases present ... ..	40 per cent.

#### TREATMENT

Excluding those in whom prostatectomy is performed for a supposedly benign enlargement, as will be seen from the above Table, in only a small proportion of the patients is a carcinoma of the prostate confined within the anatomical capsule when the patient first presents. To these early and operable cases can be added a few in whom the response to anti-androgenic treatment is so favourable that a previously doubtfully operable case becomes operable. Radical treatment, therefore, is out of the question in the majority of cases.

**Retropubic Total Prostatectomy.**—A rubber catheter is passed from the meatus into the bladder. The prostate is displayed as described for retropubic prostatectomy. Only then is it possible to be certain that the growth is confined within the capsule, and it is easy to palpate the iliac vessels and ascertain the presence or absence of affected lymph nodes. The pubo-prostatic ligaments are severed. The apex of the prostate is freed laterally and posteriorly from the underlying fascia of Denonvilliers, mainly with the finger and a swab on a holder, the catheter helping to define the membranous urethra which, after the apex of the prostate has been freed, can be drawn into the pelvis for over  $\frac{1}{2}$  inch (1.25 cm.). The apex of the prostate is grasped on either side by Allis forceps, the catheter partially withdrawn, and the urethra is divided close to the apex of the prostate. The posterior aspect of the gland is separated from the fascia of Denonvilliers from below upwards, until the seminal vesicles and the base of the bladder are displayed. The fascia is incised transversely, each vesicle being freed, and the vas with its vessels ligated and divided.



FIG. 1131.—Division of the neck of the bladder while the rectum is protected by a spatula.

Oscar Huntington Allis, 1843-1921 Surgeon, Presbyterian Hospital, New York.



After still further separating the fascia from the base of the bladder, the anterior wall of the bladder is opened transversely to expose the trigone. Thereafter the circumference of the base of the bladder is transected (fig. 1131) and the whole prostate within its true capsule, together with the seminal vesicles and as much of the bladder as necessary, is removed in a single block. Reconstruction is carried out as shown in fig. 1132. If the vesical outlet is disproportionately large, it can be narrowed by removing a V-shaped portion from its anterior wall and approximating the limbs of the V.

**Young's perineal total prostatectomy** is an alternative operation that is practised on the Continent and in the U.S.A.



FIG. 1133.—Perineal prostatectomy. Extracapsular excision of the prostate and seminal vesicles in progress.

The patient is placed in the exaggerated lithotomy position and the prostate exposed by a  $\cap$  incision in the perineum. A special instrument known as a tractor is required. It is introduced through the membranous urethra and used to draw the prostate towards the perineum while an extracapsular dissection (fig. 1133) is carried out. After the prostate and seminal vesicles have been excised *en bloc*, the membranous urethra is anastomosed to the base of the bladder using a boomerang needle. The advantages of the perineal over the retro-pubic approach are the ability to perform a biopsy as a preliminary part of the operation, and less operative shock.

Elmer Belt reports a 43 per cent. 5 years' survival rate in over 200 patients treated by total perineal prostatectomy.

Anti-androgenic therapy in addition to either of the above radical operations is usually indicated.

### Anti-androgenic Treatment :

**Rationale.**—Many carcinomata of the prostate are stimulated by male hormones that consist of testosterone (secreted by the testes), 17-ketosteroids (elaborated by the pituitary and the adrenal glands), and 17-hydroxyprogesterone (produced by the adrenal glands), and some additional hormones, as yet unidentified. Approximately 20 per cent. of prostatic carcinomata are independent of these androgenic hormones.

**Test for Hormonic Sensitivity of Prostatic Carcinoma.**—To test whether or not a given prostatic carcinoma will respond to subjugation of androgenic hormone, large doses of stilbœstrol (50 to 100 mg. per day) are given for five days, and the effect on the daily excretion of androgenic steroids is ascertained. Should the urinary steroids not decrease remarkably after the test little can be expected from castration, nor can the administration of œstrogens be expected to produce notable improvement. On the other hand, if the test is positive, considerable improvement can be expected.

**Effects of Anti-androgenic Treatment in Hormone-sensitive Prostatic Carcinomata.**—Since the advent of endocrine treatment, many hundreds of patients have been treated by castration, œstrogen therapy, or both. The results have been variable: often there has been pronounced improvement, usually temporary, but sometimes sustained. Favourable results are characterised by relief of pain, disappearance of the anæmia (which so often accompanies this disease), increased appetite, increased weight, regression of the growth, sometimes to a point when it is difficult or impos-



FIG. 1132.—Approximating the base of the bladder to the membranous urethra. (After T. Millin.)



sible to detect any abnormality. What is even more amazing is that in many cases metastases (fig. 1134), particularly bone metastases, have disappeared.

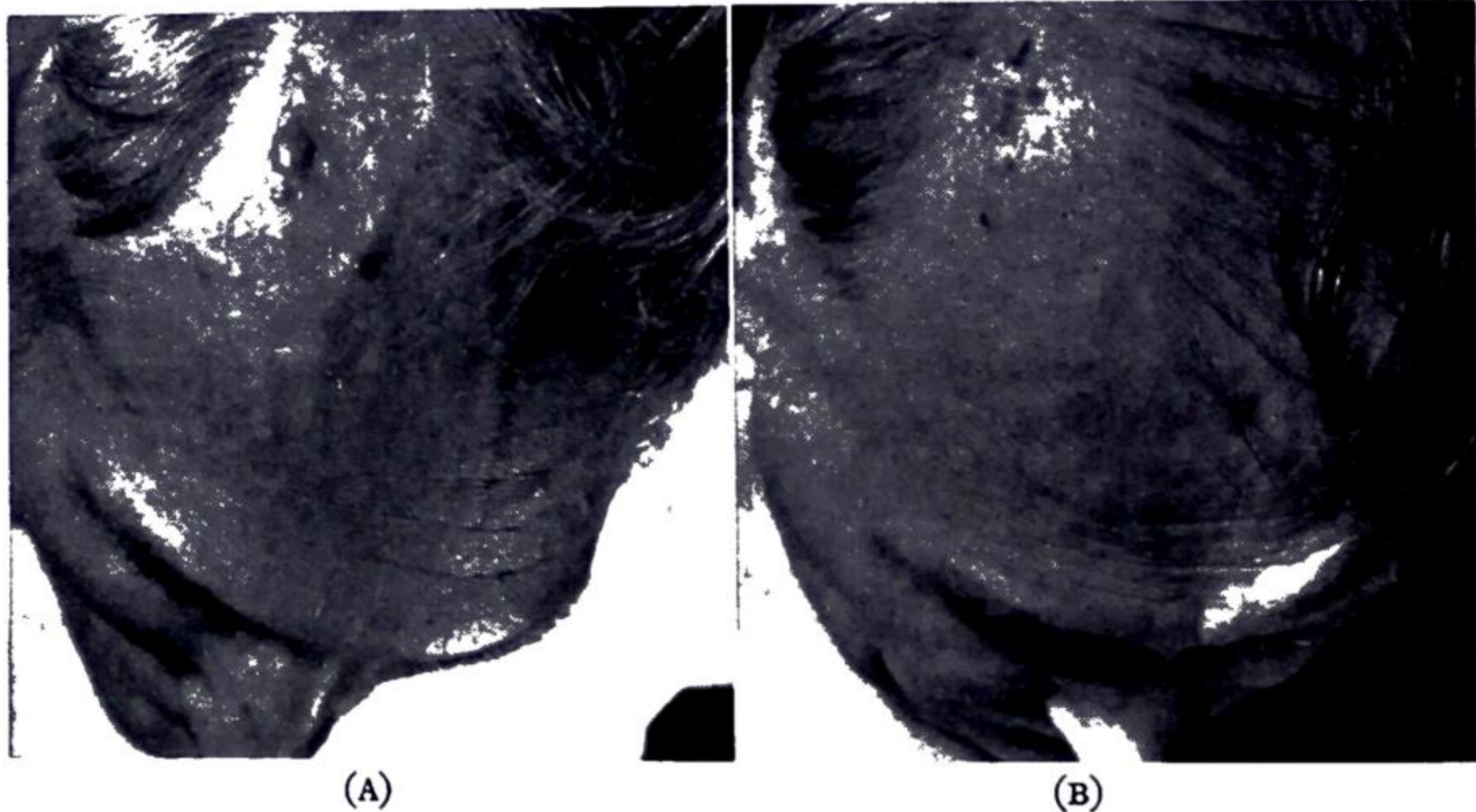


FIG. 1134.—(A) Metastases of prostatic carcinoma in the scalp. (B) Thirteen months after orchiectomy. (Professor C. Huggins, Chicago.)

Frequently the serum acid phosphatase, previously elevated, returns to normal. As yet no patient has been cured, but life in comfort has been prolonged. As the reader would anticipate, the results are considerably better when the patient has no demonstrable metastases (figs. 1135A and B).

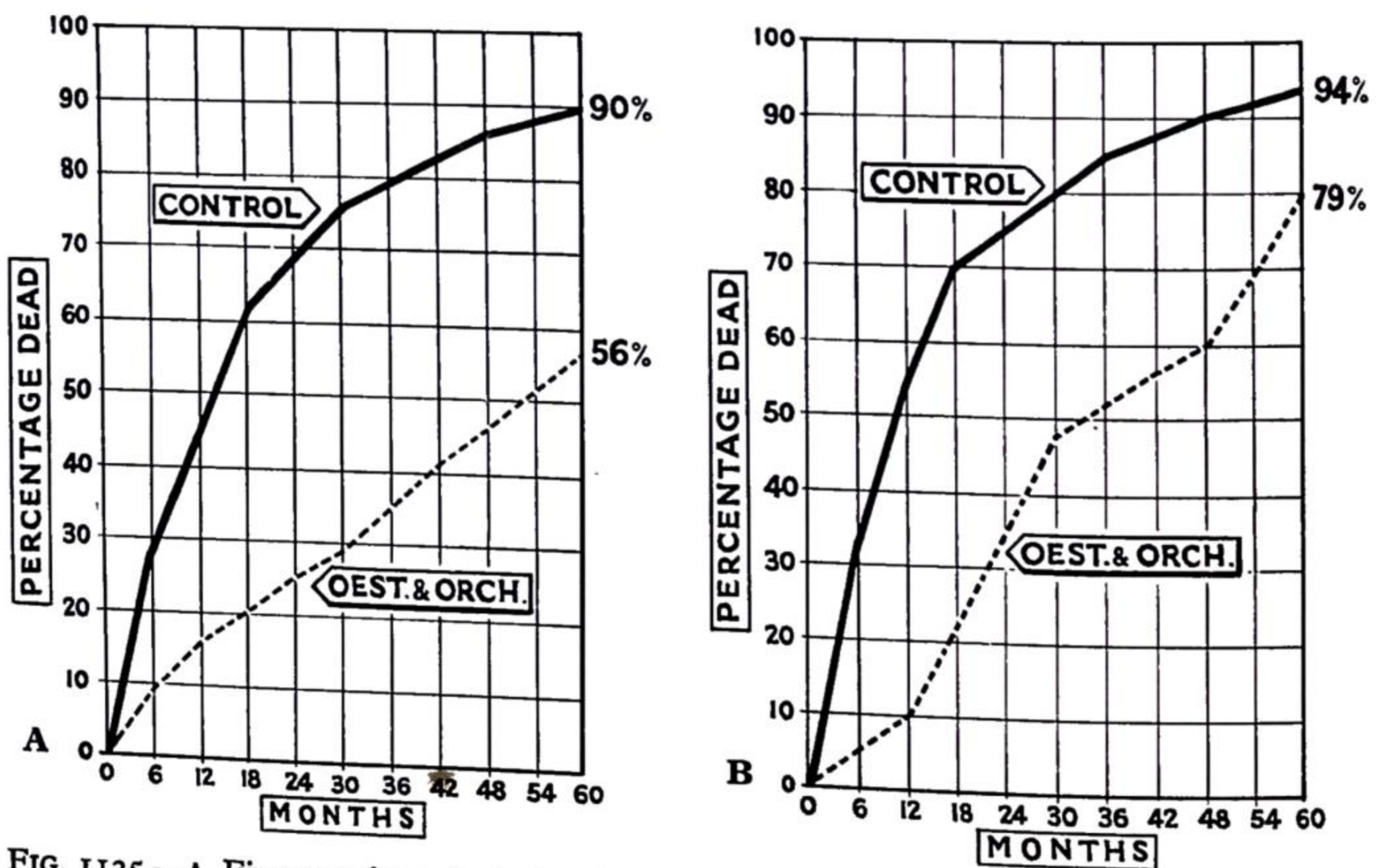


FIG. 1135.—A. Five years' survival of patients without metastases. B. Five years' survival of patients with metastases. (After R. N. Nesbit and W. C. Baum.)

Two outstanding factors have militated against better average results :  
 1. In many old men with prostatic carcinoma testicular function has ceased. Neither castration nor oestrogen therapy can benefit these patients.

Charles Huggins, Professor of Surgery, Chicago, and his co-workers introduced the treatment of carcinoma of the prostate by orchiectomy and stilbæstrol in 1941.



2. Oestrogens do not inhibit androgen production by the adrenal cortex.

*The first group* can be eliminated by androgen assays of the urine. It is useless and wasteful to give this treatment in cases where it cannot do any good, or to those in whom relapse is inevitable in a matter of weeks.

In *the second group* there seems little doubt that stilbœstrol, which stimulates the adrenal glands causing them to increase in size, is at least partially responsible for many early relapses.

### Details of Anti-androgenic Treatment:

**Bilateral subcapsular orchiectomy** is performed through a central scrotal incision. The tunica albuginea is incised and all the spermatogenic tissue is removed (fig. 1136) by gauze dissection and, if necessary, a sharp curette. After hæmostasis has been effected a prosthesis of acrylic resin or sterispon (gelfoam) can be inserted, and the edges of the tunica albuginea approximated over it.

**The Administration of Oestrogens.**—There are several preparations that can be used; all are manufactured synthetically.

**Stilbœstrol** is given by mouth; as absorption of the drug is impaired by liquid paraffin, medication with mineral oil laxatives is forbidden. No unanimity has been reached on the optimum dose, but the general tendency is to give larger doses than formerly, viz. 100 mg. per diem, which is continued for the patient's lifetime, or until it is decided for some good reason to change to another preparation. Although often effective, stilbœstrol has disadvantages:

1. It stimulates the adrenal glands, and causes them to increase in size, and not infrequently a time is reached when the androgenic output of the adrenals is sufficient to prevent regression, or even to reactivate the neoplasm. Periodic androgen excretion estimations are the only means of predicting undue adrenal activity.

2. Severe nausea, gastric upsets, and œdema of the ankles (salt retention) are engendered in a few cases.

3. Gynæcomazia (fig. 1137) with pigmentation of the nipples is often produced. Stilbœstrol gynæcomazia is described in Chap. xlii.

**Dienœstrol** is considered by some to be an improvement on stilbœstrol. It is a stronger preparation, and the dose is 45 mg. daily given by mouth.

**Tace** (tripara-anisilchlorethylene) is supplied in 12-mg. capsules, and the dose is one to

two capsules per day by mouth. Tace minimises (but does not prevent) adrenal stimulation. Its principal advantage is that it does not cause hypertrophy of the breasts.

**Honvan** (phosphorylated diethylstilbœstrol) is given intravenously. The acid phosphatase of the prostatic carcinoma cells splits the phosphate element of the preparation, thus releasing the œstrogenic hormone locally and favouring its direct action on the carcinoma cells, and the carcinoma cells only. In this way, it is claimed, this preparation is selective in action. At first 125 mg. are injected (it must be injected very slowly) three times a day for ten days. The dose is then increased to 250 mg., and eventually (enfeebled patients excepted) to as much as 500 to 1,000 mg., until the twentieth day. The dosage is then gradually decreased, until one 250-mg. capsule is given weekly, and finally monthly. The intravenous injections, like all

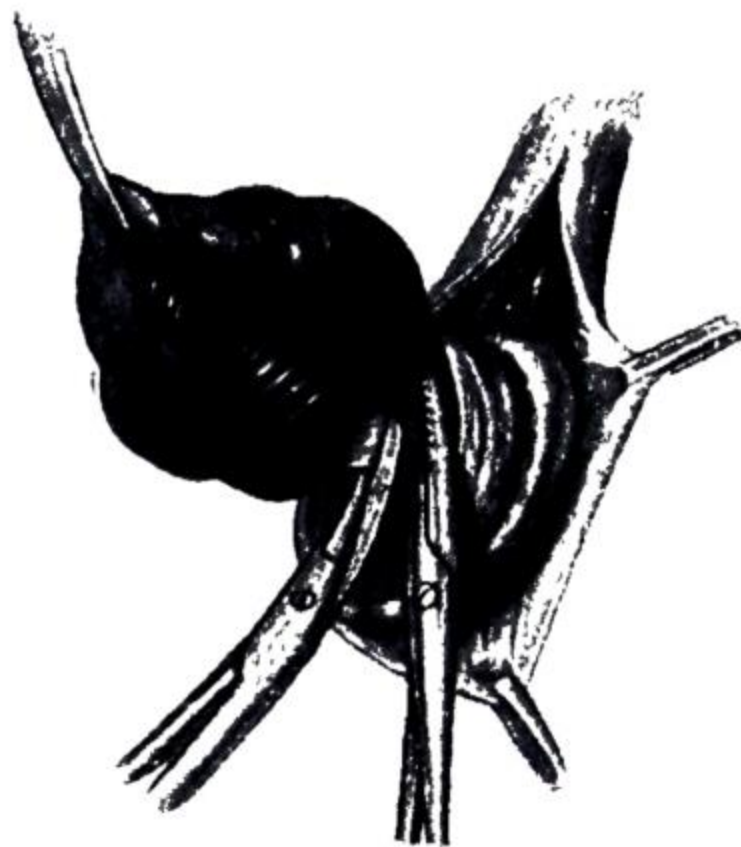


FIG. 1136.—Subcapsular orchiectomy in progress.



FIG. 1137.—Gynæcomazia following stilbœstrol therapy in a man 80 years of age with carcinoma of the prostate.



intravenous injections, requires skilled administration, but this is the only disadvantage of the use of this preparation. No untoward effects have been reported.

Exactly how oestrogens exert their baneful effect on prostatic carcinoma cells is not known. Histologically degenerative changes in the cancer cells, particularly in their nuclei, are noticeable. Considerable proliferation of the stroma is also seen.

**Treatment of Relapses.**—When a patient relapses after orchietomy and oestrogen therapy an endeavour should be made to combat the activity of the adrenal cortex. This has been achieved by bilateral adrenalectomy, cortisone administration, irradiation of the hypophysis, or hypophysectomy.

**Cortisone treatment** should be given in only small maintenance doses, since large doses contribute to androgen formation.

**Bilateral Adrenalectomy.**—Only patients with a high androgen excretion can be expected to receive benefit from bilateral adrenalectomy. The consensus of opinion is that this operation is much less successful than it is in the case of carcinoma of the breast (see p. 264). The reason for this is not understood, seeing that the rationale of the operation in the two conditions appears to be identical.

**Hypophysectomy.**—Because so often the patient is old and enfeebled, hypophysectomy is rightly considered too heroic in most instances. Furthermore, even if a remission is brought about, usually it is short-lived.

**Irradiation of the Hypophysis.**—Some improvement has been noted after relapse.

**Other Methods of Treatment when the Tumour is Hormonally Insensitive, or becomes so :**

**Irradiation** has not proved successful. A search is being made for a radio-active isotope for which the cells of prostatic carcinoma and their metastases exhibit specific cell avidity, so far without success.

**Nitrogen Mustard Therapy.**—In some instances nitrogen mustard therapy has proved useful in the control of pain in some cases of disseminated prostatic carcinoma.

## PROSTATITIS

Prostatitis is a common condition occurring in early adult, middle, and late middle life.

In both acute and chronic prostatitis the seminal vesicles are usually infected, and when, as is often the case, the prostatic urethra is involved also, there is present a triad of pathological conditions, to wit: posterior urethritis, prostatitis, and seminal vesiculitis. Symptoms due to infection of any one of these structures may predominate.

### ACUTE PROSTATITIS

Acute prostatitis is less common than the chronic form. Staphylococcal infections are the most frequent, and the majority are due to *Staphylococcus albus*. Other infecting organisms are *Esch. coli*, streptococci, and, rarely, gonococci. Often a sequel of non-gonococcal urethritis, latent infection can be activated by urethral instrumentation. Sometimes the infection is blood-borne.

**Clinical Features.**—The characteristic early symptom is a feeling of heaviness in the perineum and the patient cannot sit comfortably for any length of time. Later there is pain in the perineum which passes to the tip of the penis during micturition. Pain on defæcation is also a symptom. When the seminal vesicles are involved, blood-stained nocturnal emissions



are superadded. In severe cases the temperature rises to 102° F. (38.9° C.) or more. In cases of hæmatogenous infection the pyrexia and general malaise often overshadow the local symptoms at the commencement of the attack, and as there is no urethral discharge and there may be a negative result to culture of the urine, the diagnosis is difficult. In established cases a rectal examination reveals a large, tender prostate, and often one seminal vesicle is more distended than the other.

**Treatment.**—Appropriate antibiotic treatment, together with hot sitz baths, often results in resolution of the inflammation.

**Prostatic Abscess.**—In addition to the foregoing symptoms and signs, the advent of a prostatic abscess is heralded by the temperature rising steeply, rigors being not unusual. However, antibiotics disguise these leading features. Severe, unremitting perineal and rectal pain with occasional tenesmus often cause the condition to be confused with an ano-rectal abscess. Nevertheless, if a rectal examination is performed, the prostate will be felt to be enlarged, hot, extremely tender, and perhaps softened in one place. Retention of urine is likely to follow or, in a centrally-placed abscess, to occur at an earlier stage. Attention is directed to the frequency with which diabetic patients with acute prostatitis develop a prostatic abscess.

**Treatment.**—As soon as the diagnosis has been made the abscess should be drained without delay. It is true that if a catheter is passed to relieve acute retention of urine, sometimes the abscess is ruptured into the prostatic urethra. However, in the majority of cases such drainage is insufficient, and is followed by intractable chronic prostatitis and the development of a further abscess is not unusual. Some venereologists find that opening a prostatic abscess pointing towards the rectum gives highly satisfactory results. Most surgeons prefer drainage by another route :

(a) External urethrotomy is performed and a finger is introduced through the incision into the prostatic urethra, and through the posterior urethral wall into the abscess cavity. When necessary, septa are broken down. A Foley's catheter is passed into the bladder through the wound, and left *in situ* for six days.

(b) A few urologists advise drainage of the abscess into the urethra by transurethral resection of prostatic tissue intervening between the abscess and the prostatic urethra.

#### CHRONIC PROSTATITIS

**Ætiology.**—As a rule the infection is hæmatogenous from a distant focus, notably furunculosis, infected tonsils, or carious teeth. In a minority of cases the infection ascends from the urethra or descends from the bladder or kidneys. While pus is present in the prostatic secretion, often the responsible organism is difficult to find. Smears show bacteria in about 40 per cent. and cultures are positive in 70 per cent. of cases. The predominant organisms are staphylococci, streptococci, and diphtheroids, in that order.

**Pathology.**—The lumina of the ducts become blocked with epithelial debris and pus. This causes a soft enlargement of the organ. Later fibrosis occurs, and the prostate becomes smaller and harder.



**Clinical features** are extremely varied.

1. *As a cause of Chronic Posterior Urethritis.*—Prostatitis should not be diagnosed unless, after irrigating the whole of the urethra and massaging the prostate, the resultant specimen shows fifteen or more pus cells per high power field.

2. *As a cause of Epididymitis.*—Acute or subacute non-tuberculous epididymitis rarely occurs unless prostatitis is present.

3. *Pain :* (a) *Local* is described as a dull ache in the perineum or rectum. It is increased by sitting on a hard chair.

(b) *Referred.*—Particularly common is low back pain, sometimes extending down the legs (fig. 1138); such pain is usually attributed to lumbago or strain at work, and many sufferers from prostatitis receive orthopaedic treatment and physiotherapy without benefit.



FIG. 1138.—  
Sites of pain  
in chronic  
prostatitis.

4. *'Silent' Prostatitis.*—Arthritis, myositis, neuritis, and sometimes iritis and conjunctivitis are on occasions explained only when pus from the prostate has been obtained.

5. *Recurring attacks of mild pyrexia*, lasting about three days and accompanied by malaise, are sometimes due to chronic prostatitis.

6. *Sexual Dysfunction.*—Premature ejaculations, prosta-torrhœa, and impotence can all at times be due to prostatitis.

A rather large proportion of patients with sexual dysfunction due to chronic prostatitis become hypochondriacal.

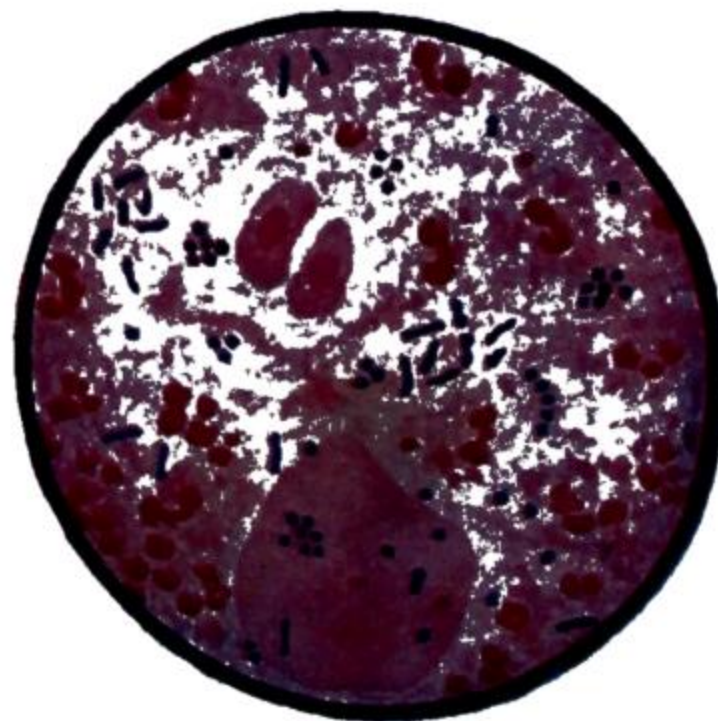
#### Diagnosis :

(a) *A three-glass urine test* is valuable. If the third glass shows urine containing prostatic threads, prostatitis is present.

(b) *Rectal examination* of the prostate may or may not confirm the diagnosis. If the organ is soft and boggy, it is obviously abnormal, as also it is if the prostate is smaller and harder than it should be. In mild chronic cases no change can be detected, and reliance must be placed on pathological examinations of the prostatic fluid.

(c) *Examination of the prostatic fluid* obtained by prostatic massage. Normal prostatic fluid is slightly opalescent and viscid. It contains a few

FIG. 1139.—Film of prostatic fluid from a case of chronic prostatitis. Stained Gram plus basic fuchsin. Numerous pus cells, staphylococci, streptococci, and diphtheroid bacilli. (Oil immersion  $\times 1,000$ .)



corpora amylacea, lipoid epithelial cells, and a few crystals. Non-stained films, in addition to revealing normal constituents, will demonstrate tricho-



monads, if present. A stained specimen shows many pus cells and sometimes bacteria (fig. 1139).

(d) *Urethroscopy* reveals inflammation of the prostatic urethra, and sometimes pus can be seen exuding from the prostatic ducts. The verumontanum is likely to be enlarged and œdematous.

**Treatment.**—Not much can be expected from antibiotic therapy unless it is administered in accordance with bacteriological sensitivity tests. The blunderbuss administration of antibiotics in this condition is to be deprecated. In a recent large series aureomycin was given to all patients. No change attributable to the antibiotic was registered. It is more than probable that in most instances 0.5 G. t.d.s. of a suitable sulphonamide, e.g. sulphatriad, for six weeks will effect as much as an expensive course of antibiotics.

Massage of the prostate per rectum is a most important measure, the prostatic secretion and the contents of the seminal vesicles being emptied thereby. Usually eight strokes on each side are given daily for a week, and then at lengthening intervals as improvement sets in. In the later stage of treatment, which usually must be prolonged over months, urethral dilatation serves to open the prostatic ducts and permits better drainage. This can be followed with advantage by irrigation of the bladder with acriflavine 1 : 5,000 or oxycyanide of mercury 1 : 8,000. In most cases the infection will be eradicated by these measures.

In rebellious cases, canalisation of the vasa, which allows irrigation of the seminal vesicles, often clears up an infection which defied other methods.

**Remote Complications.**—Long-standing chronic prostatitis terminates in fibrous prostate and median bar obstruction. Prostatic calculi are also a legacy of untreated chronic prostatitis.

#### TUBERCULOSIS OF THE PROSTATE AND SEMINAL VESICLES

Tuberculosis of the prostate and seminal vesicles is associated with renal tuberculosis in at least 60 per cent. of cases. In 30 per cent. of cases there is a history of pulmonary tuberculosis within five years of the onset of genital tuberculosis.

**Tuberculosis of one or both seminal vesicles** is more common than tuberculosis of the prostate, and is often discovered when examining a patient with chronic tuberculous epididymitis, there being no symptoms referable to the internal genitalia. On rectal examination the affected vesicle is found to be nodular and tender. In process of time tuberculous seminal vesiculitis may lead to congestion and œdema of the base of the bladder, and later to basal cystitis.

**When the Prostate is Involved.**—In 60 per cent. of cases neither of the vasa deferentia is thickened. Rectal examination reveals characteristically one or more well-defined nodules, most often near the upper or lower border of one or both lateral lobes (fig. 1140). Less frequently a larger solitary mass is felt occupying a more central position. Nodules in the prostate, which are present only in 25 per cent. of cases of tuberculous prostatitis, lack the stony hardness of carcinoma. More often tuberculous prostatitis imparts to the



examining finger a sensation of a fibrotic prostate, often traversed by a firm ridge occupying the position of the common ejaculatory duct on either side.



FIG. 1140.—Tuberculous prostatitis.  
(After R. J. Veenema and J. K. Lattimer.)

In early cases of tuberculous prostatitis there are no definite signs detected at a rectal examination, and reliance must be placed on special forms of investigation.

A patient with tuberculous prostatitis from time to time presents with one or more of the following symptoms :

*A urethral discharge* is occasionally the first symptom. Then the diagnosis has to be made from gonorrhœa and abacterial urethritis entirely on bacteriological findings, for the prostate at this early stage is likely to feel normal.

*Painful, sometimes blood-stained, ejaculations* occur in 20 per cent. of cases.

*A mild ache in the perineum* is not uncommon.

**Infertility.**—In patients with tuberculous prostatitis and/or bilateral seminal vesiculitis, fertility is very much reduced ; it is safe to say that 80 per cent. of them are sterile. In this connection, owing to the considerable interest in male fertility at the present time, a number of really early cases of tuberculous prostates-vesiculitis are being discovered by culture of the semen.

**Urinary Symptoms.**—In later cases when the posterior urethra becomes involved from extension of tubercles from the prostate or by the discharge of a prostatic abscess, there is painful, frequent micturition and sometimes terminal hæmaturia.

**Abscess Formation.**—If a cold abscess forms in the prostate, it is felt as a slightly tender, soft swelling. Like other prostatic abscesses, it usually ruptures into the urethra, more rarely through the perineum or into the rectum. Occasionally an abscess of the prostate or seminal vesicle bursts into the bladder ; later at cystoscopy a ragged, deep ulcer is seen alongside the trigone.

### Special Forms of Investigation :

**Radiography** frequently displays areas of calcification in the prostate and/or the seminal vesicles. Large scattered areas of calcification in the prostate suggest tuberculosis rather than endogenous prostatic calculi.

**Urethrography** reveals dilated prostatic ducts in well over 80 per cent. of cases. If only cases where the prostate is palpably involved are included, 97 per cent. display this characteristic finding.

**Bacteriological examination of the seminal fluid** yields positive cultures for tubercle bacilli in a high percentage of cases of tuberculous prostatitis.

**Posterior urethrography** often reveals one or more dilated prostatic ducts. Typically they are multiple and gaping (see fig. 1140). Dilated prostatic ducts are not specific for tuberculosis (they can occur in other forms of chronic prostatitis), but dilated ducts plus the finding of tubercle bacilli in the ejaculate establishes an absolute diagnosis.



Even in cases without urinary symptoms a complete urological examination is necessary.

Transmission of genital tuberculosis to the female partner is exceptional, but it does occur in the form of tuberculous cervicitis.

**Treatment.**—On no account must a tuberculous prostate or seminal vesicle be subjected to massage. Urethral instrumentation should be avoided, or reduced to a minimum in order to confirm the diagnosis. The combined therapy at present is isoniazid, 100 mg., t.d.s., and sodium P.A.S., G. 5, t.d.s., given together for a period of two years. When possible, sanatorium treatment is highly desirable. Some, however, consider it unnecessary in uncomplicated early cases, provided always the patients report once a week.

If a prostatic abscess forms, it is better to evacuate it by the perineal route than to permit it to rupture spontaneously.

Considerable involvement of the prostate, which goes on to suppuration, is a comparatively unfavourable form of genito-urinary tuberculosis. On the other hand, usually tuberculous seminal vesiculitis and non-suppurative tuberculosis of the prostate heal after an associated lesion of the kidney or epididymis has been eradicated. During the healing of the prostatic lesion, stricture of the prostatic urethra is wont to occur.

Radical prostatico-seminal vesiculectomy was performed frequently for tuberculosis in the pre-antibiotic days: now it has been practically abandoned, except for very occasional cases associated with intractable pain.

#### AFFECTIONS OF THE SEMINAL VESICLES

**Acute seminal vesiculitis** always occurs in association with prostatitis. Prior to the antibiotic treatment of gonorrhœa, gonococcal vesiculitis was a common complication of a Neisserian infection. When a seminal vesicle is distended it can be palpated per rectum as an acutely tender swelling above and lateral to the prostate. The treatment is discussed on p. 35.

**Abscess of a Seminal Vesicle.**—In addition to the usual signs of acute prostatitis, pain is frequently referred to the suprapubic region. If on rectal examination the seminal vesicle is found to be greatly enlarged and tender, the abscess should be drained through an incision in the perineum, viz.—→ The incision is deepened until the swelling is palpated, and a long hæmostat is then thrust into the abscess cavity.



**Chronic seminal vesiculitis** is probably less frequently recognised than it should be because the associated chronic prostatitis overshadows the symptoms of pain on coitus, hæmospermia, aching in the sacral region, recurrent epididymitis, and, at times, associated disturbances of micturition and defæcation. The treatment does not differ from that of a chronic prostatitis, except that in rebellious cases vasotomy and irrigation of the vesicle is often rapidly curative.

**Tuberculous Seminal Vesiculitis.**—It is debatable whether genital tuberculosis commences in a seminal vesicle or the epididymis. The clinical features and treatment of tuberculous seminal vesiculitis are discussed on p. 861 and above.



**Diverticulum of the seminal vesicle** occurs occasionally. In such cases the kidney of that side is often absent, and the diverticulum represents an abortive ureteric bud. Diverticulum of the seminal vesicle is a cause of persistent infection of the urethra; it can project into the prostate, and bring about obstruction to the prostatic urethra, or result in recurring attacks of rectal pain. The only method of demonstrating the diverticulum is by seminal vesiculography (see below). The treatment is the same as that for a cyst of the seminal vesicle.

**A cyst of the seminal vesicle** is uncommon. It should be removed by dissection through an incision similar to that for perineal prostatectomy.

**Carcinoma of a seminal vesicle** is extremely rare, but probably the diagnosis is frequently confused with prostatic carcinoma. The treatment is complete extirpation of the seminal vesicles and the prostate, but usually by the time the condition is manifest, the neoplasm is too far advanced for radical treatment, in which case hormonal treatment or deep X-ray therapy can be tried.

**Seminal Vesiculography.**—In case of sterility it is sometimes necessary to know if the common ejaculatory ducts are patent. This information can



FIG. 1141.—A normal seminal vesiculograph.

be obtained by catheterising the common ejaculatory ducts through a special posterior urethroscope. Iodoxyl is then injected up the catheter and a vesiculograph taken. The same information can be obtained more easily by vasotomy and injection of an opaque medium (fig. 1141). Seminal vesiculography is the only method of diagnosing conclusively a diverticulum of a seminal vesicle.

The value of seminal vesiculography in the diagnosis of carcinoma of the prostate is referred to on p. 854.

#### AFFECTIONS OF COWPER'S GLANDS

**Cowperitis.**—The diagnosis of Cowperitis is often wanting for lack of a simple examination. On passing the forefinger into the rectum and placing the thumb first on one side and then on the other of the median raphe of the perineum, Cowper's glands can be palpated (fig. 1142). In acute cases the least pressure causes excruciating pain. In this way the condition is differentiated from an ischio-rectal or peri-urethral abscess.

**Treatment.**—In acute cases antibiotic therapy, together with rest in bed, often bring about resolution. Should suppuration occur, incision and drainage is the proper course.

**Fistula formation** as the result of an abscess of the gland terminating in spontaneous rupture. To cure the condition it is necessary to excise the fistula and the remnants of the gland.

**Tuberculous Cowperitis** is rare, and is always associated with tuberculosis elsewhere in the genito-urinary tract.

**A cyst of Cowper's gland** either bulges into the urethra and causes disturbances of micturition, or gives rise to a unilateral swelling in the anterior part of the perineum. The cyst should be excised.



FIG. 1142.—Palpating an enlarged gland of Cowper.

*William Cowper, 1666-1709. London Surgeon. Was the first in England to dissect a marsupial. He published anatomical works in a sumptuous fashion.*



## CHAPTER XXXV

## THE URETHRA AND PENIS

HAMILTON BAILEY

## THE MALE URETHRA

**Embryology.**—From the internal urinary meatus to the sinus pocularis (uterus masculinus) the urethra is developed from the urogenital sinus. This portion of the male urethra corresponds to the entire female urethra. From the sinus pocularis to the fossa navicularis the male urethra is formed by the fusion of the edges of the medial labial folds, which also form the corpus spongiosum (fig. 1143). The urethra traversing the glans is the last to be developed, and is formed by the down-growth of a solid pencil of ectoderm; which becomes canalised shortly before birth.

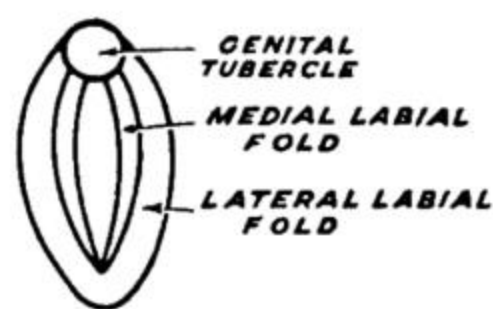


FIG. 1143.—The male and female external genitalia are undifferentiated until the end of the *third* month.

## CONGENITAL ABNORMALITIES OF THE URETHRA

**Meatal Stenosis.**—The external urinary meatus, normally the narrowest part of the male urethra, is often the seat of congenital stenosis which is associated with phimosis. In the circumcised, meatal stenosis may also be acquired or increased by fibrosis following meatal ulceration. All degrees of narrowing are encountered. When the opening



FIG. 1144.—Pin-hole meatus causing chronic retention of urine (distended bladder outlined) in a man of fifty-one. Cured by meatotomy.

is reduced to a pin-hole, back-pressure effects on the whole urinary system result. Pin-hole meatus is occasionally a cause of enuresis, and at any time of life it may result in chronic retention of urine (fig. 1144). In cases of chronic urethritis some degree of meatal stenosis hinders drainage of urethral discharges.

**Treatment.**—Meatal stenosis sufficient to (a) give rise to symptoms, (b) prevent free drainage of the discharge in cases of urethritis, or (c) obstruct the passage of full-sized urethral instruments or a cystoscope, should be treated by meatotomy. Lesser degrees of narrowing respond to dilatation with Hegar's dilators.

**Meatotomy.**—A fine-pointed scalpel is introduced into the urethral meatus, and a cut is made in a downward direction.

*In infants and children* a metal bougie of suitable calibre is passed into the meatus each day for four days, and then weekly for one month.

*In adults* it is preferable to unite the cut edges of the urethra to the skin of the glans penis with two or three catgut sutures. These stitches control hæmorrhage and

*Alfred Hegar, 1830-1914. Professor of Obstetrics and Gynæcology, Freiburg.*



prevent the lips of the meatus from re-uniting. Usually dilatation on two occasions at weekly intervals is sufficient in this instance.

**Congenital stricture of the urethra** is very rare ; some cases are due to reduplication of the urethra. Usually the symptoms are delayed until adolescence. Treatment by dilatation is effective.

**Congenital valves of the posterior urethra** are often symmetrical and occur usually just below (fig. 1145), but occasionally above, the verumontanum. They allow the ingress of a catheter but obstruct the outflow of urine, and are therefore a puzzling cause of chronic retention of urine to those unfamiliar with the condition. As a consequence, their presence often leads to a fatal termination in early life. In a few instances the valves are incomplete and the patient may reach adolescent or adult life ; however, in such cases the prostatic urethra is greatly dilated and diverticula of the bladder are present.

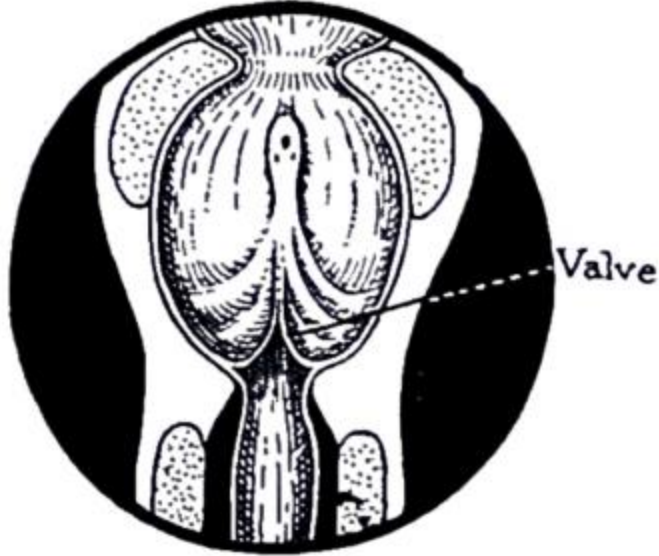


FIG. 1145.—Congenital valves of the posterior urethra. (After D. Innes Williams.)

The valves are difficult to see at cysto-urethroscopy, because the irrigating fluid sweeps them into the open position. The most reliable method of confirming the diagnosis is voiding cysto-urethrography, by which is meant that radiographs are taken during attempts to micturate after the bladder has been filled with contrast medium. Alternatively, pressure above the pubes while the radiograph is taken achieves the same objective. In this way the dilated urethra above the valves is outlined, as well as the bladder.

**Treatment.**—Suprapubic drainage of the bladder is a life-saving measure ; several weeks should intervene before attempting to remove the valves. At the second operation the retropubic space is displayed. A vertical incision is made into the bladder just above the prostate and continued downwards into the dilated prostatic urethra. Bleeding-points are coagulated with a diathermy needle and the valves are picked up with toothed dissecting forceps and excised with scissors. A catheter having been passed from the external urinary meatus, the incision into the bladder and urethra is closed with fine catgut sutures. The suprapubic catheter is not removed for several weeks. Throughout the treatment infection is controlled by antibiotic therapy. In older children and adults the valves can be excised trans-urethrally with a resectoscope.

Because of their importance in the differential diagnosis of congenital valves of the urethra, the following causes of chronic retention in childhood are included here :

**Obstruction to the neck of the bladder** (*syn.* **Marion's disease**) is analogous to hypertrophic pyloric stenosis of infants, and gives rise to symptoms identical with those of congenital valves. The diagnosis can often be appreciated cystoscopically as a hypertrophied interureteric bar. Voiding cysto-urethrography demonstrates that the posterior urethra does not fill, and clarifies the differential diagnosis between the two conditions. Treatment consists in performing cystostomy and removing a wedge from the centre of the obstructing interureteric bar. (In the adult this bar can be removed by perurethral resection.)

**Neurogenic bladder** must be excluded in both the above lesions. Spina bifida, and the accompanying lesions of the central nervous system, is the usual cause of retention of urine of neurological origin in childhood. Like obstruction due to congenital valves, cysto-urethrography shows the prostatic urethra dilated. In neurogenic obstruction, the ease with which the bladder can be emptied by manual pressure above the pubis serves as a ready means of segregating chronic retention of urine due to this cause from other varieties of chronic retention of urine.

#### HYPOSPADIAS

Hypospadias is the commonest congenital malformation of the urethra, and it occurs once in every 350 males. The external meatus is situated at some point upon the *under*-surface of the penis or in the perineum.

*Jean-Baptiste Camille-Georges Marion, Contemporary. Emeritus Professor of Urology, Faculty of Medicine, Paris.*



There are five degrees of the deformity, classified as follows :

1. **Glandular Hypospadias.**—There is an ectopic opening on the under-surface of the glans, separated from a blind depression at the normal site of the external urinary meatus. Occasionally a channel runs from the ectopic meatus to the normal meatus.

2. **Coronal Hypospadias.**—The meatus is situated at the junction of the under-surface of the glans with the body of the penis.

3. **Penile Hypospadias.**—The meatus opens at some part of the under-surface of the penis (fig. 1146).

4. **Peno-scrotal Hypospadias.**—The urethra opens at the junction of the penis with the scrotum.

5. **Perineal Hypospadias.**—The scrotum is split and the urethra opens between its two halves. This variety is sometimes associated with bilateral maldescended testes, in which event the sex of the child may be difficult to determine.

Glandular hypospadias is the most frequent variety, and is due to a failure of canalisation of the glans (see embryology). The other varieties are looked upon as an absence of the urethra and corpus spongiosum distal to the ectopic orifice, the absent structures being represented by a fibrous cord. In all except the first variety the penis is curved in a downward direction. The farther away the opening is from the normal position, the more pronounced is the bowing. In all cases the inferior aspect of the prepuce is poorly developed.

**Treatment.**—In glandular hypospadias no treatment is required, unless the opening is too small, in which case meatotomy is performed. In other varieties a plastic operation, of which there is a great variety, should be carried out. On this account circumcision during infancy should not be performed in these cases.

**Stage 1.**—*Straightening the penis* is undertaken, preferably between one and a half and two years of age. A transverse incision is made on the ventral surface  $\frac{1}{2}$  inch (1.25 cm.) distal to the external urinary meatus, and the skin on either side of the urethra is undermined, exposing the fibrotic corpus spongiosum, which is detached from before backwards by severing its fibrous attachment to the corpora cavernosa. This accomplished, the urethral orifice recedes towards the perineum; thus a coronal hypospadias becomes a penile, and a penile a peno-scrotal, and so on, and the penis is no longer tethered. The original transverse incision is further lengthened by carrying it into the under-surface of the prepuce on either side. The incision is then closed vertically, tension being relieved by making a longitudinal incision in the middle line through the skin of the dorsum of the penis and prepuce. The penis is wrapped in ribbon gauze soaked in acriflavine and paraffin.

**Stage 2.**—*Denis Browne's method of constructing a urethra* is undertaken, preferably between five and seven years of age. Diversion of all urine from the seat of operation can only be accomplished by *perineal urethrostomy*. A Malècot catheter of correct size is passed into the bladder on a sound. The sound is withdrawn slightly, and rotated through 90 degrees so that its beak can be felt in the perineum. Strictly in the middle line a small incision is made, and the catheter is seen within the urethra. The wall of the catheter is grasped in a hæmostat while the assistant withdraws the



FIG. 1146.—Penile hypospadias. The patient passes urine through the orifice demonstrated by the probe.

*Denis Browne, Contemporary. Surgeon, Hospital for Sick Children, Great Ormond Street, London. Achille-Etienne Malècot, 1852-?. He invented his catheter while Interne des Hôpitaux de Paris.*



sound. The butt end of the catheter is then drawn along the urethra and made to emerge in the perineum. Two cotton sutures are tied around the catheter and utilised to anchor it to the edges of the perineal wound.

*Fashioning a New Urethra.*—An incision is made as outlined in fig. 1147 (A). The flaps are undermined, special attention being paid to freeing the skin in the direction of the perineum, so that when the flaps are united they lie well forward of the old

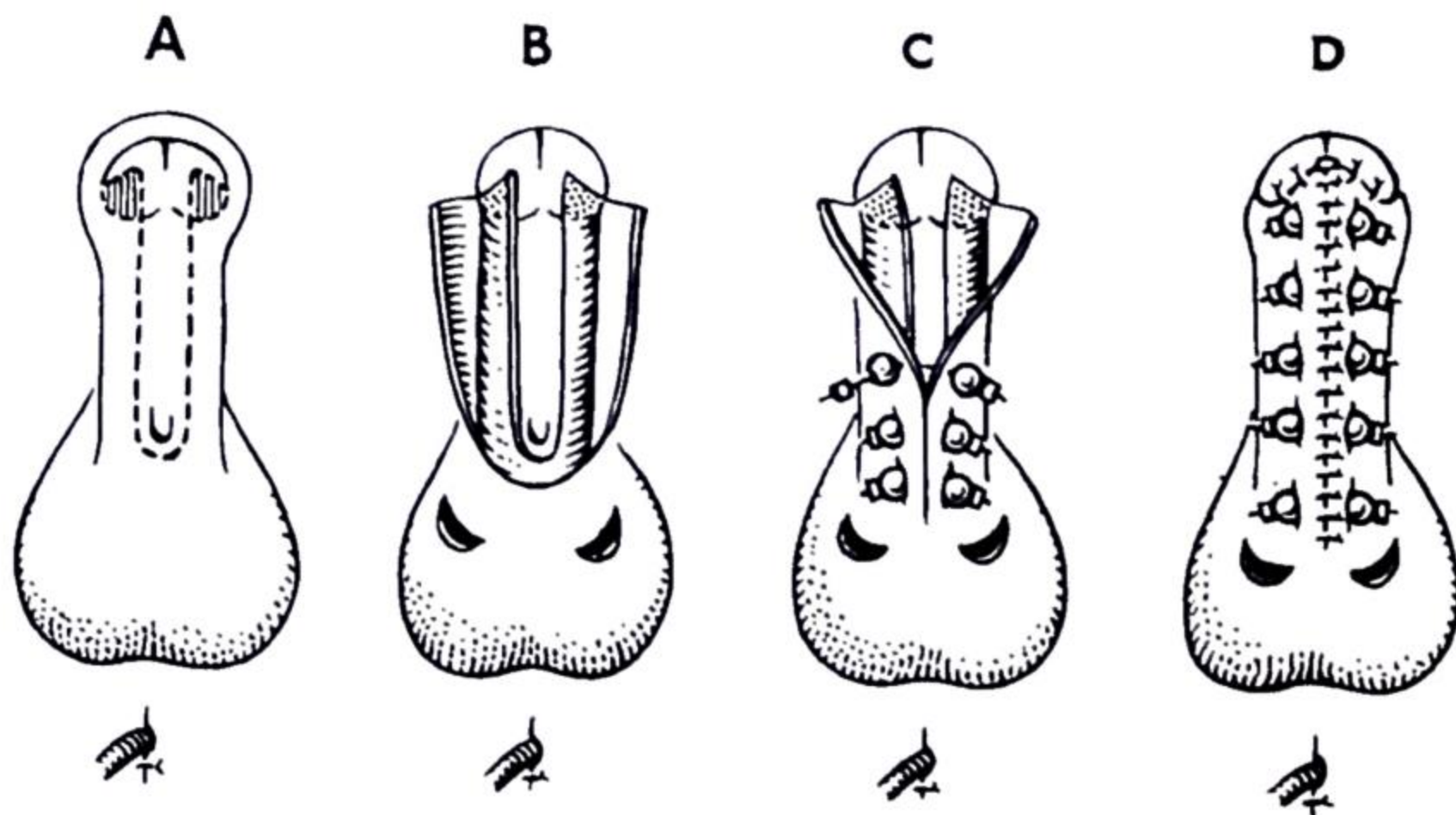


FIG. 1147.—Denis Browne's operation for hypospadias. The buried strip of skin forms the new urethra.

urethral opening. When the undermining involves the scrotum, stab wounds should be made on either side to allow the ready escape of blood and serum. Next, with sharp scissors, a triangular area of glans is bared of skin on either side of the proposed new meatus (fig. 1147 (B)). An incision is made through the skin along the whole length of the dorsum of the penis. This is to relieve tension, and is allowed to epithelialise. The flaps are sutured, but not too tightly. Browne employs glass beads and small sections of soft aluminium tubing, which are crushed, and hold the sutures in place (fig. 1147 (C)). No dressing is employed—only a spray of penicillin and sulphanilamide powder. Penicillin is administered systemically for a week, at the end of which time the sutures are removed. The Malécot catheter is withdrawn on the tenth day, and the perineal wound usually closes three to five days later.

#### EPISPADIAS

Unlike hypospadias, epispadias is exceedingly uncommon; it occurs in one in 30,000 males and one in 400,000 females. There are epispadia glandis (fig. 1148), epispadia penis, and epispadia totalis, which is usually associated with ectopia vesicæ. In the first two varieties the urethral orifice is situated on the dorsum, and in the second variety the penis curves upwards in addition. The embryological explanation of epispadias is not less obscure than that of ectopia vesicæ (see p. 787).

**Treatment.**—The operative treatment is similar in principle to that of hypospadias, and is somewhat less difficult to perform.



FIG. 1148.—Epispadia glandis.

#### INJURIES

Rupture of the urethra is divided into two distinct classes—rupture of the bulbous urethra, and rupture of the membranous urethra (*syn.* intrapelvic rupture) (fig. 1149). Each is again redivided into complete and incomplete.



## RUPTURE OF THE BULBOUS URETHRA

Rupture of the bulbous urethra is the more common accident. Almost without exception there is a history of a fall astride a projecting object. In the days of sailing-ships, the common cause was falling astride a beam while

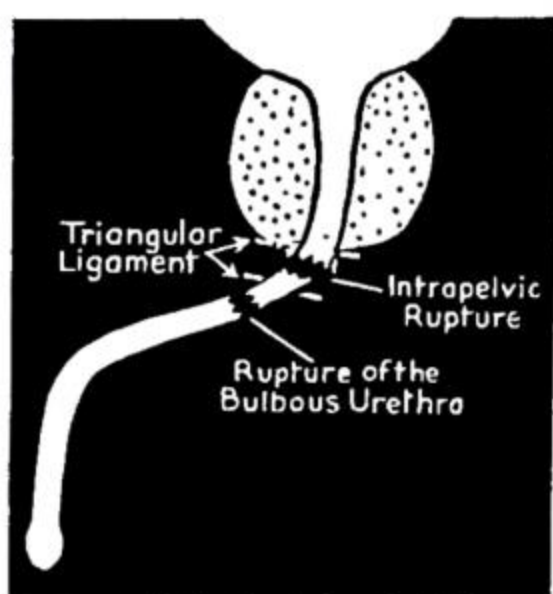


FIG. 1149.—Showing the two distinct varieties of rupture of the urethra.

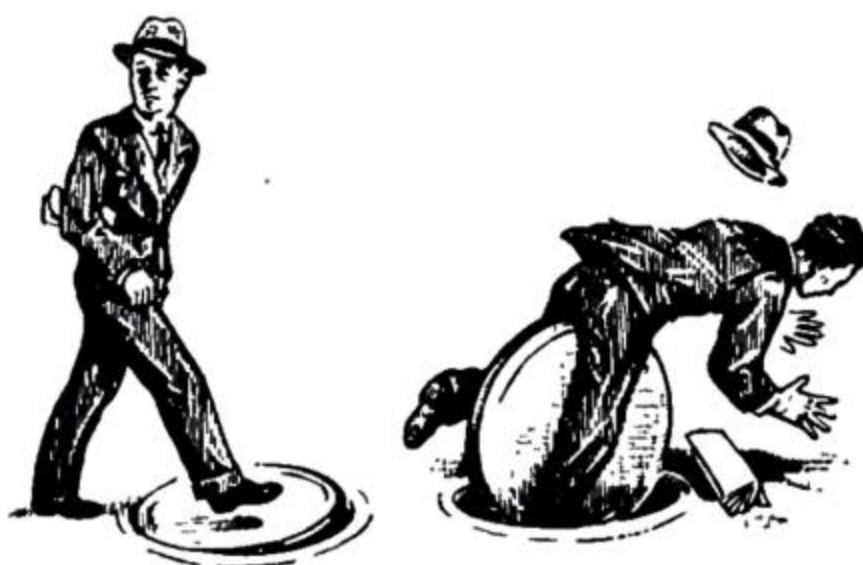


FIG. 1150.—The type of accident which results in rupture of the bulb of the urethra. (After V. J. O'Connor.)

aloft. To-day a loose manhole cover (fig. 1150) and cycling accidents account for a number of cases.

**Clinical Features.**—The triad of signs of a ruptured bulbous urethra is urethral hæmorrhage, a perineal hæmatoma, and retention of urine, to which may be added a fourth—pain.

**Preliminary Treatment and Investigation.**—If the accident is suspected, in order to prevent the possibility of extravasation, *the patient should be told not even to try to pass urine.* No attempt should be made to catheterise him until he is in the operating theatre, where asepsis can be assured and operation can be undertaken in necessary cases. At the earliest opportunity penicillin, and a suitable dose of morphine, are administered. When circumstances are extenuating and the bladder is full, it should be emptied by suprapubic puncture until the patient can be admitted to a surgical service, where the following investigation is undertaken. The urethra is irrigated carefully, and a plastic or gum-elastic bi-coudé catheter of moderate size passed along the penile urethra, the beak of the instrument being directed strictly to the *roof* of the urethra. An attempt is made to pass the catheter gently through the damaged bulbous urethra.

*If the rupture is incomplete,* the catheter will pass onwards into the bladder.

*If the rupture is complete,* the catheter cannot be passed farther than the bulb, and its arrest synchronises with a flow of blood.

### Treatment:

**Incomplete Rupture.**—Suprapubic cystostomy is performed by introducing a small de Pezzer catheter into the bladder: small because when it is removed the cystostomy wound will close quickly. If there is considerable swelling of the perineum, as well as bruising, an incision is made in the middle line of the perineum and blood and blood-clots are evacuated. By avoiding the use of an indwelling urethral catheter, subsequent stricture formation is minimised. The after-treatment is similar to that of complete rupture.

**Complete Rupture.**—Suprapubic cystostomy is performed and a metal bougie is passed through the internal urinary meatus and held in position by an assistant. The

*Oscar Michel Benvenuto de Pezzer, 1853-1917. Assistant in the Urological Department, Necker Hospital, Paris.*



patient is then placed in the lithotomy position and a second bougie is passed from the external urinary meatus. An incision is made in the middle line of the perineum. Each end of the ruptured urethra can be identified by the bougie it contains. Bleeding vessels having been ligated, the bougies are withdrawn from the field of operation and the roof of the urethra is united with two or three interrupted 000 chromic catgut sutures. The perineal wound is packed lightly with ribbon gauze soaked in flavine solution, and the skin is approximated by a stitch at each end, leaving the remainder open. The patient is taken down from the lithotomy position and the bladder is closed around a de Pezzer catheter. The suprapubic wound is closed in layers, leaving a corrugated rubber drain in the prevesical space.

**After-treatment.**—The patient is given a six-day course of sulphatriad, and penicillin is administered systemically. The bladder is irrigated twice a day with 1:4,000 acriflavine solution. The perineal wound is syringed with the same solution and protected by a dry dressing until it heals by granulation. The prevesical drain is removed at the end of forty-eight hours. On the fourteenth day a well-lubricated metal bougie (12/14 for an adult) is passed from the meatus. If the bougie enters the bladder readily, the suprapubic drainage tube is removed. If any difficulty or bleeding ensues, the de Pezzer catheter is left in place for a further week. The urethra is dilated at weekly, then longer, intervals until it can be shown by urethroscopy and urethrography that no stricture is present.

#### COMPLICATIONS OF RUPTURE OF THE BULBOUS URETHRA

**Subcutaneous extravasation of urine** occurs in complete rupture if the patient attempts to pass urine (see p. 869).

**Stricture.**—This common complication is due, for the most part, to infection, often introduced by attempts to pass a catheter, or, in cases of incomplete rupture, by tying in a catheter.

Both these complications are largely preventable, and in this connection it is well to bear in mind the words of Rutherford Morison: "Rupture of the

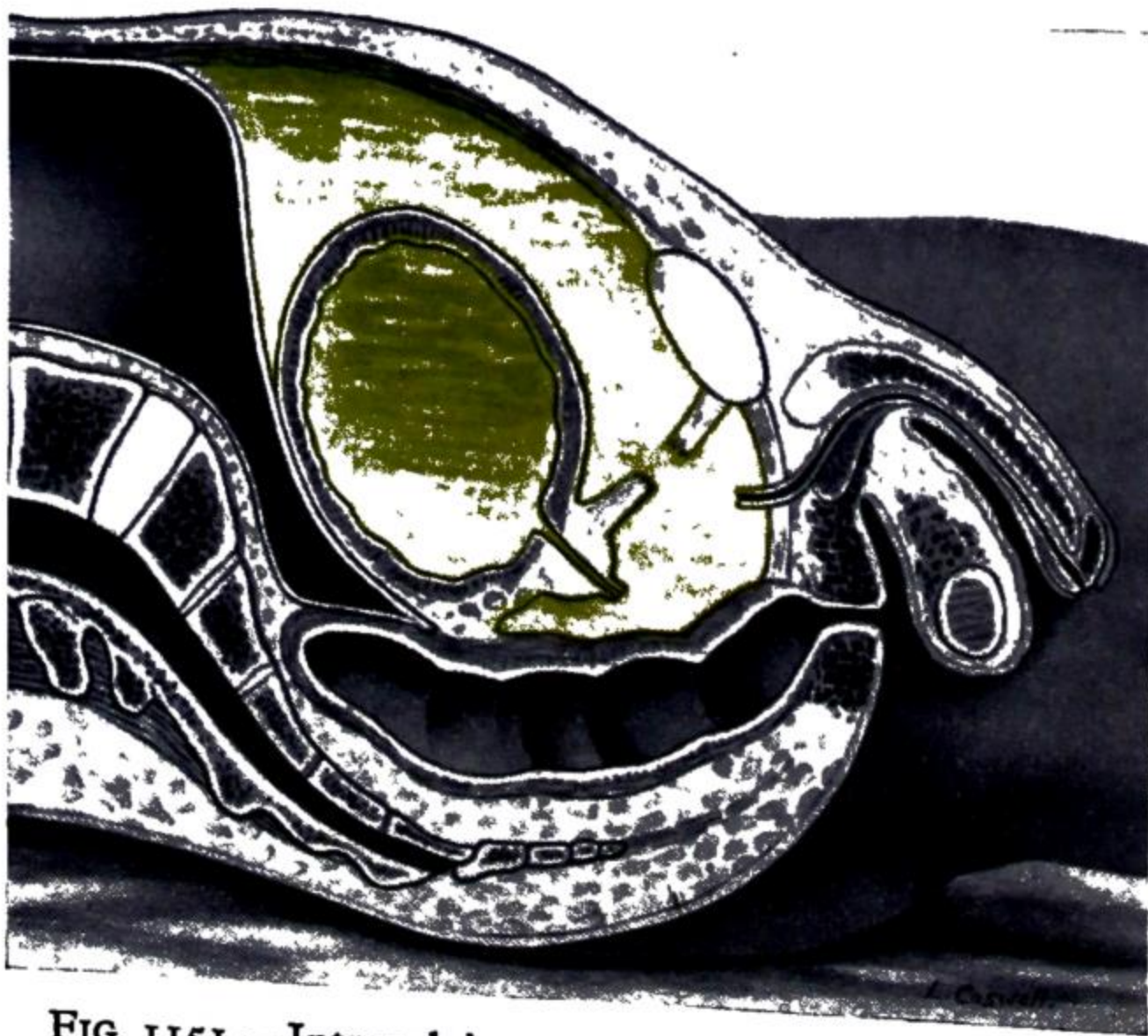


FIG. 1151.—Intrapelvic rupture of the urethra. Note the displacement of the bladder backwards, due to the tearing of the pubo-prostatic ligaments.

urethra is one of the most serious of accidents, and unless your skill can prevent the development of a stricture, you are presiding at the opening of a lifelong tragedy."

#### RUPTURE OF THE MEMBRANOUS URETHRA (*syn.* INTRAPELVIC RUPTURE)

Intrapelvic rupture of the urethra occurs in the membranous portion near the apex of the prostate (see fig. 1149). It is a complication of a fracture of the true pelvis or dislocation of the symphysis pubis; never-

theless, only 6 per cent. of cases of fractured pelvis are thus complicated. Blood, and later urine, are extravasated into the prevesical space and, because the pubo-prostatic ligaments are torn, the prostate and the bladder become

*Rutherford Morison, 1853-1939. Professor of Surgery, University of Durham, Newcastle upon Tyne.*



displaced backwards and upwards, thus producing wide separation of the ends of the severed urethra (fig. 1151).

**Clinical Features.**—Signs of shock and those of a fractured pelvis prevail for some hours. Usually urethral hæmorrhage is trivial in amount, or absent. Often it is only when the patient has not passed urine since the accident and hypogastric pain increases that signs of rupture of the urethra become manifest. On abdominal examination an ill-defined swelling is felt in the hypogastrium, usually more in evidence on one side than the other. In some cases the rounded dome of the distended bladder can be distinguished from the swelling caused by the prevesical extravasation. Per rectum the prostate cannot be felt; the area normally occupied by it is tender and unsupported.

**Investigation.**—(a) *Radiography.*—When possible radiographs to confirm the diagnosis and ascertain the nature of the displacement of the fractured pelvis are highly desirable.

(b) *Urethrography,* utilising a medium that is employed for intravenous pyelography or, more conveniently, iodised jelly delivered from a collapsible tube, will enable an intrapelvic rupture of the urethra or an extraperitoneal rupture of the bladder to be distinguished from a lesion not requiring operation.

(c) In the absence of facilities for (b), an attempt should be made to pass a catheter from the external meatus: one should be mindful lest the withdrawal of a few ounces of blood-stained urine from the prevesical space (see fig. 1151) be mistaken for an entry into the bladder.

It is necessary to add that (b) and (c) must be undertaken with rigorous aseptic precautions, in the operating theatre for preference.

### Treatment:

During the operation the patient receives either a blood transfusion, or a dextran or plasma infusion, to combat shock. The first step is to make a suprapubic incision which opens the prevesical space. As a rule it is only after this has been done that it is possible to distinguish between an extraperitoneal tear of the bladder (see p. 791) and an intrapelvic rupture of the urethra. The guiding rule is, if the bladder is even moderately distended the lesion must be situated below the vesical sphincter. Thus the diagnosis of intrapelvic rupture of the urethra is confirmed. Direct suture of the membranous urethra is impracticable, yet it is imperative to bring into direct apposition the widely separated ends of the urethra. This is accomplished in the following way. The bladder is opened suprapubically and a metal bougie is passed through the internal meatus to the seat of the rupture. A second metal bougie is passed from the external urinary meatus. The two bougies are manipulated until their tips touch (fig. 1152). By slowly withdrawing the first bougie and steadily advancing the second, while keeping their tips in contact, it is possible to guide the second bougie past the seat of the rupture into the bladder. The first bougie is withdrawn and a piece of plain rubber tubing of such a size as to fit tightly is



FIG. 1152. — Intrapelvic rupture of the urethra. Showing the tips of the metal bougies in contact.



threaded on to the beak of the second bougie, which is withdrawn, carrying with it the rubber tubing. Outside the external urinary meatus the bougie is disengaged from the rubber tubing, and to the latter is fastened, by means of a stitch, the tip of a Foley's catheter. By pulling on the vesical end of the rubber tubing the tip of the Foley's catheter is drawn into the mouth of the suprapubic wound, where it is disconnected from the rubber tube. At this stage it is advisable to tie a long piece of silk firmly to the tip of the Foley's catheter, and to wind the excess around a wooden spatula. (The reason for this is that should the balloon burst, the Foley's catheter can be replaced in the ward by the railroad method.) This completed, the balloon of the catheter is moderately distended with water and the side tube is ligated (see fig. 1153).

*Concluding the Operation.*—The catheter is drawn down so that the balloon rests upon the bladder neck. The bladder is closed around a large drainage tube, which is used for suction (sump) drainage, leaving two pieces of corrugated rubber (one passing to the right and the other to the left) in the prevesical space.

### After-treatment:

**Urological.**—(1) By the mediation of a length of silk, attached to the bell end of the catheter and transfixing both walls of the catheter, extension is applied to the catheter via a pulley and a weight; thus the severed ends of the urethra are brought into contact (fig. 1153). The weight applied is

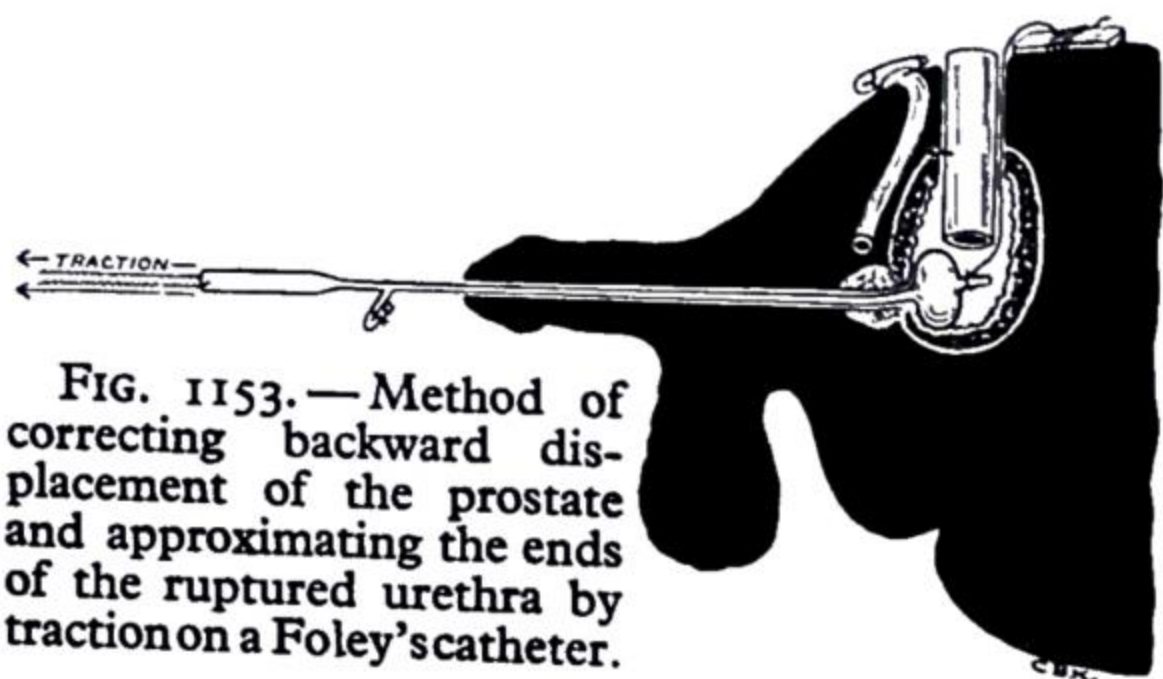


FIG. 1153.—Method of correcting backward displacement of the prostate and approximating the ends of the ruptured urethra by traction on a Foley's catheter.

2 lb. (900 G.) for the first three days and 1 lb. for the next ten days. Bed-cages are arranged so as to prevent the bedclothes touching the taut silk cords.

(2) Suction (sump) drainage of the bladder is maintained for twelve days, the objective being to keep urine away from the severed end of the urethra.

(3) The urine is kept

alkaline and antibiotic treatment is given for at least ten days, the urine being examined bacteriologically every third day.

(4) On or about the twelfth day the Foley's catheter is removed, and during the process the silk attached to its tip is unwound from the spatula; thus the silk lies along the whole length of the urethra, one end being tied to the spatula and the other emerging from the external urinary meatus. By this expedient, facile dilatation can be carried out every third day by the railroad method. Sump drainage is also discontinued on the twelfth day in favour of a suprapubic de Pezzer catheter. By the end of three and a half weeks the silk thread and the de Pezzer catheter are removed. If correct urethral alignment has been obtained (which is the objective of the above method) the membranous urethra shows but little tendency to stricture formation.

**Orthopædic.**—The management of the fractured pelvis is described on p. 1198.

### EXTRAVASATION OF URINE

**Superficial extravasation** occurs in neglected cases of complete rupture of the bulbous urethra, i.e. when operation is not undertaken within twelve to twenty-four hours.



The extravasated urine cannot pass (1) behind the middle perineal point, because of the attachment of the perineal (Colles's) fascia to the triangular ligament; (2) into the thighs, for the deep layer of the superficial fascia of the abdominal wall (Scarpa's fascia) blends with the pubic portion of the fascia lata just distal to the inguinal ligament; (3) into the inguinal canals, because of the intercolumnar fibres and fascia of the external oblique (external spermatic fascia).

It therefore must pass (1) into the scrotum; (2) beneath the superficial fascia of the penis; (3) up the abdominal wall beneath the deep layer of the superficial fascia (fig. 1154).

**Treatment.**—Urgent operation is a necessity.

Multiple incisions are made in the infiltrated tissues of sufficient depth to penetrate the limiting fascia. By the time extravasation has occurred it is unlikely that the urethra can be repaired in the way described already (see p. 869), for the sutures would cut out of the œdematous inflamed tissues. It is therefore often advisable to adopt the sutureless operation of Rutherford.

Suprapubic cystostomy is performed and a metal bougie is passed through the internal urinary meatus. The patient having been placed in the lithotomy position, another metal bougie is passed from the external urinary meatus to the perineum, and perineal section is carried out. A Foley's catheter is introduced from the external urinary meatus into the bladder in the same way as that described for intrapelvic rupture of the urethra, and the bladder is closed around a de Pezzer catheter. The perineal wound is left widely open. The urethral catheter is removed after three or four days. In other respects the after-treatment is similar to that for complete rupture of the bulbous urethra.

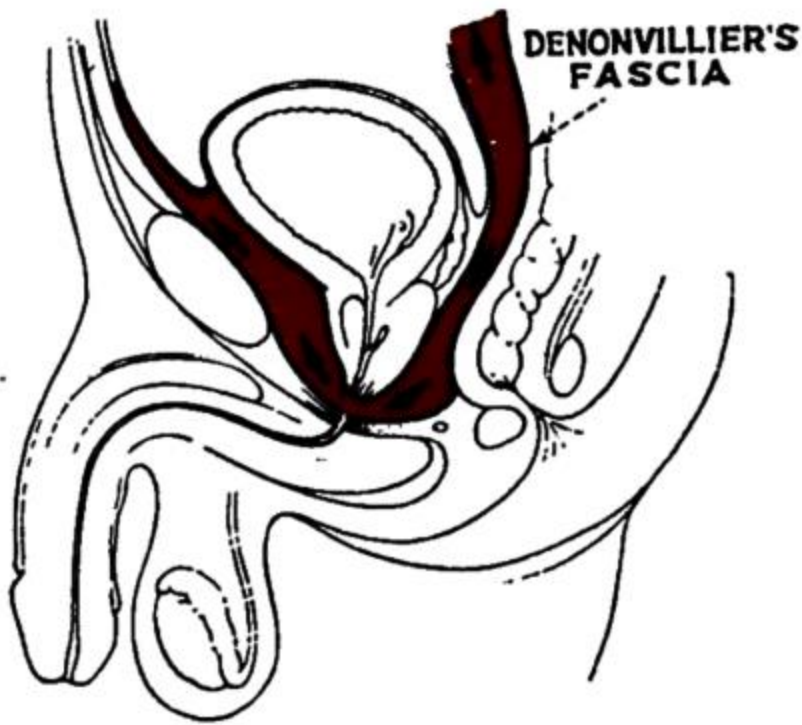


FIG. 1155.—Area occupied by extravasated blood and urine in the case of intrapelvic rupture of the urethra.

In these conditions urine extravasates in the layers of the pelvic fascia and in the retroperitoneal tissues.

**Treatment.**—When extravasation is proceeding from the bladder, it is necessary to drain the prevesical space (cave of Retzius) and to perform suprapubic cystostomy. The treatment of the various conditions which give rise to deep extravasation of urine are considered in their appropriate sections.

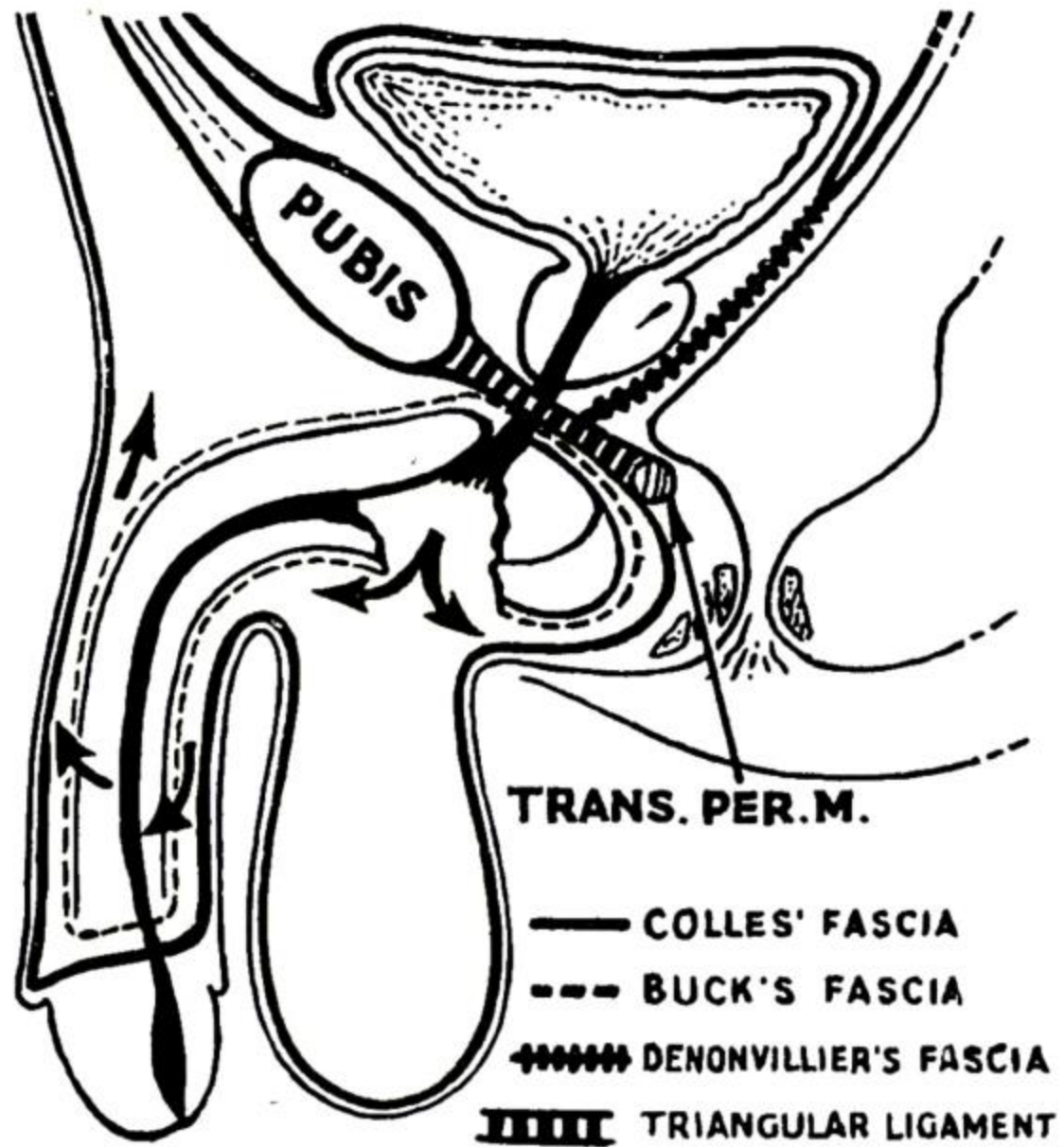


FIG. 1154.—The fascial planes concerned in superficial extravasation of urine.

**Deep extravasation** (fig. 1155) occurs in the case of extraperitoneal rupture of the bladder, intrapelvic rupture of the urethra, and after suprapubic puncture, when the bladder has been allowed to refill. It can also result from rupture or

Abraham Colles, 1773-1843. Surgeon, St. Stephen's Hospital, Dublin. Professor of Surgery for thirty-two years.  
 Antonio Scarpa, 1747-1832. Anatomist and Surgeon, Venice.  
 Gurdon Buck, 1807-1877. Surgeon, New York Hospital, New York.  
 Charles Pierre Denonvilliers, 1808-1872. Professor of Anatomy, later Professor of Surgery, Paris.  
 Henry Rutherford, 1861-1929. Surgeon, Glasgow Royal Infirmary.  
 Anders Retzius, 1796-1860. Professor of Anatomy, Karolinska Institutet, Stockholm.



## INFLAMMATIONS

## ULCERATION OF THE URETHRAL MEATUS

Ulceration of the meatus in young male children (fig. 1156) is a common clinical entity. It is never found in the uncircumcised. It is common after circumcision, though an interval of three to eighteen months may elapse between the operation and the onset of symptoms. Lack of protection given by the prepuce is the initial cause.



FIG. 1156.—Ulceration of the urinary meatus in a child of one year.

Friction of the clothing and ammoniacal urine are important secondary ætiological factors. The ulcer causes a scab to form which closes the meatus, and the child can only urinate by bursting this scab. This process is usually accompanied by pain and screaming, and a few drops of blood may be passed. Ulceration and scab formation alternate, and if neglected, cicatricial contracture of the meatus may result eventually in an acquired pin-hole meatus.

According to M. F. Campbell, the lesion commences as a local erythema surrounding a congenital stenosed meatus. The erythema is followed by herpetic vesicles that rupture to form ulcers, which become confluent. With drying of the ulceration, the area becomes covered with a scab (fig. 1156).

**Treatment.**—Meatotomy, followed by intermittent dilatation of the meatus, is curative so regularly as to support Campbell's hypothesis. If there is an associated ammoniacal dermatitis the diapers should be washed, not with soap but with a saturated solution of boric acid or a 1 in 80 solution of roccal (Bayer Products Ltd.). The baby itself is washed with the same solution, no soap being used. Ascorbic acid, 50 mg. (grain 1) daily, is prescribed.

## URETHRITIS

**Gonorrhœa** (see p. 32).

**Non-gonococcal urethritis** has become a world problem; it is now nearly as common (especially among military personnel) as gonorrhœa in the male. The incubation period is somewhat longer than that of gonorrhœa. The cause of this infection has yet to be discovered. A virus of the pleuro-pneumonia group has been incriminated, but at the present time this is considered not to be the cause, but an early symbiotic intruder. In most instances the infection is the result of coitus with a woman suffering from leucorrhœa and a cervical erosion, and whenever possible the female partner should be examined and treated, otherwise reinfection is probable. While in many cases organisms in the discharge are absent, in others, especially those of long standing, a profuse and varied flora is found. Undoubtedly most of these organisms are the result of secondary infection.

The symptoms are identical with those of gonorrhœa, and the diagnosis can only be established by failing to find the gonococcus on several occasions.

**Treatment.**—Non-gonococcal urethritis is a self-limiting disease, which makes the results of treatment difficult to assess. E. E. Prebble has found that urethral irrigations with oxycyanide of mercury in a strength of 1 in 8,000 and the temperature of the irrigating fluid 105° F. (40.5° C.) given once daily for three to seven days is successful in 85 per cent. of cases. In some quarters treatment by local irrigation is decried as old-fashioned, whereas treatment exclusively by antibiotics (which are very costly but are less

Meredith Fairfax Campbell, *Contemporary*; Emeritus Professor of Urology, New York College of Medicine, New York.  
Ernest Earlam Prebble, *Contemporary*; Director of the V.D. Department, Royal Infirmary, Liverpool.



troublesome to administer) are in favour generally. Good results have been obtained by oxytetracycline and also by the newer antibiotic, spiramycin, given orally four times a day for five days (R. R. Willcox). Furacin urethral suppositories quickly render the patient asymptomatic, but on withholding the treatment early relapse is the rule. In most instances refractory cases are due to misdiagnosis, the most common being overlooking the presence of a urethral polyp or especially a trichomonas infection.

**Urethritis due to *Trichomonas Vaginalis*.**—Although infection due to *Trichomonas vaginalis* is regarded as a disease of women, there is increasing evidence of its occurrence in men as well; indeed, the carrier of the disease is often a male in whom the parasite causes no symptoms. In men, the small number of parasites present in the discharge, and the difficulty in finding them, accounts for the fact that infection with *Trichomonas vaginalis* is not widely recognised, and such infection is considered to be due to non-gonococcal urethritis. The type of discharge is in no way diagnostic: it is slight to moderate in amount, greyish in colour, and of a thin or mucoid nature. It is only by examining at once a specimen of the discharge as a 'hanging drop' preparation that this protozoon<sup>1</sup> (fig. 1157) can be identified. *T. vaginalis* urethritis in the male often proves a most difficult infection to eradicate, the treatment being handicapped by the high rate of reinfection, which emphasises the necessity for treating, whenever possible, the women as well as the men. It is doubtful if any antibiotic has a specific lethal effect on this protozoon. The most promising results have followed local treatment with furacin urethral suppositories, and this form of medication may well become the treatment of choice. In addition, an important consideration is alkalinisation of the urine.



FIG. 1157.—*Trichomonas vaginalis* from a urethral discharge (unstained).

#### REITER'S DISEASE

The condition commences as a non-gonococcal urethritis, the urethritis being subacute, usually devoid of organisms, and the discharge being clear and viscid. A few days later conjunctivitis occurs, at first unilateral, and then bilateral. Usually in ten days to two weeks arthritis supervenes (acute hydrarthrosis of at least one joint is present in every case). Another concurrent manifestation that often accompanies the onset of arthritis is keratoderma blennorrhagicum, consisting of nodules, vesicles, and pustules, frequently found on the soles of the feet. Pleuro-pneumonia-like organisms have been isolated from the various lesions of this condition in approximately 30 per cent. of cases.

**Differential Diagnosis.**—In untreated gonorrhœa, arthritis and ophthalmic infection were not rare in the past. The absence of the gonococcus is of the highest importance in coming to the conclusion that the symptoms are due to Reiter's disease. In Reiter's disease the urethritis, as well as the arthritis, is milder and the incubation

<sup>1</sup> Black-head disease in turkeys is caused by a flagellated protozoon almost identical with *T. vaginalis*.

Richard Robert Willcox, *Contemporary Venereologist, St. Mary's Hospital, London.*  
Hans Reiter, *Contemporary, Sometime Professor of Hygiene, University of Berlin.*



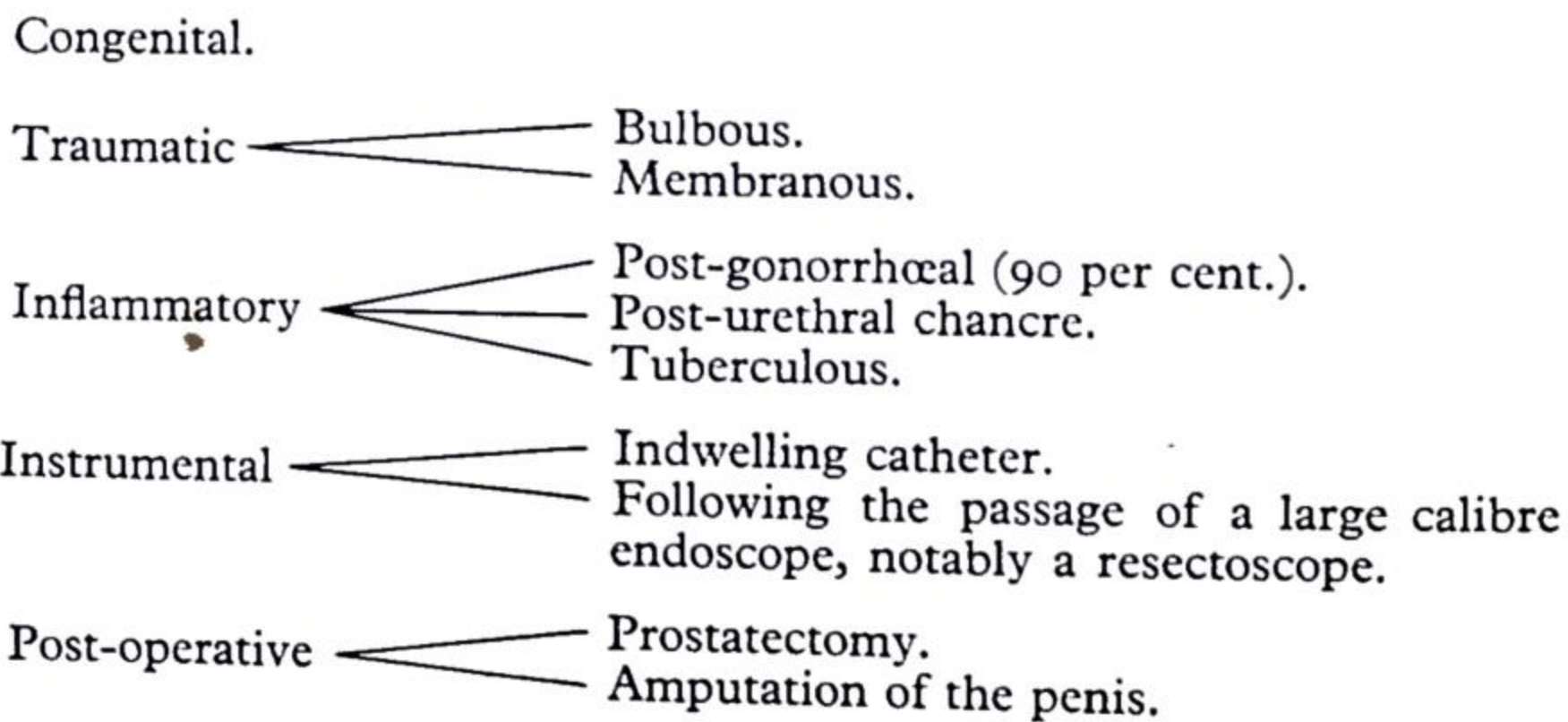
period is much longer in Reiter's disease than in gonorrhœa. Furthermore, never are the ocular manifestations of Reiter's disease so destructive as those of gonorrhœa.

**Prognosis.**—Usually the disease is self-limiting over a period of weeks or months, and on the whole the prognosis is good, no fatality having been reported. The urethritis and conjunctivitis frequently subside, but more often than not the arthritis persists for many months.

**Treatment.**—While the ophthalmic complications must be treated thoroughly following the usual lines (eye-baths and shielding the eyes from a bright light), there is no evidence that any form of treatment at present in use has any influence on the course of the disease (W. Fowler). Various antibiotics and fever therapy induced by graduated doses of triple typhoid vaccine (TAB) have been tried, the last being given for the arthritis.

#### URETHRAL STRICTURE

Urethral strictures are divided conveniently into the following varieties :



**Post-gonorrhœal stricture**, which has become less common since the introduction of the antibiotic treatment of gonorrhœa, is situated most frequently (*a*) in the bulb (70 per cent.); (*b*) at the peno-scrotal junction; (*c*) in the distal part of the spongy urethra, in that order. The membranous and prostatic parts of the urethra are exempt.

Multiple strictures are relatively common, and in a urethroscopic study of eighty-seven consecutive cases I found that in over 30 per cent. the stricture was triple. When there are two strictures, the deeper is the narrower; when there are three strictures, the deepest is the narrowest. If a stricture in the penile urethra has a very narrow orifice, there is seldom another stricture behind it.

**Pathology.**—Following inadequately treated gonorrhœa, infection persists in the periurethral glands, and spreads to the periglandular tissues, which become infiltrated with round cells and fibroblasts. Gradually the infiltrated periurethral tissues contract with the formation of scar tissue, localised thrombophlebitis of the corpus spongiosum playing a part in the more dense varieties. Whereas in the bulbous urethra the fibrosis is most in evidence in the roof, in the penile urethra it predominates in the floor. Most strictures develop during the first year after gonorrhœal infection, but they may not give rise to dysuria for ten to fifteen years.

**Clinical Features.**—In a stricture of large calibre the only symptoms are the occasional passage of flakes (desquamated epithelium) in the urine and a varying amount of urethral discharge (gleet), most in evidence in the early morning. As might be expected, often these symptoms are neglected until the diminished calibre of the urethra causes considerable difficulty in micturition. Then the leading symptom is dysuria. In contradistinction to obstruction due to an enlarged prostate, the patient finds he must strain



to empty the bladder. Another distinguishing feature is the patient's age. He is often considerably younger than the prostatic sufferer, or the symptoms of dysuria date back to some time prior to the fiftieth year. As the calibre of the stricture diminishes so the urinary stream becomes increasingly narrow, and eventually it is projected with so little force that it drops almost immediately. Micturition is prolonged, and after it has seemingly ended dribbling occurs. This is due to urine trickling from the dilated urethra above the stricture. Increasing frequency of micturition, at first during the day and then both by day and by night, is another common complaint, due either to incomplete emptying of the bladder at each act of micturition, or to cystitis, or to both. In long-standing cases it is often possible to palpate the stricture from without as an induration in the urethral floor. The evil effects of urethral obstruction upon the bladder, ureters, and kidneys are similar to those of prostatic obstruction (p. 836). Untreated, sooner or later retention of urine supervenes. Sometimes acute retention sets in while the stricture is still of moderate calibre ; it is then due to superadded œdema of the urethral mucous membrane in the neighbourhood of the stricture, brought about by voluntary retention, alcoholic excess, or recrudescence of local infection. In other cases narrowness of the stricture results in increasing inability to expel residual urine, and acute-on-chronic retention, or retention-with-overflow, supervenes.

**Urethroscopy** renders the diagnosis of urethral stricture very precise.

The stricture can be seen as a white scar of fibrous tissue, and its position in the urethra, the size of its contained lumen, and its dilatability can be judged (fig. 1158).

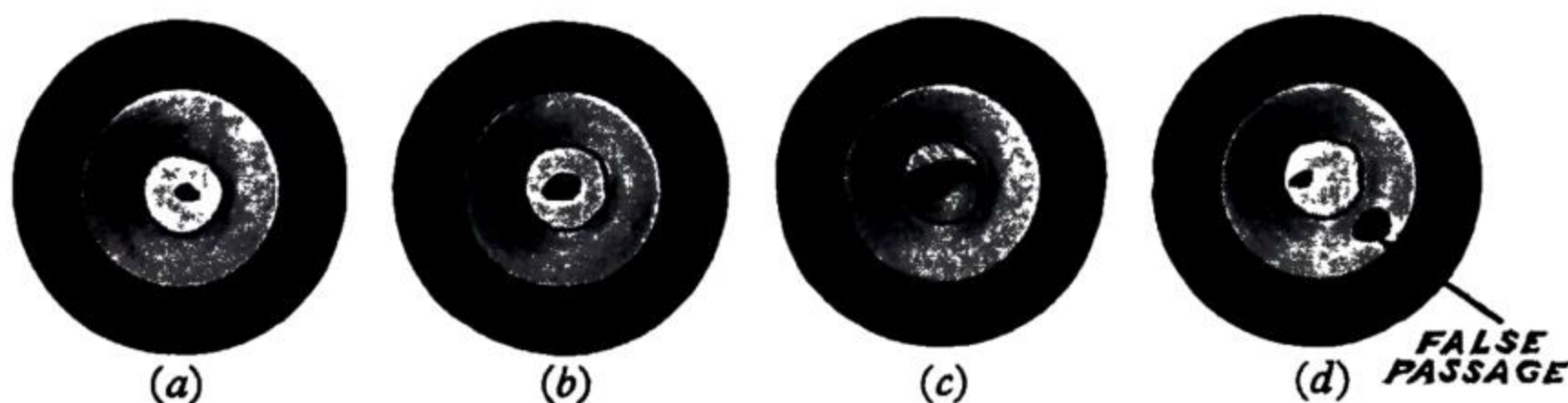


FIG. 1158.—Urethroscopic appearances. (a) Fine-bore stricture. (b) Moderate-bore stricture. (c) Crescentic stricture of the roof. (d) Stricture with false passage.

Often a stricture encircles the whole urethra, and the lumen is more or less centrally placed, but from time to time a variety of urethroscopic appearances is noted in individual cases ; for instance, the stricture may take the form of a crescent.

**False passages** may be seen. They are recent penetrations of the urethra in front of the stricture due to unskilful attempts to pass a bougie. False passages are particularly liable to bleed, and it is of paramount importance to cease æro-urethroscopy if urethral hæmorrhage occurs, for fatal air embolism has resulted from air being pumped into the cavernous tissue through a urethral wound.

**Urethrography** is another valuable measure for investigating certain strictures of the urethra. By this means it is



FIG. 1159.—Urethrogram showing a stricture of the membranous urethra following fracture of the pelvis.



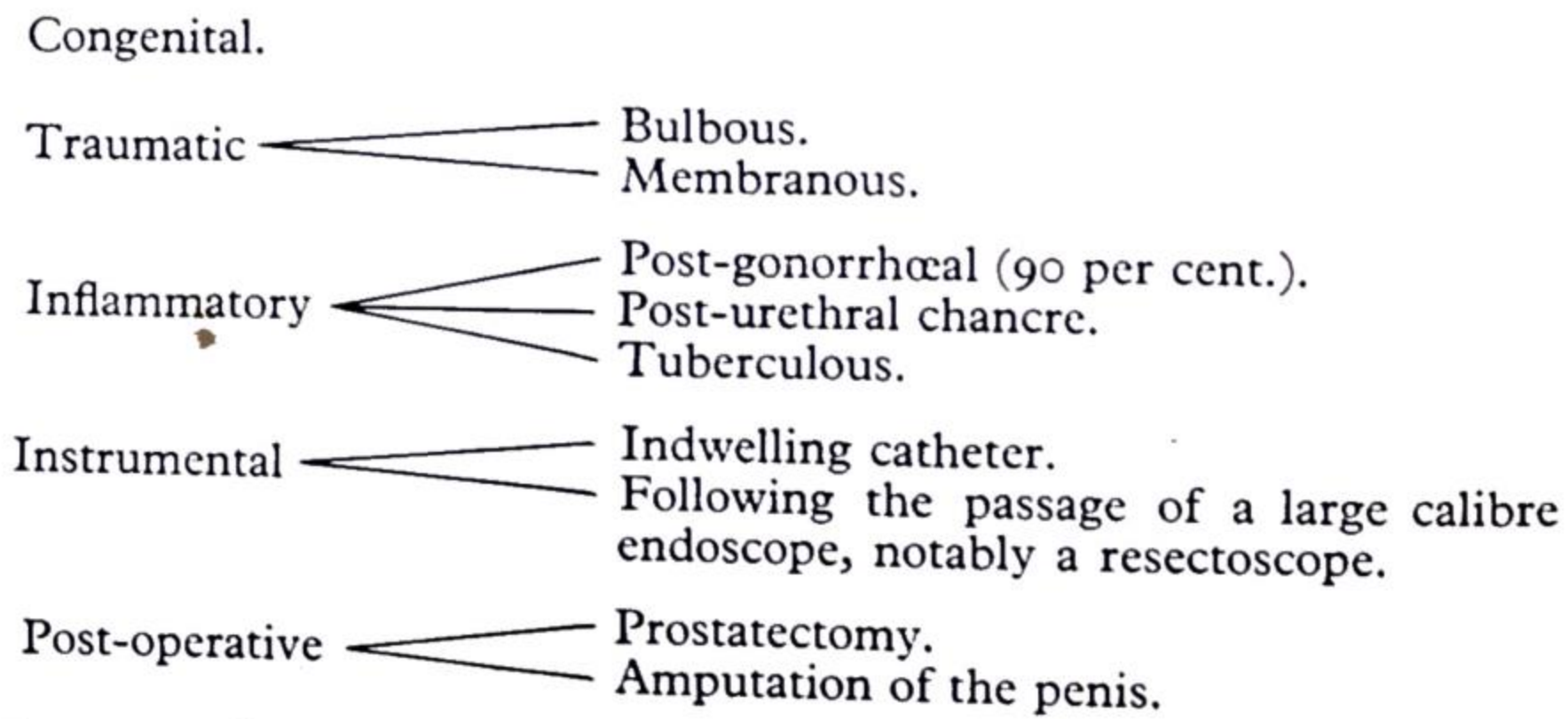
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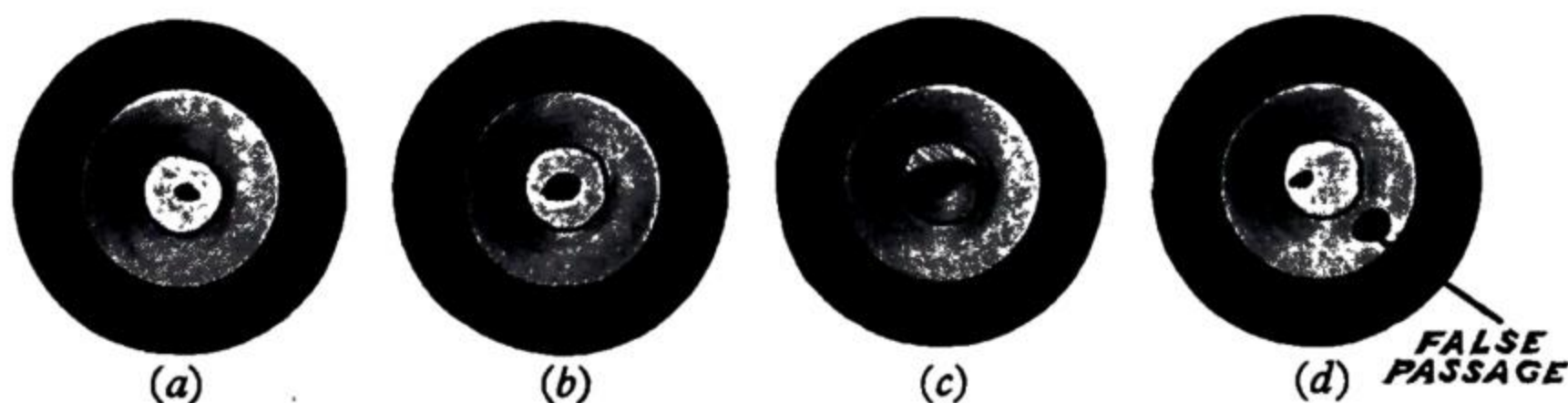


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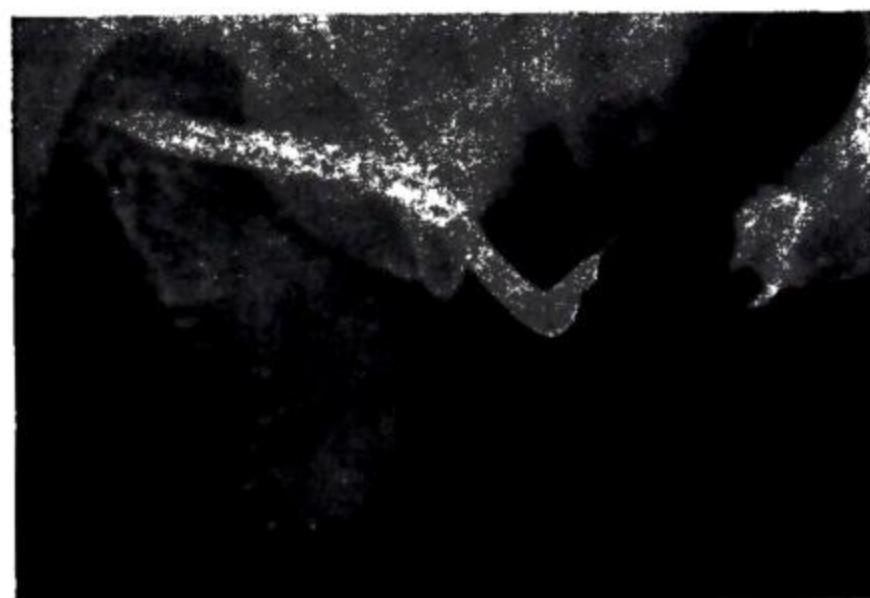


FIG. 1159.—Urethrogram showing a stricture of the membranous urethra following fracture of the pelvis.



possible to gain information concerning the length of a stricture, of dilatation or diverticulum formation above the stricture, or failure of the medium to pass a stricture (fig. 1159). The technique of urethrography is described on p. 717.

#### INSTRUMENTAL TREATMENT

**Intermittent Dilatation.**—In the majority of instances, provided the patient attends regularly, dilatation at suitable intervals is a satisfactory form of treatment. Before each dilatation the glans penis and urinary meatus are cleansed, and the anterior urethra is irrigated with a mild antiseptic solution, after which local anæsthetic (e.g. nupercaine jelly) is instilled. Dilatation must be carried out extremely gently with lubricated bougies of increasing size.

On no account should the stricture be forcibly or over-dilated, both of which result in traumatism that induces inflammatory œdema and subsequent deposition of more fibrous tissue.

Strictures of very small calibre should be dilated twice a week. With this exception it is sufficient for the patient to attend for treatment at weekly intervals until the calibre of the urethra is nearly normal, when the interval is lengthened. Full calibration having been obtained, the intervals between dilatations can be extended to six months, and finally to one year. A few strictures are cured by full dilatation, but in the majority the patients must be kept under supervision for the remainder of their lives.

**Cortisone as an Adjuvant Measure.**—Steroid therapy offers a most valuable addition to the management of urethral strictures. It can be administered by mouth or by injection into the tissues in the neighbourhood of the stricture.

(a) **By Mouth.**—1.5 mg. of prednisone and 300 mg. of aspirin are given four times a day for three weeks after dilatation.

(b) **By Local Injection.**—Following anæsthetisation of the urethra, 6.25 mg. of hydrocortisone is injected in the neighbourhood of the stricture at 5 and 7 or 3 and 9 o'clock, using a 22-gauge needle and a 2-ml. syringe. Subsequently the dose is increased to 12.5 mg. After three injections, followed by dilatation, often the stricture disappears entirely.

Steroid therapy prevents the formation of new scar tissue after dilatation, and existing scar tissue becomes quite soft, and dilates easily.

**Gum-elastic bougies** (*syn.* French bougies) (fig. 1160) should be the standard instruments in the early stages of treatment of all but the very finest strictures. It is usual to commence with a No. 10 French, and if this cannot be passed, progressively



FIG. 1160.—Gum-elastic bougie.

smaller bougies are employed. Eventually it may be necessary to resort to filiform bougies.

**Filiform bougies** are gum-elastic bougies varying in size from 1 to 3 French. If one fails to pass, it is often valuable to insert several as far as the stricture. By manipulating each back and forth, frequently one of them can be induced to negotiate the stricture (fig. 1161). To distend the urethra with sterile olive-oil and apply a penile clamp to the glans penis prior to attempting the foregoing method adds to the



chances of its success, because obstructing folds of mucous membrane are separated by the oil distension. If this method fails, it is sometimes possible to pass a filiform bougie through the stricture under the vision afforded by a urethroscope. If any



FIG. 1161.—'Faggot' method of introducing a bougie through a stricture.

bleeding has been occasioned by the attempt to pass bougies, urethroscopy should be postponed for several days. Very few urethral strictures are impassable, but it often requires patience to insinuate even the finest urethral guide: only when even a filiform bougie cannot be passed on three successive occasions is a stricture held to be impassable.



FIG. 1162.—Filiform bougie with follower.

**Filiform Bougies with Followers.**—Filiform bougies furnished with threaded hollow mounts at their proximal ends are to be preferred, because screw-ended gum-elastic bougies of a larger size can be attached and guided by the filiform through the stricture. In this way many strictures of very small calibre can be dilated sufficiently to render subsequent dilatations less arduous.

By means of gum-elastic bougies a stricture is dilated up to the size of 14 French. Thereafter metal bougies are to be preferred.



FIG. 1163.—Lister's metal bougie.

**Lister's metal bougies** (*syn.*

English bougies) (fig. 1163) are indicated after the second or third attendance of the patient, when it has been proved that the stricture is responding to dilatation by the French bougies. Metal bougies of a smaller size than 7/9 English should not be used, for fear of making a false passage.



FIG. 1164.—Kollmann's curved urethral dilator.

**Kollmann's dilator** (fig. 1164) is used in the last stages of treatment to dilate the stricture fully. This instrument is particularly useful in post-prostatectomy strictures. The straight pattern, designed for

strictures placed more anteriorly, is now seldom employed.

**Continuous dilatation** necessitates some days of in-patient treatment, but it is of immense benefit in cases where little or very slow progress is made by intermittent dilatation. In a number of instances continuous dilatation obviates the necessity for operative treatment.

#### OPERATIVE TREATMENT

**Suprapubic catheterisation** with decompression of the bladder is required when retention of urine, due to a urethral stricture, cannot be relieved by urethral instrumentation. With the relief of retention, reduction of congestion and œdema of the strictured portion of the urethra ensues, and a week or ten days after the bladder has been decompressed it is often possible to insert a bougie via the external urinary meatus through a previously impassable stricture, in which event treatment is by continuous dilatation.

#### Elective Procedures:

So satisfactory are the results of regular dilatation that only a very small percentage of patients with a urethral stricture require operative treatment. In former days, when post-gonococcal urethral stricture was exceedingly common, a number of operations were practised that gave good results. At the present time the procedures about to be described fulfill almost every requirement. Before deciding on operative treatment it is desirable to

Lord Lister, 1827-1912. Professor of Surgery at Glasgow, Edinburgh, and London.  
Artur Kollmann, 1858-1941. Urologist, Leipzig.



undertake urethrography, in order to determine the location and extent of the stricture or strictures.

**Internal Urethrotomy.**—For cases of resilient stricture of the bulbous or penile urethra, and particularly for cases of multiple strictures which can be dilated only with recurring difficulty, internal urethrotomy is the operation of election in a number of clinics. Before internal urethrotomy is undertaken renal function must be tested and proved satisfactory, and urinary infection controlled as far as possible by a sulphonamide and an antibiotic. The filiform guide of the instrument is passed through the stricture, and in cases where it is known that this part of the procedure is difficult, the guide is passed before a general anæsthetic is administered. On to



FIG. 1165.—Thomson-Walker's urethrotome.

the base of the guide is screwed the staff of the instrument, with its obturator in position. The well-lubricated staff is made to follow the guide, which curls up within the bladder. The wings of the staff are firmly held by an assistant in the middle line at an angle of 45 degrees from the horizontal. The obturator is removed, and into the groove it occupied is passed a triangular knife (fig. 1165). The penis is stretched with the left hand behind the corona, and the knife, which has a bevelled apex so that it cannot cut the normal urethra, is advanced along the groove until it meets the stricture. By a sharp thrust of the knife the stricture is divided. As the knife is withdrawn, its posterior edge cuts the stricture again. The staff, with its attached guide, is removed and large metal bougies up to 14/16 English are passed. A No. 14 gum-elastic catheter is tied into the urethra and retained for three days, during which time bladder washes are given twice daily. Internal urethrotomy is but a prelude to intermittent dilatation by bougies, which should be commenced fourteen days after the operation.

**Johanson's Urethroplasty** is well suited to dense or resilient strictures of the pendulous urethra. *Stage 1:* The floor of the urethra is laid open from the external urinary meatus to a point well proximal to the deepest stricture (fig. 1166 (A)). The cut edges of the urethra are then sutured meticulously to those of the adjacent skin (fig. 1166 (B)) using interrupted 000 chromic catgut stitches. The urine is side-tracked by an indwelling catheter connected to a water-seal bottle for six days. The patient then returns home. The hypospadias thus created provides unequalled drainage and complete rest for the whole of the strictured area.

*Stage 2:* About two months later, when considerable healing will have occurred, Denis Browne's operation for hypospadias (see p. 867) is performed.

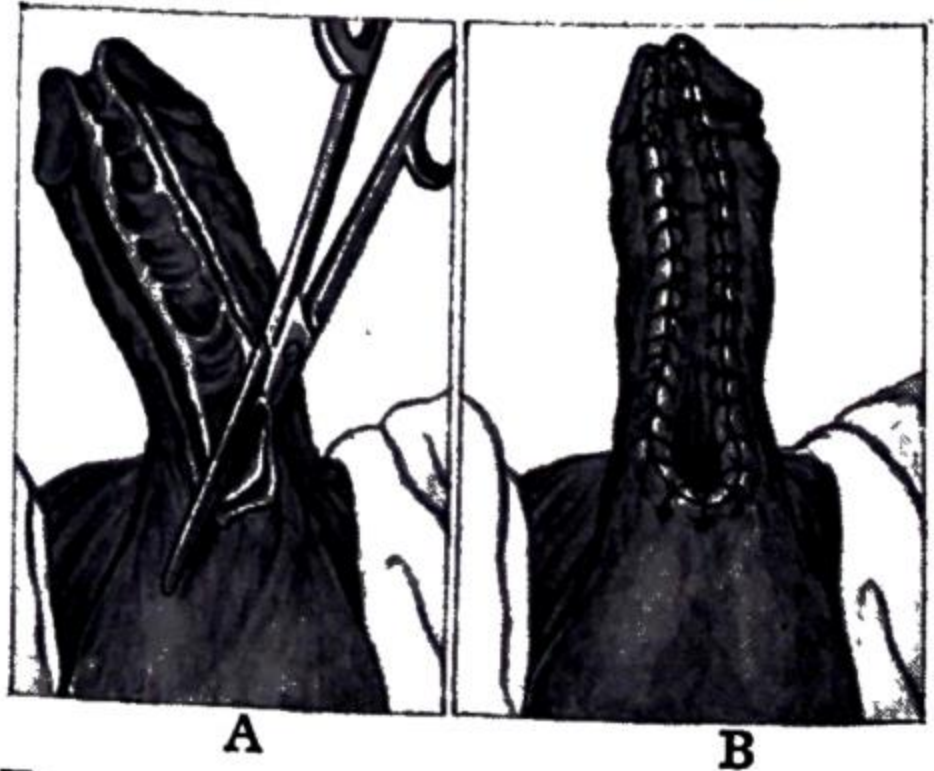


FIG. 1166.—Johanson's urethroplasty. Stage 1.

#### OTHER CAUSES OF URETHRAL STRICTURE

**Congenital stricture** has been considered on p. 866.

**Traumatic stricture** follows unskilful or delayed treatment of rupture of the bulbous urethra. If dilatation is unsatisfactory, the question of excision of the stricture should be considered, especially in boys.

The so-called stricture following rupture of the membranous urethra is often not a stricture at all but a complete loss of continuity of the urethra (see fig. 1151). It can sometimes be remedied by mobilising the prostate through a perineal incision and then either uniting the roof of the apex of the prostate with that of the distal end of the urethra, or, if the gap is too great, by turning up a flap of distal urethra and uniting it to the superior surface of the apex of the prostate. The wound is left unsutured,

Sir John Thomson-Walker, 1870-1937. Surgeon, St. Peter's Hospital, London.  
Bengt Johanson, Contemporary. First Assistant Surgeon, Serafimlasarettet, Stockholm.



and the subsequent treatment is similar to that detailed for rupture of the urethra. Urinary continence cannot be guaranteed after such an operation.

**Post-instrumental stricture** can occur in any part of the urethra from trauma due to the passage of a large-calibred endoscope or from urethritis due to an indwelling catheter. To avoid the former, some surgeons advise performing internal urethrotomy before attempting to pass a resectoscope in patients with a narrow urethra.

**Post-operative Stricture.**—A stricture develops in about 4 per cent. of cases after prostatectomy, irrespective of the method employed for the removal of the prostate. The stricture is usually situated in the proximal end of the prostatic urethra.

In many cases the stricture can be dilated by regular intermittent dilatation. When the stricture takes the form of a shelf at the junction of the bladder with the prostatic bed, the bladder must be opened and the shelf excised.

Post-operative stricture can also follow partial or complete amputation of the penis. Methods of avoiding this complication are given in the section dealing with these operations. Regular dilatation is satisfactory.

#### COMPLICATIONS OF URETHRAL STRICTURE

1. Retention of urine (see p. 794).
2. Urethral diverticulum.
3. Periurethral abscess.
4. Urethral fistula.
5. All the attendant evils of 'back pressure,' culminating in bilateral hydronephrosis, combined with a susceptibility to urinary infection and an increased liability to urinary calculus.
6. Hernia, hæmorrhoids, or rectal prolapse may be induced by the straining.

#### **Diverticulum of the male urethra** (*syn.* urethral pouch)

Urethral diverticula are of three varieties :

1. Congenital.
2. Due to increased intraurethral pressure behind a stricture.
3. Due to the long-continued presence of a urethral calculus.

In many cases the pouch can be seen (fig. 1167), and those which are not obvious at first become so when the patient interrupts the stream of urine.

**Treatment** is excision of the sac and removal of the cause if it is obvious.



FIG. 1167.—A urethral diverticulum.



FIG. 1168.—Common situations of a periurethral abscess. (After F. Papin.)

#### PERIURETHRAL ABSCESS

Periurethral abscesses are of two main varieties :

**Penile periurethral abscess** arises as an infection of one of the glands of Littre, and is usually a complication of acute gonococcal urethritis. A tender induration can be felt on the under-surface of the penis (fig. 1168). Left to nature, frequently the abscess bursts externally, and a urinary fistula is liable to result.

**Treatment.**—The passage of a bougie often causes the abscess to burst into the urethra. When this is unsuccessful, a ureteric meatotome is passed through a urethroscope and the abscess is opened by diathermy. When an abscess lies behind a stricture of the urethra it must be drained externally.

**Bulbous periurethral abscess** runs a variable course. Its most acute form, formerly termed periurethral abscess with extravasation of urine, is



better termed periurethral phlegmon, because in 50 per cent. of cases there is no stricture of the urethra present. Of the remainder, the majority have a passable stricture, while in the minority the stricture is impermeable (H. C. Rolnick). Consequently, in the majority of cases there is no reason why *urine* should extravasate. The condition is due to a spreading cellulitis caused by streptococci and anaërobic organisms invading the same cellular plane as that of superficial extravasation of urine (see p. 872).

**Clinical Features.**—There is pain in the perineum, considerable elevation of temperature, repeated rigors, and a rapid pulse-rate. In early cases the tenderness and swelling is limited to the perineum. Later, often in a matter of hours, the scrotum and then the penis become œdematous. From thence the infection spreads beneath the superficial fascia of the abdominal wall.

**Treatment.**—Pre- and post-operative penicillin and streptomycin greatly lower the mortality of the condition.

**Operation.**—The perineal abscess should be opened. In addition, if spreading cellulitis is present, incisions deep enough to traverse the superficial fascia are made into the infiltrated scrotum, penis, and abdominal wall, wherever considered necessary. When there is partial or complete retention of urine, if the infection is limited to the scrotum and the penis, after changing gloves and instruments, suprapubic cystostomy should be performed. If the superficial layer of the abdominal wall is implicated, it is best to drain the bladder by performing perineal urethrostomy. It should be noted that the abscess usually communicates with the urethra by a minute opening which cannot be found, and the urethra must be sought and its floor incised after passing an instrument from the external urinary meatus.

**After-treatment.**—In addition to antibiotics, intravenous dextrose-saline may be beneficial if the patient is dehydrated, and should be continued for forty-eight hours if the output of urine is satisfactory. After instilling hydrogen peroxide into them, the various incisions are irrigated with weak potassium permanganate solution. Later sitz baths of the same solution are given. When the infection has been overcome and the wounds commence to granulate, the stricture of the urethra, if present, is treated by one of the methods described already.

**Chronic periurethral abscess** is nearly always situated in the perineum (fig. 1169) and is associated with much periurethritis. It is almost invariably the result of a long-standing stricture of the bulbous urethra. The abscess should be opened, together with the various pockets that are often present. Later the associated stricture must receive thorough treatment. The condition is liable to be complicated by a urethral fistula which occurs either spontaneously or as a result of incision of the abscess.



FIG. 1169.—Bulbus periurethral abscess.

#### URETHRAL FISTULA

The most frequent cause of an acquired external urethral fistula is bursting or incision of a periurethral abscess. When the opening is situated in the penile urethra or at the peno-scrotal junction, the amount of urine that escapes at each act of micturition is often small. A fistula following a periurethral abscess of the bulbous urethra can be either single or multiple. In the latter case the fistulae originate behind a tight stricture and the patient passes most or all of his urine through the various fistulae (watering-can perineum). A fistula can also follow external urethrotomy when there is a stricture situated more distally.

Sitz bath = a bath in which the patient sits in a bath-tub, bathing only the hips and the buttocks.

Harry Charles Rolnick, Contemporary. Chief, Department of Urology, Cook County Hospital, Chicago.



**Treatment.**—A small fistula often closes spontaneously after repeated dilatation of the urethra. Searing the track with the diathermy needle often encourages closure. Occasionally urethroplasty (see p. 880) is indicated.

#### URETHRAL CALCULUS

Calculi occur less frequently in the urethra than in any other part of the urinary tract. A urethral calculus can arise primarily in the urethra behind a stricture or in an infected urethral diverticulum. The latter are composed of phosphates. Less rarely a calculus which has migrated from the ureter becomes arrested in the prostatic, bulbous, or penile portions of the urethra. Migratory calculi are arrested in the urethra relatively frequently in children under the age of two, the explanation being that the comparatively large vesical neck allows them to pass out of the bladder.

**Clinical Features.**—In the case of a migratory calculus arrested in the urethra, typically there is a history of an attack of renal colic two or three days previously. During micturition the patient experiences sudden pain in the urethra and the stream of urine ceases abruptly. A few drops of blood-stained urine follow, and then there is retention of urine. A stone can be palpated readily through the floor of the urethra. When the stone has been arrested in the prostatic urethra a rectal examination usually reveals a tender, hard nodule in the middle line of the prostate, generally near its apex. A calculus forming behind a urethral stricture often does so without causing much additional discomfort and it sometimes attains a considerable size before giving rise to retention of urine or painful dysuria. In some cases such a stone can be felt easily; in others, owing to peri-urethral thickening, its presence is not suspected until it is seen at urethroscopy, or a grating sensation is experienced on passing a gum-elastic bougie or a characteristic click is heard if a metal bougie has been employed. In all but superficially placed calculi giving rise to acute symptoms, radiography is necessary to confirm the presence, and particularly to reveal the size, of the calculus (fig. 1170) before commencing treatment.



FIG. 1170.—Radiograph showing calculus impacted in the bulbous urethra.

#### Treatment :

(1). *Prostatic Urethra.*—When the stone is arrested in the prostatic urethra a general anæsthetic is given, and a metal bougie is inserted along the urethra as far as the calculus. In recent cases of impaction the stone can be pushed into the bladder, where it can be crushed by litholapaxy and the fragments evacuated. In cases of long-standing the stone is hour-glass shaped, and impacted firmly, in which event it is best approached by an incision similar to that employed for perineal prostatectomy.

(2). *Membranous and (3) Bulbous Urethra.*—Occasionally a small stone can be removed from the deeper parts of the urethra by means of urethral forceps passed through a urethroscope. On no account must aero-urethroscopy be employed (danger of air embolus if bleeding occurs). A stone impacted in the deep urethra sometimes can be worked forward while the urethra is distended with lotion. Another expedient is to pass a number of filiform bougies beyond the stone, twist them, and endeavour to dislodge the calculus by pulling all the bougies out together. A stone impacted in the fossa navicularis, or manipulated into this position, sometimes can be removed by urethral forceps, or by inserting a probe behind it.

*Operative Measures* (situations 2 and 3).—Meatotomy is often required to permit the stone to be withdrawn. When a stone cannot be removed by one of the expedients described above, an incision is made through the floor of the urethra on to the stone (external urethrotomy). After the stone has been extracted, in the absence of a stricture and gross infection, the urethra can be closed in layers.

#### URETHRAL APOPLEXY

Urethral hæmorrhage is an uncommon manifestation of hypertension. The hæmorrhage is sudden, painless, and profuse. The timely recourse to the use of a sphygmomanometer is likely to confirm the diagnosis. In half the cases the bleeding comes from the anterior urethra.



**Polypi** are usually multiple and occur most frequently in the region of the verumontanum. As seen at urethroscopy, each polypus is a pale, finger-like projection (fig. 1171) with blood-vessels coursing over it. Polypi are never



FIG. 1171.—Polypi in a male posterior urethra. They occur also in the posterior urethra of females.

found without chronic infection. Sometimes, if the infection can be cured, the polypi disappear; conversely, if polypi are destroyed, chronic urethritis, which previously resisted treatment, often responds to it. Possibly this condition should be classified as a granuloma.

**Papilloma.**—From time to time a solitary papilloma occurs, most often within the fossa navicularis and, as it enlarges, it protrudes from the external urinary meatus (fig. 1172).

Multiple papillomata associated with penile papillomata (see p. 895) sometimes spring from mucous membrane just within the external urinary meatus.

Papillomatosis of the urethra is most often associated with papillomata of the bladder—the posterior urethra is considerably more often affected than the anterior urethra.

The typical symptom of papilloma of the urethra is slight hæmaturia immediately preceding micturition.

**Angioma** is rare. The hæmaturia to which it gives rise is often profuse, and may occur independent of micturition.

**Treatment** of all the foregoing neoplasms is diathermy coagulation through a urethroscope. Exceptionally the neoplasm is so accessible that it can be fulgurated without employing a urethroscope.

**Carcinoma** is rare. More than half the cases occur in the pendulous urethra; the remainder are divided between the bulbous and the membrano-prostatic portions. In a number of instances a urethral stricture is antecedent to the carcinoma. Spread to the inguinal lymph nodes occurs in a high proportion of cases. Blood-borne distant metastases are uncommon unless the cavernous tissue of the penis becomes implicated.

**Clinical Features.**—As a rule, the first and only symptom is a profuse urethral discharge. Carcinoma of the urethra is therefore one of the many causes of non-gonococcal urethritis. Later, the discharge becomes blood-stained and the symptoms of stricture of the urethra supervene. The chronic nature of the condition in a man past forty years of age, the presence of blood in the discharge or in the urine, and a tendency to bleed easily during instrumentation, and above all palpable induration, are factors that lead to a suspicion of carcinoma. In the deeper parts of the urethra,



FIG. 1172.—Papilloma of the fossa navicularis extruding from the external urinary meatus.



sometimes the first manifestation is an indolent periurethral abscess that after incision, not only fails to heal, but the periurethral thickening increases rather than decreases.

Biopsy then establishes the diagnosis.

**Prognosis.**—There is a great difference in the prognosis, according to whether the carcinoma is situated anteriorly, or posteriorly in the urethra.

**Treatment.**—When the growth is in the anterior part of the penile urethra partial amputation of the penis can be carried out, and provided the growth has been diagnosed reasonably early, long survival can be expected. Complete amputation with the construction of a perineal meatus is required when the neoplasm is situated more posteriorly.

When the carcinoma is situated further back a still more extensive operation, which includes radical prostatectomy, is the only hope of eradicating the disease.

In all cases dissection of the inguinal lymph nodes should be undertaken if there is clinical evidence of their involvement.

### THE FEMALE URETHRA

**Urethritis.**—As in the male, acute urethritis can be due to gonorrhœa or to non-gonococcal urethritis. Likewise chronic urethritis may or may not be due to gonorrhœa, and in its severe forms is a urethro-trigonitis. The symptoms are increased frequency, pain on micturition, urgency, terminal hæmaturia, and low back pain. Urethral tenderness is an important sign of infection of Skene's tubules, which is a potent source of chronicity in anterior urethritis. In cases of posterior urethritis, urethral polypi are often present and can be seen on urethroscopy.

**Treatment.**—In addition to appropriate antibiotic treatment, local treatment is necessary. In cases of non-gonococcal urethritis furacin urethral suppositories are sometimes beneficial. Intermittent dilatation of the urethra, by promoting drainage of infected foci within the urethra, often helps to eradicate the infection. If polypi are present, the condition is seldom remedied unless they are removed by fulguration. Swabbing the urethra with 10 per cent. solution of silver nitrate is also helpful. Excision of the distal 1 cm. of the urethral mucous membrane is the best method of curing chronic infection proved to be due to infection of Skene's tubules.

**T. Vaginalis Urethritis.**—About 12 per cent. of women suffer from *T. vaginalis* vaginitis, one-third of whom are unmarried. In a large percentage of cases *Trichomonas vaginalis* infection must be regarded as a venereal disease; the way in which the remaining patients become infected is speculative. Lavatory seats are often blamed, and their culpability is almost impossible to disprove for *T. vaginalis* can survive thereon for forty-five minutes (M. Joan Whittington). On the other hand, the fact that virgins are never infected with this protozoon adds to the scepticism with which this explanation is received. Trichomonal vaginitis is complicated by urethritis in many instances. This form of urethritis responds remarkably well to furacin urethral suppositories, but the vaginitis must be treated also.

**Senile urethritis** is an atrophic lesion due to deficiency in endogenous ovarian hormone. Furacin suppositories are without effect, but suppositories containing diethylstilbœstrol 0.1 mg. in a topical anæsthetic agent are extremely effective.

*Alexander J. C. Skene, 1838-1900. Surgeon, Long Island College Hospital, New York.*  
*Margaret Joan Whittington, Contemporary. Biologist, attached Whitechapel Venereal Clinic, The London Hospital.*



**Prolapse of the Urethra.**—Prolapse of the posterior margin of the urethra occurs in many women past the menopause, and is symptomless unless it is associated with senile urethritis when, on account of straining on micturition, the condition is progressive. Prolapse of the urethral mucous membrane occurs also as a congenital condition. When half or more of the circumference prolapses the local discomfort, especially on walking, is proportionate to the degree of the prolapse. The urinary meatus is examined while the patient strains: when the prolapse is complete the opening of the urethra is central; when it is partial, the opening is eccentric.

**Treatment.**—The associated urethritis, if present, must be treated first. Often lesser degrees of prolapse can be cured by making one or more linear grooves in the long axis of the mucous membrane of the urethra with a diathermy needle, employing the coagulating current. Subsequent contraction of the scar reduces or obliterates the prolapse. More advanced cases are treated by transfixing the whole thickness of the prolapse as far from its extremity as possible with four catgut sutures placed at equidistant intervals. Redundant urethral mucous membrane is excised distal to the sutures, which prevent retraction of the stump into the canal. The cut edges of the skin and mucous membrane are then united.

**Urethral Stricture.**—An adult female urethra which fails to admit freely a No. 20 French bougie is the seat of a urethral stricture.

The causes are (a) urethritis, not necessarily gonococcal, and (b) trauma as the result of difficult labour. Inflammatory stricture is situated at the external meatus; traumatic stricture usually affects the middle or posterior part of the urethra.

Sometimes the stricture will only admit a guide, and in these cases particularly acute retention of urine is prone to occur. Dilatation of the stricture yields satisfactory results. The recognition and treatment of a stricture often clears up an obscure case of dysuria.

**Urethral diverticulum** (*syn.* urethrocele) is more common in women than in men. Arguments favour a congenital origin in one of Gartner's ducts<sup>1</sup>, but some diverticula are acquired by (a) rupture of a distended urethral gland or (b) injury of the urethra during parturition. A small uninfected pouch may be symptomless. As the diverticulum increases in size, inability to pass all the urine at one time, or dribbling after micturition, occurs. Once infected—and infection is almost inevitable if the diverticulum is not evacuated completely at each micturition—recurrent attacks of cystitis perpetuated by reinfection from the diverticulum continue in spite of antibiotics and chemotherapy. On digital examination a swelling can be felt on the anterior vaginal wall in the line of the urethra, and when it is compressed, urine, usually obviously purulent, is expressed. If the beak of a curved metal bougie is passed gently along the floor of the urethra, from time to time the orifice of the diverticulum is large enough for the beak to enter the sac. In 10 per cent. of cases a stone forms in the diverticulum. Occasional hæmaturia is then sometimes a symptom.

**Treatment.**—The simplest method is to open the diverticulum through an incision in the vaginal wall. After irrigating the interior of the diverticulum, the mucous membrane is curetted, and the cavity is packed lightly with oxycel. The incision in the diverticulum and vaginal wall is then closed by interrupted catgut sutures. An indwelling catheter remains in place for a week. It is presumed that fibrosis obliterates the sac (V. Lane). This procedure is so often successful that formal excision is seldom required, and is reserved for diverticula with a wide mouth.

**Calculus** impacted in the female urethra is exceptional. When it occurs it can be removed by grasping it with forceps while a finger on the anterior vaginal wall presses it forward.

#### NEOPLASMS

**Urethral caruncle** is common in middle-aged and elderly women. The condition presents as a soft, raspberry-like, pedunculated, granulo-

<sup>1</sup> The unobliterated distal end of the mesonephric duct.

Hermann Treschow Gartner, 1785–1827. Surgeon and Anatomist, Copenhagen.  
Victor Lane, Contemporary. Assistant Surgeon, Urological Department, Meath Hospital, Dublin.



matous mass about the size of a pea, attached to the posterior urethral wall near the external urinary meatus. Histologically it is composed of highly vascular connective tissue stroma infiltrated with polymorphonuclear leucocytes and covered by squamous epithelium.

**Clinical Features.**—There is increased frequency of micturition, and often great pain during and after micturition. Terminal hæmaturia often occurs, and there may be a blood-stained discharge independent of micturition. The condition can be diagnosed on inspection, although it must be differentiated from prolapse of the mucous membrane. With a probe it can be determined that the protrusion arises from a pedicle attached to the posterior urethral wall. The mass is exquisitely tender and bleeds readily.

**Treatment.**—The pedicle should be divided flush with the floor of the urethra with a diathermy needle, using a cutting current, after which that portion of the urethra from which the pedicle arose is coagulated with the diathermy current. The chronic urethritis with which the condition is always associated should be treated by furacin suppositories and intermittent urethral dilatation until the patient is symptom-free.

**Papillomata acuminata** occur on the external urinary meatus, and spread on to the labia minora. They differ in no respect from, are acquired in the same way as, and the treatment is similar to that of, papillomata acuminata of the penis (see p. 895). In female Africans papillomata acuminata are common, and they increase at an alarming rate when the patient becomes pregnant. Towards term, so great does the neoplastic mass become that sometimes it obstructs labour and necessitates Cæsarean section (C. Bowesman).

**Carcinoma of the urethra** occurs twice as frequently in the female as in the male. Whether or not a caruncle can become malignant is disputed, but a visible bleeding protrusion is the commonest manifestation of a carcinoma of the urethra, and the most common site of the carcinoma in its early stages is the external urinary meatus. A carcinoma commencing within the urethra gives rise to dysuria, hæmaturia, and sometimes retention of urine. Usually induration serves to distinguish it from an innocent tumour.

**Treatment.**—Carcinomata of the papilliferous type should be treated by excision of the mucous membrane of the urethra: the bladder mucosa can be brought down to reconstruct a new lining for the urethra. When the compressor urethræ must be sacrificed, total urethro-cystectomy is indicated.

**Radium** is of no value in squamous-celled carcinomata, which are usual, but transitional-celled neoplasms are fairly sensitive to the emanations; therefore if biopsy shows a transitional-celled neoplasm, interstitial radium can be employed. The dose is 600 r for seven days. A self-retaining catheter should be inserted and the vagina plugged, so that irradiation of the rectum is minimised.

*Charles Bowesman, Contemporary. Lately Surgical Specialist, Colonial Medical Service, Kumasi, Ghana.*



FIG. 1173.—A urethral caruncle.



The inguinal nodes, which are involved in over 50 per cent. of cases, should be treated as in the male. Because of late diagnosis, often the prognosis is poor.

## THE PENIS

### RARE CONGENITAL ABNORMALITIES

**Duplication of the Penis** (*syn.* Diphallus).—In most reported instances the duplicated organs lay side by side in a horizontal plane, a tandem arrangement being exceedingly uncommon. Associated urological deformities are the rule, rather than the exception, and many of these are incompatible with life. Rarely is operative treatment indicated, especially if the organs are associated with duplicated bladders. Only when one organ has no functional urethra should excision of it be recommended.

**Transposition of the Penis and Scrotum.**—The penis lies hidden behind the scrotum—the normal arrangement in marsupials. Provided other uro-genital deformities are absent, or are of a minor character, the penis can be brought in front of the scrotum by a simple plastic operation.

### PHIMOSIS

While the condition can be acquired as a result of chronic or acute inflammation of the lining of the prepuce, usually it is due to congenital narrowing of the preputial orifice, often associated with an unduly long foreskin. In extreme examples of congenital phimosis, when the patient micturates the prepuce balloons out first, and a fine, weak stream of urine follows. Dysuria with residual urine, hydro-ureters, and hydronephroses are rarely due to phimosis, but more often occur as a result of atresia meati which may lie hidden by the phimosis. The treatment of phimosis is circumcision.

### CIRCUMCISION<sup>1</sup>

**In an Infant.**—The parts are washed with soap and water, and painted with a non-irritating antiseptic, e.g. metaphen. If it is not possible to retract the prepuce, the preputial orifice should be stretched with a hæmostat in order that the post-coronal sulcus can be cleansed of contained smegma. A pair of sinus forceps is applied obliquely to the prepuce, parallel to the corona, just beyond the tip of the penis (fig. 1174), and the skin distal to the forceps is excised



FIG. 1174.—Applying sinus forceps preparatory to excising the redundant skin.

with scissors close to the forceps, which are then removed. The outer layer of the preputial skin retracts, leaving the glans covered by the inner layer, which is divided in the middle line anteriorly by introducing a blade of delicate scissors between it and the glans. Each leaf of the deep layer of skin (formerly called the mucosa) is excised, leaving a narrow collar around the corona. The frænal artery usually requires ligation (fig. 1175), as well as several small vessels on the dorsum. The cut edges of the deep and superficial layers are approximated with fine catgut sutures. A wisp of cottonwool soaked in tinct. benzoin co. makes an excellent waterproof dressing, which comes off when the patient is sat in a bath six days later. Alternatively, a narrow strip of tulle gras can be employed.

**In adolescents and adults** the following method is preferable. The prepuce is retracted until its tense orifice is apparent, or until the tip of the glans comes into view, and on to the edge of the prepuce are placed three hæmostats, one in the middle line ventrally and two



FIG. 1175.—The 'four-in-one' frænal stitch.

<sup>1</sup> Apparently circumcision did not originate among the Jews: they took the custom from either the Babylonians or the Negroes, probably the latter. It has been practised in West Africa for over 5,000 years.



on either side of the middle line dorsally. The prepuce is then slit up in the middle line dorsally to within  $\frac{1}{2}$  inch (1.25 cm.) of the corona. The under-surface of the prepuce having been completely separated from the glans and the corona, the layers of each flap are excised, keeping  $\frac{1}{2}$  inch distal to the corona. The superficial layer is



FIG. 1176.—Method of circumcision in an adult described in the text. (After A. I. Dodson.)

retracted and bleeding-points are secured and ligated. The inner layer of the prepuce having been trimmed to  $\frac{1}{8}$  inch (0.3 cm.) from the corona, the two cut edges are approximated accurately with fine interrupted catgut stitches (fig. 1176). The cut edges in the immediate vicinity of the frænum can be neatly drawn together by a mattress suture. The ends of appropriately placed stitches can be left long to anchor a circular dressing of ribbon tulle gras.

#### PREPUTIAL CALCULI

Late in life, chronic posthitis resulting in fibrosis further constricts an already inadequate orifice of a preputial sac. It is in examples of this kind, when the prepuce has not been retracted nor its interior cleansed for many years, that preputial calculi are wont to form. Three types of preputial calculi are described :

1. Those resulting from inspissated smegma.
2. Those consisting of a mixture of smegma and urinary salts.
3. Those consisting entirely of urinary salts.

The treatment is circumcision.

#### PARAPHIMOSIS

The tight prepuce has been retracted but cannot be returned, and it is constricting the glans which is engorged and œdematous. The diagnosis is apparent at a glance.

**Treatment.**—One ml. of normal saline containing 150 turbidity units of hyaluronidase is injected into each lateral aspect of the swollen ring of prepuce. Fifteen minutes later the swelling is much reduced, and in recent



FIG. 1177.—Reducing a paraphimosis.

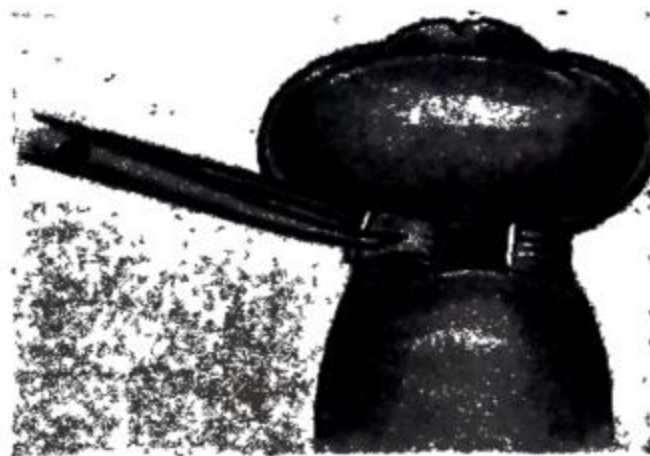


FIG. 1178.—Excising the constricting band.

cases reduction (fig. 1177) can be accomplished with ease. If this is unsuccessful, a general anæsthetic must be given and the constricting band is incised, and the narrow cuff of skin which formed the constricting band excised (fig. 1178). There is now no obstruction to reduction, and there remains only to remove a broad cuff of normal skin on the proximal side of the gap and unite the cut free edges, thus performing circumcision.



## INJURIES

**Avulsion of the Skin of the Penis.**—Entanglement of clothing in rotating machinery accounts for the majority of these injuries. Repair can be carried out by burying the shaft of the penis in the scrotum (fig. 1179), with subsequent surgical release at a propitious time.



FIG. 1179.—  
Covering the  
denuded shaft  
of the penis by  
burying it in a  
scrotal tunnel.

**Fracture of the penis** is a very uncommon accident due, most often, to the erect organ being bent forcibly downwards. Following trauma, the erect organ suddenly becomes flaccid. The extravasation of blood, which is considerable, causes great pain and swelling. In recent cases incision, clearing out blood-clot, and suture of the ruptured corpus cavernosum has yielded good results.

## STRANGULATION OF THE PENIS BY RINGS

Removal is prevented by venous engorgement. Consequently aspiration of the corpora cavernosa may assist in removal of the ring in early cases, otherwise a ring cutter or a hacksaw must be employed. If a tight ring is not removed within six hours, unless the bladder is drained suprapubically, or external urethrotomy is performed, rupture of the urethra with extravasation will ensue.

## INFLAMMATIONS

**Balanoposthitis.**—An inflammation of the prepuce is known as posthitis; an inflammation of the glans penis is called balanitis. Frequently the opposing surface of the prepuce and the glans are implicated in the inflammatory process—hence the term balanoposthitis.

The occasional presence of glycosuria makes it imperative to test the urine for sugar in every case. Three varieties are recognised, all of which are favoured by phimosis.

1. **Simple** is associated with an accumulation of evil-smelling smegma. There are patches of redness and desquamation, especially in relation to the corona, and a serous discharge. The principal early symptom is itching. Neglected for years, it leads slowly to cicatricial stenosis of the prepuce, contraction of the frænum, and sometimes narrowing of the external urinary meatus. During the chronic stage it becomes practically symptomless, and in some cases patches of leukoplakia develop. The latter is a precarcinomatous condition.

2. **Purulent.**—When the prepuce cannot be retracted and particularly when the frænum has been torn at coitus, a simple balanoposthitis is liable to become more acute and painful. The prepuce is red and swollen, and pus exudes from beneath it. Bacteriological examination of the pus is essential, and it usually reveals a highly mixed infection; much less frequently a pure culture of one organism. Cases of diphtheria of the glans have been reported. Even with bacteriological assistance, it is not possible to exclude a Hunterian chancre or urethritis behind a prepuce that cannot be retracted.

3. **Erosive** (*syn.* fourth disease<sup>1</sup>) is due to Vincent's organisms (spirilla and fusiform bacilli), probably transmitted by infected saliva. The surface of the glans and post-coronal sulcus, together with the under-surface of the prepuce (it usually occurs in the uncircumcised), becomes eroded in small

<sup>1</sup>The other three venereal diseases being syphilis, gonorrhœa, and soft chancre.  
*Jean-Hyacinthe Vincent, 1862-1950. Professor of Epidemiology, Val de Grâce Military Hospital, Paris.*



areas that appear white. In more severe lesions these erosions are succeeded by ulcers with reddened borders and a yellowish-white base, in which event constitutional symptoms will be in evidence. Ultra-acute cases associated with gangrene and sloughing of a large portion of the glans penis, that were not infrequently fatal and known as phagedæna, are now rarely encountered.

**Treatment.**—Simple balanoposthitis of comparatively short duration responds to daily cleansing of the parts with normal saline solution, provided the prepuce can be retracted. Long-standing cases are benefited by the application of an ointment containing testosterone propionate in addition. When the foreskin cannot be retracted, syringing beneath it, together with systemic antibiotic therapy, often reduces the inflammation sufficiently to allow circumcision to be undertaken with safety. In other circumstances a preliminary dorsal slit of the prepuce, as described below, will give access for adequate local treatment.

In purulent and erosive cases, pending the bacteriological report, the administration of an antibiotic with a wide range of activity, e.g. aureomycin, is advisable, together with frequent syringing of the preputial sac with normal saline. As soon as the acute inflammation abates, removal of a V-shaped portion from the dorsum of the prepuce greatly facilitates accurate diagnosis and efficient treatment.

As Vincent's and several other organisms frequently present are anaerobic, dressings soaked in 1 : 10 hydrogen peroxide or zinc peroxide are of value. After the infection has abated completely, circumcision is desirable, if only for cosmetic reasons.

#### HARD CHANCRE (*syn.* HUNTERIAN CHANCRE)

The glans penis and the prepuce are the sites of election for a primary chancre: not infrequently a chancre lurks behind the prepuce. In the case shown in fig. 1180 (A) the patient complained of a 'discharge.' On retracting the prepuce, a sore was revealed (fig. 1180 (B)); it was characteristically indurated.

Hunterian chancre is described on p. 27, and soft chancre on p. 35.

#### PENILE HERPES

Herpes, which is due to a virus infection, occurs rather frequently on the glans and the prepuce. Rarely is it seen in the vesicular phase because the vesicles rupture early. The resulting erosions are superficial, red, and frequently take the form of multiple circular lesions encroaching upon one another, which is characteristic. Unlike other conditions from which it must be differentiated, penile herpes is painful and tender. Should doubt exist as to the diagnosis, infection by the virus of herpes can be confirmed by inoculating embryo chicks with some of the exudate.

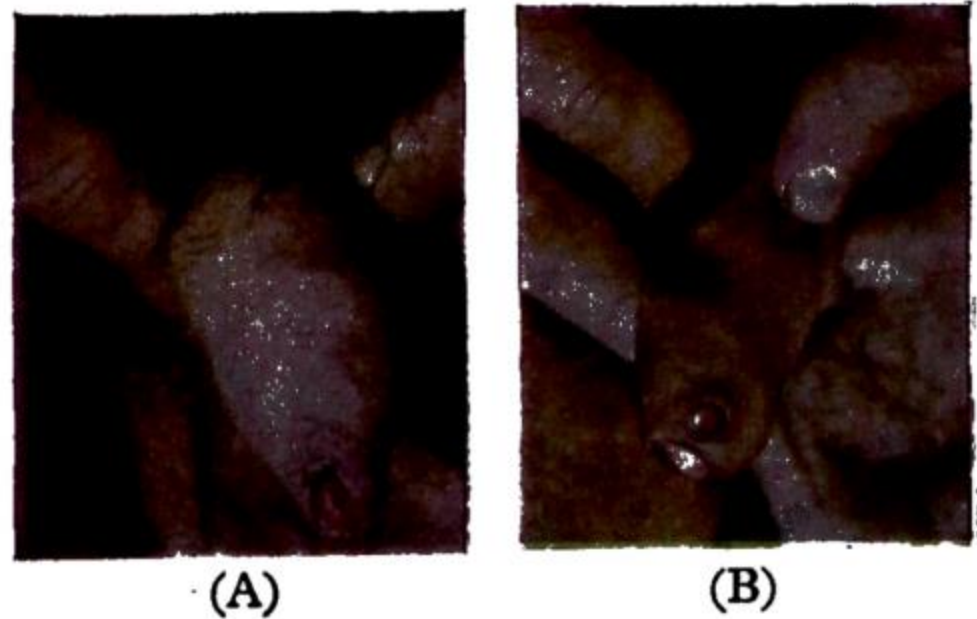


FIG. 1180. — (A) A discharge was the patient's complaint. On retracting the prepuce a Hunterian chancre (B) was revealed. (Dr. D. Erskine, London.)

*John Hunter, 1728-1793. Surgeon, St. George's Hospital, London. He bequeathed 13,682 specimens, prepared and mounted by his own hands. Many were destroyed by enemy action, but the remainder now constitute the Hunterian Collection of the Royal College of Surgeons of England.*



LYMPHOGRANULOMA INGUINALE (*syn.* LYMPHOGRANULOMA VENEREUM)

Although predominantly a tropical venereal disease, lymphogranuloma inguinale is not rare in temperate climates where there is a mixed population of white and negro races. The condition is encountered in England mainly in seafarers whose ships have come from afar. The infection is caused by a filtrable virus of the psittacosis-lymphogranuloma inguinale group.

**The Primary Lesion.**—Because the symptoms are so slight, rarely does the patient present with the primary lesion, but a careful history unfolds the occurrence of a primary sore on the genitals in 25 per cent. of cases. The sore takes the form of fleeting, painless, herpetic vesicles. Exceptionally it is within the anterior urethra, when it constitutes one of the many causes of non-gonococcal urethritis.

**The Secondary Lesion.**—Almost invariably the patient presents only when the secondary lesion has appeared, i.e. two to six weeks after exposure to infection. Constitutional symptoms are generally absent, although in white people pyrexia and anæmia are sometimes in evidence. The secondary local lesion is as follows :

*In the Male.*—A lymph node in one groin (or, in 25 per cent. of cases, in both groins) enlarges, usually in the medial part of the groin. The infection spreads to other nodes, and often the femoral group become involved. Palpable enlargement of the iliac lymph nodes is also found in 25 per cent. of all



FIG. 1181.—Lymphogranuloma inguinale. (Professor F. A. R. Stammers, Birmingham, England.)

cases. Soon periadenitis occurs, and a brawny mass presents, increases in size, and the overlying skin (in white races) becomes purple. Untreated, the lymphadenopathy proceeds to liquefy. Unless treated by aspiration, the mass breaks down and discharges thick yellowish-white pus free from organisms. The resulting sinus (fig. 1181) or sinuses persist for months or years. An occasional aftermath is lymphatic obstruction resulting in elephantiasis of the scrotum and penis. With this exception, complications are rare in the male, and consist of transient joint effusions.

*In the Female.*—If the primary lesion lies in the anterior part of the vulva, an inguinal bubo follows, as in the male. When, as is much more usual, the primary lesion is on the vaginal wall or cervix, œdematous thickening of the posterior vaginal wall occurs and it is not long before the para-rectal lymph nodes enlarge and suppurate. As a result of this intense para-rectal inflammation, dense fibrosis of the rectal wall follows with the formation of a stricture of the rectum (p. 651). Elephantiasis of the vulva sometimes develops in chronic cases. Ischio-rectal abscess and rectovaginal fistula are not infrequent complications.

**Confirmatory Tests:**

1. **The Frei Test**<sup>1</sup>.—The original Frei antigen consisted of bacteriologically sterile pus obtained from an unruptured bubo of a patient suffering from the disease. This is more reliable than the now frequently employed lygranum (E. R. Squibb and Sons), which is an extract of the content of yolk

*Wilhelm Siegmund Frei, 1885–1943. Dermatologist, State Hospital, Spandau, near Berlin; later emigrated to New York.*



sacs of embryo chicks infected with the virus. One or 2 minims (0.05 or 0.1 ml.) of either of these is injected intradermally. A positive reaction appears within forty-eight hours, and is a red papule of at least  $\frac{1}{4}$  inch (6 mm.) in diameter.

2. **The complement fixation test**<sup>1</sup> is more sensitive than the foregoing, and has the merit of giving a positive result earlier in the course of the disease.

3. **Biopsy** is employed when it is necessary to differentiate enlarged nodes from Hodgkin's disease or to exclude a neoplasm.

**Treatment.**—The disease responds both to sulphonamides and to several antibiotics. Many patients derive more benefit when two different drugs are exhibited successively than from any single drug. C. D. Alergant has found the best results accrue from :

(a) A course of sulphathiazole, 1 G. four times a day for ten days, to be followed by

(b) A course of aureomycin, 250 mg. six-hourly for a similar period, in patients who respond poorly or incompletely to (a).

If resolution has not been effected by the end of the dual course, the dose of aureomycin is doubled.

Fomentation to the bubo should be eschewed, as it favours softening and increases the necessity for aspiration, which in necessary cases should be carried out before the skin becomes involved. If general treatment is commenced reasonably early, aspiration will be required in only 10 per cent. of cases.

Other complications such as stricture of the rectum must be treated on their merits.

#### GRANULOMA INGUINALE (*syn.* GRANULOMA VENEREUM)

It is highly important not to confuse *granuloma inguinale* with *lympho-granuloma inguinale*. It is true that *granuloma inguinale* sometimes affects the inguinal region (although not the lymph nodes thereof) and that both are mainly tropical or subtropical diseases, but these are the only points of similarity between these two completely different diseases. *Granuloma inguinale* was rarely seen in England until the West Indians began to immigrate in substantial numbers. This disease is due to the *Donovana granulomatosis*, a Donovan body that can be seen as a Gram-negative rod found characteristically in the cytoplasm of large mononuclear tissue cells.

**Clinical Features.**—The disease affects predominantly the inguinal, genital, crural, perineal, and perianal regions. The primary lesion is a vesicle that is surrounded by an area of erythema and induration. The overlying epithelium soon disintegrates and the lesion develops, either as a slightly raised ulcer (fig. 1182) or a mass of exuberant granulation tissue. Pain and tenderness are singularly absent unless secondary infection occurs.

<sup>1</sup> Unfortunately, these tests, unlike a Wassermann reaction in syphilis, cannot be used as a test for cure.

Cecil David Alergant, *Contemporary. Venereologist, Newsham General Hospital, Liverpool.*  
Charles Donovan, 1863-1951. *Lieutenant-Colonel, Indian Medical Service.*



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Charles Donovan, 1863-1951. *Lieutenant-Colonel, Indian Medical Service.*



The lesion progresses slowly by peripheral extension, and also by satellites due to auto-inoculation.

Extragenital granuloma inguinale (by which is meant that the lesion is distant from all the common sites set out above) occurs in 6 per cent. of cases,



FIG. 1182.—Granuloma inguinale.  
(Dr. W. Fowler, Wolverhampton.)

but usually these lesions are due to auto-inoculation. Disseminated disease from a genital primary lesion is particularly liable to occur in pregnant women, who thereby become extremely emaciated, with sores in various parts of the body. In general it can be stated that granuloma venereum of the cervix uteri is a most serious lesion, and not a few women die from the effects of involvement of the pelvic viscera. In none of the manifestations of the disease does complete recovery occur without thorough treatment, but sometimes there is partial healing with the formation of thick or keloid scar tissue.

**Confirmatory Test.**—If a needle is drawn through the tissues near the edge of the lesion, sufficient material is obtained for microscopical examination after staining.

**Treatment.**—The treatment of choice is oxytetracycline (terramycin) 2 G. daily for twenty days. In necessary cases, after an interval, a further course is sometimes required.

#### TUBERCULOUS ULCERATION OF THE PENIS

Rarely does the penis become infected with tuberculosis. When it does so, the organ becomes infected by direct contact, with the result that an ulcer appears on the glans penis. Most of the reported cases have occurred in Chinese. The diagnosis can be made with certainty only by biopsy of the ulcer. Provided the disease is localised, the response to modern antibiotic therapy for tuberculosis is favourable.

#### CHORDEE

Chordee is due to an inflammatory effusion into the corpus spongiosum or corpora cavernosa. As a consequence the erect organ is bent downwards or laterally. In the acute stage erections are very painful. Chordee is not a common condition, and is usually a complication of acute gonococcal urethritis.

**Treatment.**—An ethyl-chloride spray is useful in quelling erection, but painful. The best method is to prescribe stilboestrol 6 mg. daily. After the acute attack has subsided the cavernous tissue is sometimes left permanently damaged by fibrosis, causing deformity of the organ.

#### INDURATIO-PENIS-PLASTICA (syn. PEYRONIE'S DISEASE)

Usually the patient is over forty years of age and seldom is there a history of venereal disease. At the onset pain and curving of the penis on erection cause the patient to seek advice, but after a few weeks the pain disappears. On palpation an indurated plaque can be felt on the dorsal surface of one corpus cavernosum. The

*François de la Peyronie, 1678–1747. Surgeon to Louis XV and Founder of the Royal Academy of Surgery, Paris.*



condition is slowly progressive and sometimes extends across the middle line. Its ætiology is unknown; bygone trauma is a possible explanation.

**Treatment** has remained an unsolved problem for 200 years. The most promising results have followed œstrogen therapy (10 mg. every four days for a month). When this fails, vitamin E (300 mg. daily for six months) brings about improvement in about a quarter of cases. Accessory measures that are sometimes accredited with success are X-ray therapy, diathermy, and electrolysis. Hydrocortisone has proved to be without value in this condition.

#### PERSISTENT PRIAPISM

The penis remains erect, and is painful. Most often the erection is due to idiopathic thrombosis occurring in the prostatic venous plexus. Less frequently it is associated with leukæmia or sickle-celled anæmia. Secondary malignant deposits in the corpora cavernosa, or in the pelvis, account for about 7 per cent. of cases. In another, completely different, category are cases of priapism due to spinal injury or disease.

**Diagnosis.**—A low spinal anæsthetic will cause priapism of neurogenic origin to abate temporarily. A differential blood-count is advisable.

**Treatment.**—Local applications are useless. Anticoagulant therapy, controlled by daily prothrombin activity estimations, together with adequate sedation for fourteen days, brings about restitution in the majority of cases. Should this treatment not bid fair after a trial of several days, the repeated aspiration of the corpora cavernosa is of value. When this fails, or is unsatisfactory, a small incision into a corpus cavernosum should be made, and blood and blood-clot evacuated. Should gangrene threaten, early amputation is advised.

#### NEOPLASMS OF THE PENIS

**Papillomata Acuminata**<sup>1</sup> (*syn.* venereal warts), the commonest benign growths of the penis, occur both in the uncircumcised and the circumcised. Most often they are situated in the coronal sulcus (fig. 1183), but in the male they can occur anywhere on the penis, scrotum, perineum, and the anal region. Usually they are moist, and attended by an offensive serous discharge.

Often they are transmitted by sexual contact.

In some cases the papillomata are believed to be due to a virus infection.

#### **Treatment:**

(a) **By Podophyllin.**—The parts are cleansed thoroughly with aqueous green soap and zephirin. Before this treatment is undertaken the surrounding parts should be protected by smearing them with a zinc oxide ointment. A 20 per cent. solution of podophyllin in tinct. benzoin is applied with a sterile applicator, and the prepuce is held back for three to five minutes until the tincture dries. The patient is instructed to wash the part thoroughly in thirty minutes. Thereafter he must pay particular attention to cleanliness. The papillomata gradually disappear. Often such treatment is followed by considerable local reaction, and is painful. For this reason the alternative treatment (b) is advisable, especially if it is considered necessary to circumcise the patient.

(b) **Fulguration** of the growths by diathermy.



FIG. 1183.—  
Penile papillomata.  
(Dr. D. Erskine, London.)

<sup>1</sup> *Acuminatus* (Lat.) = sharp pointed.



(c) **Radium.**—For large papillomata, if there is even a suspicion of malignancy, radium treatment is advisable.

#### CARCINOMA OF THE PENIS

**Ætiology.**—For a reason that is only partially understood, circumcision correctly performed soon after birth confers almost total immunity against carcinoma of the penis. Thus, in the whole of the world's literature up to 1947, only four cases of carcinoma of the penis occurring in a circumcised Jew had been reported, and only about half a dozen in Gentiles who had been circumcised in early infancy. On the other hand (and this is the fact so difficult of explanation) circumcision after early infancy does not provide the same degree of protection. Mohammedans, who are circumcised between the ages of four and nine years, exemplify this.

Reverting to the tiny group of patients who in spite of being circumcised in early infancy have developed carcinoma of the penis, and taking into consideration the readiness with which patients associate the appearance of a neoplasm in any accessible situation with a blow, the frequency with which some form of definite abrasion (e.g. catching the penis in a zipp fastener) has preceded the carcinoma seems to defy the vagaries of coincidence.

For practical purposes, then, carcinoma of the penis occurs only in men who have not been circumcised in early infancy, and undoubtedly the development of this neoplasm is favoured by chronic balanoposthitis. Furthermore, there are definite *pre-carcinomatous* states, viz. :

(a) **Leukoplakia of the glans** is exactly comparable to the well-known condition of the tongue.

(b) Long-standing **penile papillomata** (see p. 895).

(c) **Paget's Disease of the Penis.**—"I have seen a persistent rawness of the glans like a long-standing balanitis followed by cancer of the substance of the penis" (Sir James Paget). Because it is very rare, it is possible that penile Paget's disease escapes detection until an actual carcinoma has developed. Treatment is by radium or diathermy excision.

(d) **The penile erythroplasia of Queyrat** is a rare condition which simulates carcinoma closely, and is premalignant. The disease is characterised by raised red patches on the glans or on the prepuce, which are velvety to touch, and dry. Often the condition responds to radiotherapy; if it does not do so quickly and obviously, local amputation of the penis should be performed (L. Queyrat).

**Racial Preponderance.**—It is often stated that the highest incidence of this disease is found in Asiatics, particularly among Chinese and the inhabitants of Malaya. However, carcinoma of the penis is equally common among African races who do not practice circumcision. For instance, it is the most common malignant tumour occurring in male Hottentots. In Europe it accounts for 5 per cent. of carcinomata in males.

**Pathology.**—There are two types of carcinoma of the penis—the flat, infiltrating, and the papilliferous. The former is often associated with leukoplakia, while the latter commences in papillomata of long standing. The growth remains purely local for months. The earliest spread is to the inguinal, and then to the iliac, lymph nodes. Direct spread to the body of the penis is prevented for many months by the fascial sheath of the

*Sir James Paget, 1814–1899. Surgeon, St. Bartholomew's Hospital, London.*  
*Louis Queyrat, 1856–1933. Physician to the Hôpital Cochin, Paris.*



corpora cavernosa, but once this barrier becomes broken the growth extends more rapidly and the iliac lymph nodes (fig. 1184) become involved. Distant metastatic deposits are infrequent, even late in the course of the disease.

**Clinical Features.**—It is a mistake to believe that this is a disease confined to the elderly—40 per cent. of the sufferers are under forty years of age. The progress of the disease is slow; the first symptoms are



FIG. 1185.—Papilliferous carcinoma of the penis. (Mr. Nils Eckhoff, London.)

a mild irritation and a purulent discharge from the prepuce. These symptoms are often neglected (fig. 1185), and usually by the time the patient reports, sometimes more than a year after symptoms have appeared, there is a blood-stained, foul

discharge. Pain is singularly absent. The inguinal lymph nodes are enlarged in over 60 per cent. of cases, but in only half of these is the enlargement due to secondary deposits, the remainder being due to sepsis. In a number of instances the prepuce cannot be retracted, and in order to view the lesion the prepuce must be slit up. In cases where the diagnosis is in doubt a biopsy should be performed.

Untreated, the whole glans becomes a fungating and particularly foul-smelling mass. Later, the inguinal lymph nodes fungate through the skin of the groin, and finally death relieves the victim, often suddenly, by torrential hæmorrhage following erosion of the external iliac artery.

### Treatment :

**Partial amputation** is the treatment of choice in comparatively early cases of carcinoma of the penis: naturally the results are better when there are no demonstrable metastases. Notwithstanding, the five-year survival rate of those with inguinal lymph-node involvement, after partial amputation and dissection of the inguinal lymph nodes, is over 30 per cent.

A tourniquet, in the form of a No. 6 French rubber catheter, is placed around the most proximal portion of the penis, being tied once, and the knot clipped in a hæmostat. An abdominal pack is placed over the glans penis and with a piece of strong silk is tied tightly to the shaft of the penis at the proposed level of section. A guillotine amputation is then performed, and the pack, with its contents, is dropped into a receptacle. The exposed cross-section of the penile stump is examined for extensions of the growth. If, as is usual, none is present, the dorsal vessels are ligated. The corpus spongiosum is dissected from the corpora cavernosa for 1 cm. A long straight needle carrying a double stout catgut suture is passed from the ventral to the dorsal aspect of the fibrous septum separating the two corpora cavernosa, the needle entering just distal to the attached portion of the

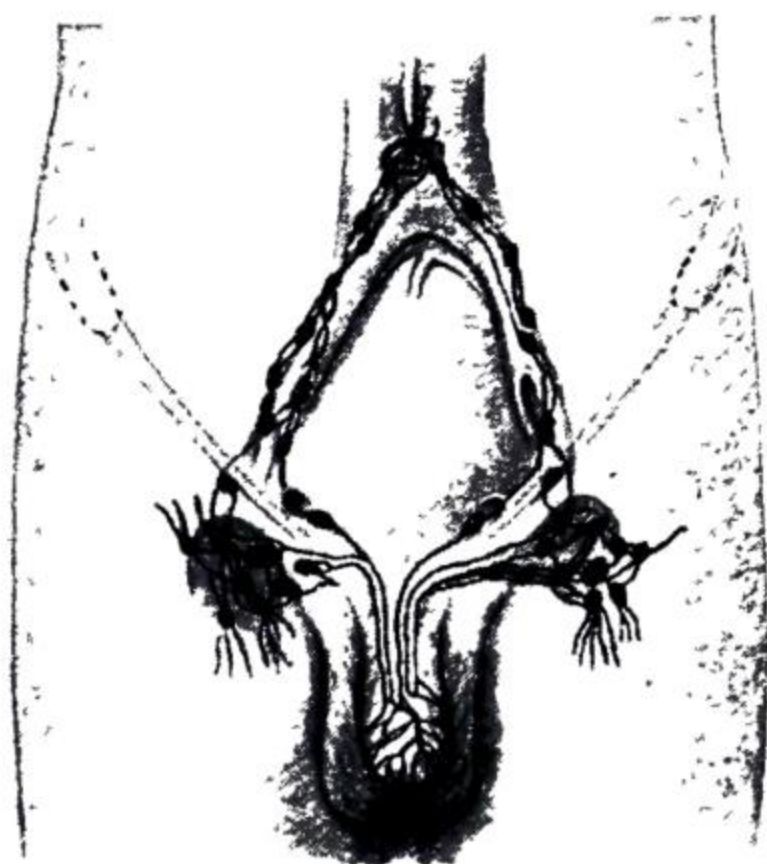


FIG. 1184.—The lymphatic drainage of the penis. The superficial lymphatic vessels drain into the inguinal while the deep lymphatics drain into the iliac lymph nodes. (After Archie L. Dean.)



FIG. 1186.—Partial amputation of the penis.



corpus spongiosum. The needle having been removed (fig. 1186), each corpus cavernosum is ligated firmly. The free portion of the urethra and its surrounding corpus spongiosum is divided on the dorsal aspect for nearly 1 cm. The tourniquet is now removed. The urethra is attached to the adjacent skin by interrupted stitches that pass through the whole thickness of the corpora cavernosa. Bleeding-points having been ligated, the remaining portion of the skin edges are approximated vertically over the cut corpora cavernosa. An indwelling catheter can be employed until the dressings are dispensed with.

**Complete amputation** includes the separation and removal of the corpora cavernosa from the pubic bones and division of the corpus spongiosum as far back as to leave at least  $\frac{1}{2}$  inch (1.3 cm.) protruding from the perineum. This is the best treatment for advanced cases.

**Radium** gives good results in cases of the papilliferous variety that have not extended around the majority of the circumference, and when there is no induration of the body of the penis.

Needles containing 1 mg. of radium are inserted at equidistant intervals into the base of the growth. Additional needles containing 0.5 mg. are inserted into a papilliferous growth. The needles are left in place for seven days, and a total dose of 7,000 r results. There is an extensive local reaction which subsides in two or three weeks, and healing occurs in about six weeks.

**The Treatment of Associated enlarged Inguinal Lymph Nodes.**—It is permissible to wait for at least three weeks after the local lesion has been dealt with by one of the methods described. If the enlargement is due to inflammation, the nodes will decrease in size or disappear with antibiotic treatment. When these nodes remain unaltered at the end of this period, or do not undergo complete resolution within a further period of two or three weeks, block dissection of the more affected side should be undertaken unless the patient is very old or infirm. In a minority of cases contralateral block dissection is required a few weeks later.

If the enlarged nodes are massive and fixed (inoperable), X-ray therapy causes some temporary regression.

**Secondary carcinoma of the penis** occurs from time to time, and about a hundred cases have been reported. The primary source of the disease is

Bladder	. . .	33 per cent.
Rectum	. . .	22 per cent.
Prostate	. . .	17 per cent.

In the remainder of the cases the primary growth has been situated in other organs. The metastasis arrives in the penis in one of three ways: (a) by direct spread; (b) by retrograde lymphatic transport; (c) retrograde venous embolism via the dorsal vein of the penis. The condition must be differentiated from Peyronie's disease. Of necessity, secondary carcinoma of the penis occurs only late in the course of the disease; nevertheless, in many instances active treatment is worth while. One patient lived without recurrence for nine years after amputation of the penis.

#### RARE MALIGNANT TUMOURS OF THE PENIS

**Sarcoma** of the penis occurs from time to time. The treatment advised is wide excision, and if the tumour is likely to prove radio-sensitive, post-operative radiotherapy in addition.

**Neurilemmoma** has been reported.



## CHAPTER XXXVI

## THE TESTES AND THE SCROTUM

HAMILTON BAILEY

## CONGENITAL ABNORMALITIES

**Anterior inversion** is said to be present in one in every twenty males. The epididymis lies anteriorly, and the body of the testis and the tunica vaginalis posteriorly. When the organ is diseased this anomaly causes confusion in diagnosis, and is referred to on p. 920.

**Supernumerary testis** (*syn.* Polyorchism) is exceedingly rare. The accessory testis is small, and in the majority of instances communicates with a common epididymis (fig. 1187). Usually it occurs on the left side. Only at operation can the diagnosis be made with certainty.



FIG. 1187.—Polyorchism; usual arrangement. (After P. St. G. Anderson.)

**Polar inversion** occurs less frequently. In some cases the testis is fully inverted, in which case the globus major lies inferiorly (fig. 1188(B)), or in other cases it lies horizontally (fig. 1188(C)).

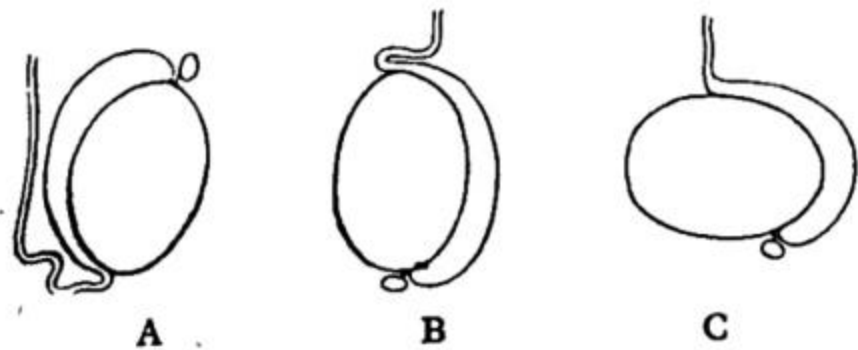


FIG. 1188.—A. Normal. B. Inverted. C. Horizontal inversion.

Both varieties of this abnormality predispose to torsion (see p. 906).

Complete inversion is difficult, if not impossible, to detect clinically. When the testis is displayed, complete inversion is

recognised most readily by observing that the hydatid of Morgagni is situated at the lower, instead of the upper, pole.

**Imperfect descent of the testis** is an important subject that must be discussed fully.

## IMPERFECT DESCENT OF THE TESTIS

Under this heading are included two conditions :

**Incomplete Descent.**—The testis is arrested in some part of its path to the scrotum.

**Maldescended** (*syn.* *Ectopic*) **Testis.**—The testis is abnormally placed outside this path.

**Development of the Testes.**—The testes develop from the genital fold, which lies medial to the mesonephros (Wolffian body), and therefore in early foetal life they lie in the upper part of the cœlomic cavity behind the peritoneum and below the developing kidneys. The primitive testis as it increases in size is attached to the posterior abdominal wall by a mesentery, the mesorchium, which contains the testicular blood-vessels and nerves, derived from the twelfth and tenth dorsal segments respectively. A reflection of the mesorchium attaches the testis to the



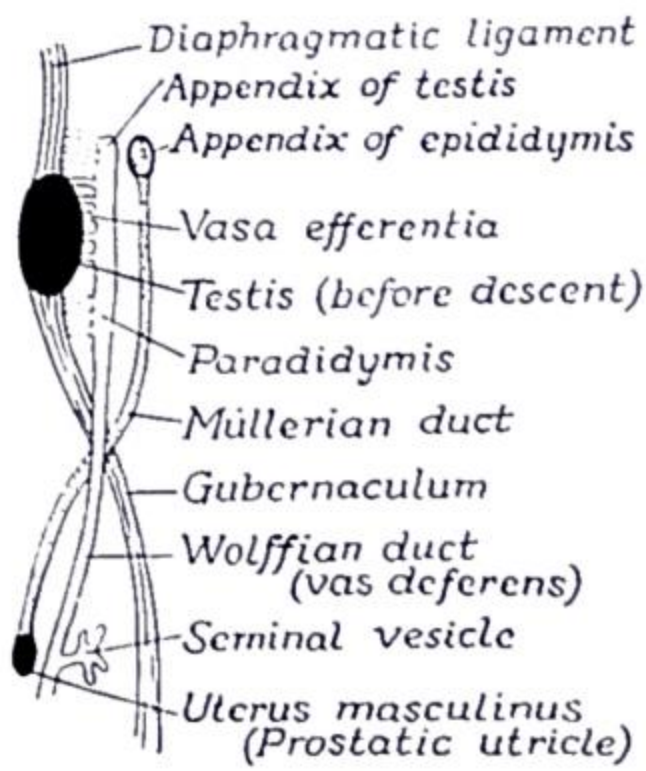


FIG. 1189.—Arrangement of the testis and the ducts related to it before descent. (After O. Hertwig.)

mesonephros. About the tenth week of intra-uterine life some of the transverse tubules of the mesonephros (fig. 1189) unite with the rete testis to form the vasa efferentia; others remain rudimentary. The larger portion of the Wolffian body disappears, but the Wolffian duct becomes the epididymis and vas deferens. About this time the testis becomes attached to the lower part of the ventral abdominal wall by a fold of peritoneum called the inguinal fold. Within this fold lies mesenchyme which, during the fourth month, becomes fibromuscular tissue. This is the gubernaculum, which becomes attached above to the lower pole of the testis, while below its actively proliferating cells grow downwards through the abdominal wall to become attached to the subcutaneous tissue of the skin that later forms the scrotum. The outwardly growing gubernaculum carries with it a funnel-shaped protrusion of peritoneum—the processus vaginalis—and a prolongation of every layer of the abdominal wall.

**The descent of the testis** is entirely a retroperitoneal process—the testis slides downwards behind the peritoneum towards its ultimate resting-place. It is believed that in the early stages of development degeneration of the cranial end of the gland and growth at the caudal end (the two processes taking place *pari passu*) results in the testis coming to occupy a position lower than that at which it originated. Chorionic gonadotrophin from the maternal circulation certainly stimulates the rate of growth of the testis and possibly, it is thought, the hormone plays some part in the migration of the organ. The gubernaculum (= a rudder) was first described and so named by John Hunter, who evidently believed that its function was to guide the testis into the scrotum. Failure of the gubernaculum to elongate in proportion to the growth of surrounding structures is in part responsible for any traction it exerts upon the testis. During the last two months of foetal life (fig. 1190) accumulation of meconium causes intra-abdominal pressure to rise, and this may assist in the expulsion of the testes through the inguinal canals (Sir Arthur Keith). *The third inguinal ring* (Lee McGregor) is the mouth of the scrotum. It is located 2 cm. caudal to the superficial inguinal ring in the adult, but is immediately adjacent in the foetus. This is the gateway to the scrotum, and all important is the patency of this ring during the descent of the testis.

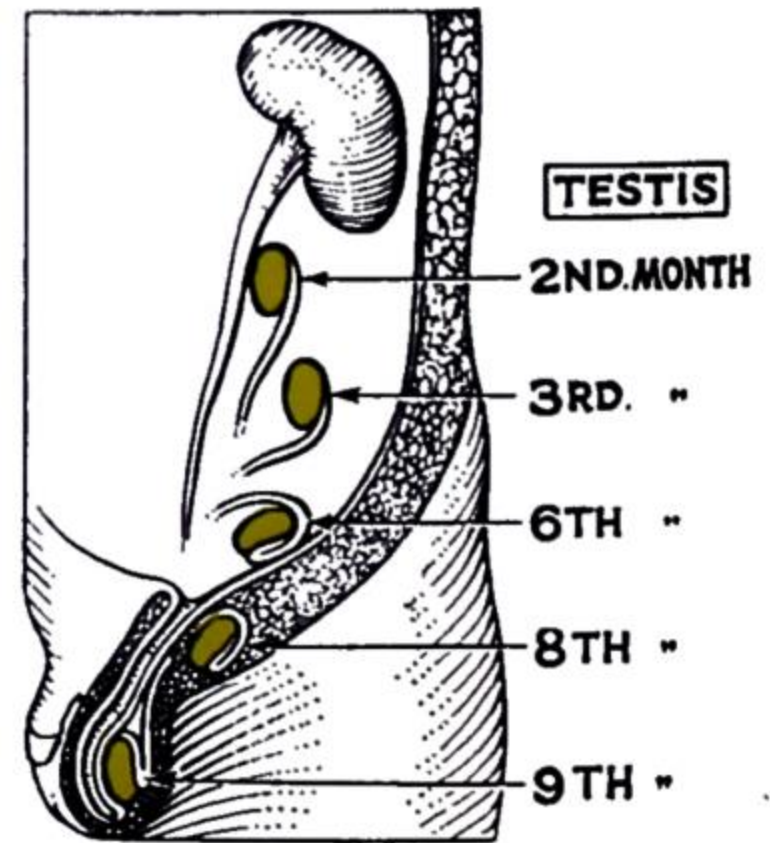


FIG. 1190.—The migration of the testicle. It should reach the scrotum shortly before birth.

Normally the left testis descends a little earlier than the right. Failure of a testis to develop fully unless it is housed in the scrotum<sup>1</sup> or subcutaneously, has been attributed to the somewhat higher temperature to which a retained testis is subjected.

#### Obstacles to Descent :

1. Adhesions attaching the spermatic vessels to the internal abdominal ring. Remedied by severing these adhesions.
2. Shortness of the spermatic vessels. Often remedied by mobilising these vessels (see fig. 1194).
3. Shortness of the vas (very rare). Sometimes remedied by division of the inferior epigastric artery.
4. Adherence of the tunica vaginalis of an ectopic testis to tissues outside the line of normal descent. Remedied easily by dissecting the tunica from these structures.

<sup>1</sup> The scrotum is a thermo-regulator to the testes and keeps them at a temperature at least 2° F. lower than that of the inguinal canals.

Johannes Peter Müller, 1801–1858. Professor of Anatomy and Physiology, Berlin.  
 John Hunter, 1728–1793. Surgeon, St. George's Hospital, London. Founder of the Hunterian Museum.  
 Sir Arthur Keith, 1866–1955. Curator of the Hunterian Museum of the Royal College of Surgeons, England.  
 Lee McGregor, Contemporary. Consulting Surgeon, General Hospital, Johannesburg.



**Morphology.**—Most of the misplacements of the testes in man are a counterpart of the varying normal placements of the testes in animals. In the whale and the elephant the testes remain in the undescended abdominal position throughout life. Rodents and hibernating animals, such as the hedgehog, the mole and the bat, maintain open inguinal canals, and the testes are housed in the abdomen, to descend into the scrotum only during the breeding season. In swine the testes are perineal. In macaque monkeys they are in the inguinal canals until the sixth year; in chimpanzees they enter the scrotum soon after birth. Man is the only member of the animal kingdom that has testes in the scrotum at birth.

#### INCOMPLETELY DESCENDED TESTIS

##### Incidence:

*In the Neonatal Period.*—At birth, and for a variable number of weeks afterwards, the cremasteric reflex, which is so active in young boys, is absent. C. G. Scorer examined 2,000 newborn male infants and found that the incidence of imperfect descent on one or both sides was 4 per cent. in full-term infants and 30 per cent. in premature infants. A follow-up of all cases showed that in more than 50 per cent. the testis or testes reached the scrotum during the first month of life.

More often than not imperfect descent of the testis is not detected during infancy, although sometimes the absence of one or both testes is recognised by the child's parents.

*In later childhood and puberty* the incidence is 2 per cent. Frequently the condition still remains unrecognised unless a routine examination is made by the school medical officer. In a small percentage of cases the presence of a hernia, pain in the region, or acute torsion, in that order of frequency, directs attention to the abnormality.

*In Adult Life.*—It is inconceivable that a man can fail to notice the absence of one or both testes in his scrotum, yet there must be many with this abnormality who do not seek advice about it unless symptoms develop. So it comes about that sometimes the condition is first discovered at the medical examination for entrance to one of the Public Services. In an examination of 10,000 recruits during World War II the incidence was found to be 0·8 per cent. In 10 per cent. of unilateral cases there is a familial history.

**Pathology.**—Up to the age of six years there are no macroscopical differences between an incompletely descended testis and a normal testis. After that time, due it is believed to the higher temperature to which it is subjected, the development of the incompletely descended organ becomes progressively retarded. By the time puberty has been reached the incompletely descended testis is flabby and hardly more than half the size of its intrascrotal counterpart. Histologically the epithelial elements are grossly immature, and by the age of sixteen irreversible destructive changes have occurred in the germinal epithelium (F. Hinman, junior). About the time of puberty another remarkable departure from the normal commences to become apparent in the incompletely descended organ; the body of the testis and the epididymis begin to separate. By the time early manhood is reached this separation is unmistakable (fig. 1191). The *external secretory mechanism* of an incompletely descended testis functions but feebly, and often after a few



FIG. 1191.—Characteristic separation of the epididymis from the body of a maldescended testis. Specimen from a man of twenty-three. Note the inversion.

Charles Gordon Scorer, Contemporary. Surgeon, Hillingdon Hospital, Uxbridge, Middlesex.  
Frank Hinman, Junior, Contemporary. Assistant Clinical Professor of Urology, University of California Medical School, San Francisco, Cal., U.S.A.



months or years, ceases; in short, its power of spermatogenesis is negligible.

Sir Astley Cooper rightly taught that patients with bilateral retained testes were usually sterile, whereupon one of his pupils, a cryptorchid, left the room and committed suicide. At the necropsy which followed, motile spermatozoa were demonstrated. It is therefore unsafe to deny the possibility of parentage to those with retained testes.

*The internal secretory activity* of an incompletely descended testis is reduced. In bilateral cryptorchism about half the normal amount of androgen is produced: notwithstanding, the secondary sexual attributes of a cryptorchid are seldom noticeably in abeyance.

If an incompletely descended testis is brought down satisfactorily *before puberty* it often develops and functions satisfactorily.

**Clinical Features.**—The right testis alone is affected in 50 per cent. of cases, the left alone in 30 per cent., while double arrested descent occurs in 20 per cent. The testis may be:



FIG. 1192.—A cryptorchid, aged 12. Note the retracted, underdeveloped scrotum. In cases of retractile testes the scrotum is comparatively well-developed.

1. *Retained within the abdomen* extraperitoneally, usually just above the internal abdominal ring, but occasionally at a higher level.

2. *In the Inguinal Canal.*—Early in life the testis is a soft structure, and when, as in this instance, it is submerged in the non-resisting floor of the inguinal canal, and shielded by the overlying tendinous aponeurosis of the external oblique, it cannot be felt.

When both testes are situated either in the abdomen or the inguinal canals and are consequently impalpable, the condition is known as cryptorchidism (hidden testes) (fig. 1192).

3. *In the superficial subinguinal pouch.*—Very frequently during childhood the testes are mobile, each be-

ing withdrawn by the contraction of the cremasters into the superficial subinguinal pouch (fig. 1193), a space lined by loose areolar tissue lying beneath Scarpa's fascia and superficial to the external oblique aponeurosis (D. Browne), or into the inguinal canal. Reflex retraction occurs from a very slight stimulus such as touching the thigh or the abdomen, or even by exposure of the parts. Not infrequently this testicular mobility continues throughout childhood on both sides, or less frequently on one side. At all times it is liable to be mistaken for arrested descent unless a special method of examination is undertaken, if necessary on more than one occasion. Retractable testes should be suspected if the scrotum is normal; in arrested descent the corresponding side of the scrotum is undeveloped. This inspection completed, the pulps of two fingers are placed over the superficial inguinal pouch, exerting moderate pressure. By drawing the fingers towards the neck of the scrotum a testis of the retractile

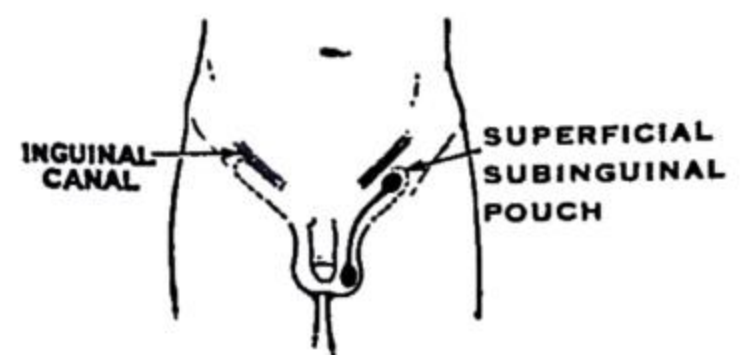


FIG. 1193.—Mechanism of retractile testis. (After D. Browne.)

Sir Astley Cooper, 1768-1841. Surgeon, Guy's Hospital, London.

Antonio Scarpa, 1747-1832. Anatomist and Surgeon, Venice.

Denis J. Browne, Contemporary. Surgeon, Hospital for Sick Children, Great Ormond Street, London.



type can be pushed into the upper part of the scrotum, where it is grasped between the finger and thumb of the other hand. *Only if the testis cannot be made to touch the bottom of the scrotum<sup>1</sup> is it imperfectly descended.* When the testis can be placed in a normal position temporarily it is not truly an imperfectly descended testis, and it should be known by its befitting title 'retractile testis.' Such testes require neither endocrine nor operative treatment. In course of time (it may be delayed until puberty), the testis will take up a normal position permanently.

In early life 80 per cent. of non-apparent testes are of the disappearing variety, i.e. retractile. In the remaining 20 per cent. true incomplete descent is present.

### The Hazards of Incomplete Descent

1. *Sterility* in bilateral cases.
2. *Pain.* An inguinal testis is liable to oft-repeated trauma.
3. *An associated indirect inguinal hernia* is present in 70 per cent. of cases, and in adolescent and adult patients it is frequently the hernia that causes the symptoms.
4. *Torsion* (see p. 906).
5. *Epididymo-orchitis.*—Right-sided epididymo-orchitis occurring in an incompletely descended organ is extremely difficult, if not impossible, to differentiate from appendicitis. Occasionally epididymo-orchitis occurring in a retained abdominal testis gives rise to peritonitis.
6. *Atrophy*, even before puberty, sometimes occurs when the testis is situated in the inguinal canal. This is attributed to slight trauma.
7. *Slight Increased Liability to Malignant Disease.*—For many years the frequency with which malignant disease attacks an incompletely descended testis has been hotly disputed. Some compute that 1 in 20 abdominal and 1 in 80 inguinal testes become malignant; others say this estimation is far too high. Be that as it may, it is clear that orchiopexy does not confer any decreased liability to, but it does improve the prospects of early diagnosis of, malignant disease. From time to time a neoplasm in an incompletely descended testis announces its presence by the descent of the testis.

**Hormone Treatment.**—Of many preparations having a gonadotrophic action, chorionic gonadotrophin extracted from the placenta (Pregnyl) is the one usually employed.

If a course of hormone treatment is deemed advisable it should be given at about six years of age (G. I. M. Swyer), and 1,000 international units given twice a week until the testes descend, the limit of the course being ten weeks, after which it must never be repeated.

In cases of incomplete descent of the testis *per se*, hormone treatment is inadvisable for the following reasons: (a) in the majority of cases there is a mechanical barrier to descent; (b) a potential or actual hernia is present so often; (c) the injections are painful; (d) if retractile testes are eliminated, the chances of successful hormone treatment are small (under 20 per cent.); (e) there is a danger of the treatment precipitating puberty. Incidentally, the cost of the preparation is not inconsiderable.

<sup>1</sup> Only by applying the test conscientiously and correctly in every case will the extravagant claims of some of those who employ endocrine therapy, and particularly those who manufacture these products, be dissipated.



The only indications for hormone treatment are :

1. Cases of bilateral incomplete descent associated with hypogenitalism and obesity.
2. In lieu of waiting for retractile testes to descend, thereby avoiding jibes that small boys have to endure from others in the changing rooms of swimming-baths, etc. (E. F. Scowen).
3. In cases of real uncertainty as to whether the case is one of testes retracting into the inguinal canal or one of true incomplete descent.

**Orchiopexy**<sup>1</sup>.—Most surgeons favour performing the operation between the ages of six and eight years. The recent tendency is to choose the earlier age, in order to reduce the incidence of thermal damage to the germinal epithelium. If herniotomy must be carried out much before this time, it is better to postpone orchiopexy, for in very early life the friability of the peritoneum makes separation of the frail spermatic vessels from it exceedingly difficult. After the age of puberty the percentage of successful operations, which at the optimum age approaches 80 per cent., falls considerably. In cryptorchidism one side should be operated upon at a time, with an interval of six months between the operations.

The operation consists of two concurrent steps: (1) mobilising the spermatic cord and the testicular vessels; (2) retaining the mobilised testis in the descended position.

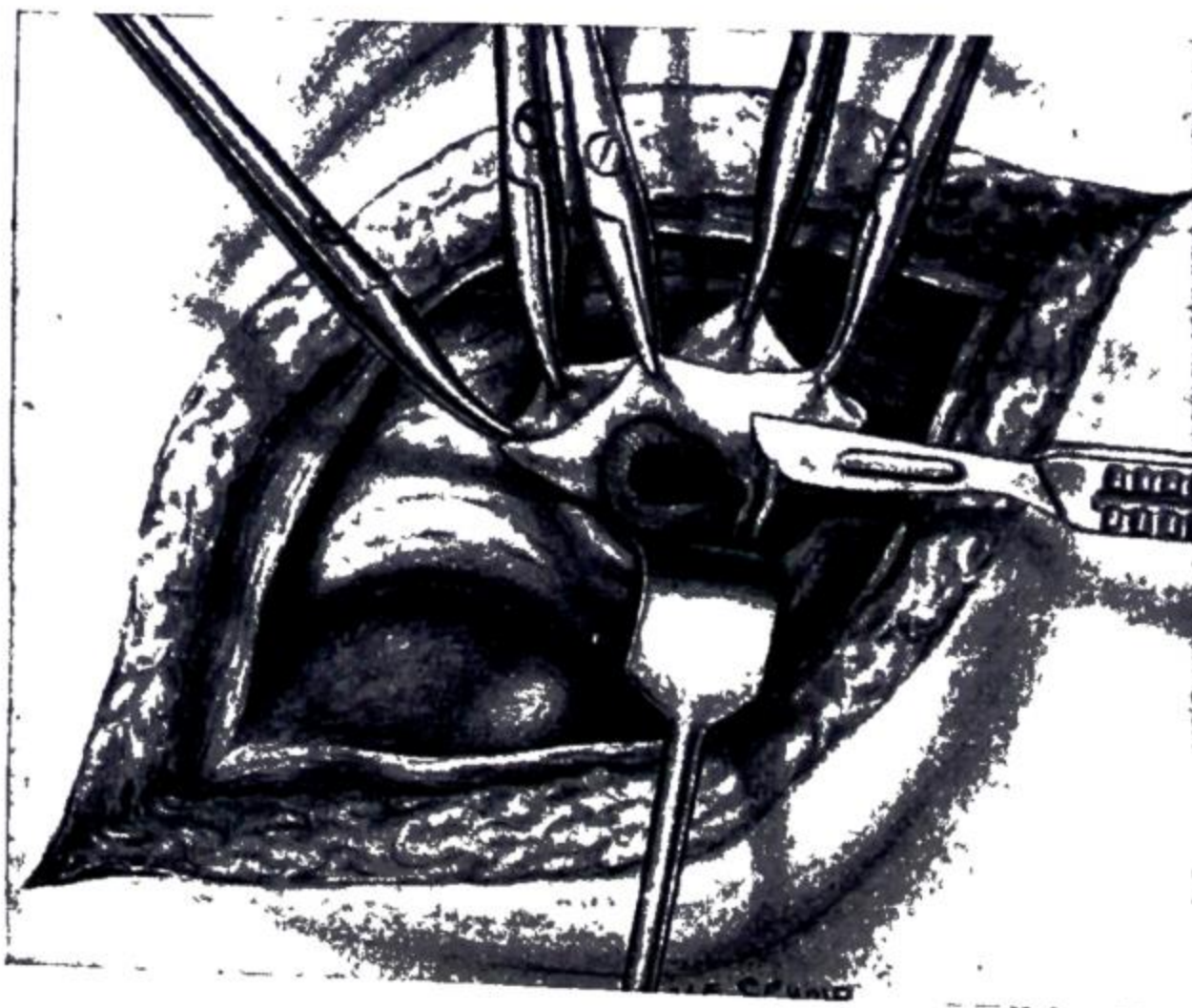


FIG. 1194.—Dissecting the spermatic vessels from the peritoneum. The internal oblique has been 'button-holed' in order to free the vessels at a higher level.

1 inch (2.5 cm.). It is most exceptional for the above measures to fail to elongate the pedicle sufficiently for the testis to be placed in the scrotum, and even beyond it: the avoidance of vascular tension is the keystone of plastic surgery. The empty half of the scrotum is stretched thoroughly with the index finger passed into it through the inguinal incision.

2. *Retaining the testis in the scrotum* is effected by one of a number of ingenious methods, of which the following are popular :

(a) *Ombredanne's operation* is suitable for patients under the age of ten years. A suture is attached to the lower end of the tunica vaginalis of the mobilised testis, and the two ends are left long. A short vertical incision about 1 inch (2.5 cm.) in length is made in the opposite side of the scrotum,  $\frac{1}{2}$  inch lateral to the median raphe, and deepened until the corresponding tunica vaginalis is seen. Between this and the

<sup>1</sup> The term orchidopexy is etymologically incorrect (F. Torek).

Eric Frank Scowen, *Contemporary*. Physician, St. Bartholomew's Hospital, London.  
 Franz Torek, 1861-1938. Surgeon, Lenox Hill Hospital, New York.  
 Louis Ombredanne, *Contemporary*. Surgeon, Hôpital des Enfants Malades, Paris.

I. *Mobilising the Spermatic Cord* (see p. 900).—The inguinal canal is opened. The cord and testis are freed from surrounding structures and a concomitant inguinal hernial sac is dealt with. Near the internal inguinal ring all the coverings of the cord are divided; every muscle fibre and fibrous band is severed, leaving only the vas and its blood-vessels and the spermatic blood-vessels. Sometimes this provides sufficient length for the testis to be placed in the scrotum. If not, the spermatic vessels are dissected from the peritoneum (fig. 1194) to which they are adherent. This abolishes the wide, outward curve of these vessels, thereby gaining up to





FIG. 1195.—Method of passing the suture attached to the testis through the septum dartos and the skin of the opposite side of the scrotum.

septum dartos, a bed is prepared by blunt dissection. The free ends of the suture are seized in a hæmostat, which is passed through the inguinal incision into the scrotum. The tip of the hæmostat is thrust against the septum dartos, permitting a small incision to be made through the septum exposing the tip of the hæmostat and the suture it grasps (fig. 1195). The jaws are loosened and the ends of the suture are drawn through the scrotal wound. Before removing the hæmostat its jaws are opened sufficiently to stretch the tiny opening in the septum to about half the size of the testis, which is pulled through the opening into the opposite side of the scrotum by traction on the suture. The hole in the septum dartos is closed around the cord just sufficiently tightly to prevent the testis escaping from its new abode, but not tightly enough to compress



FIG. 1196.—The disposition of the testes in relation to the septum dartos following bilateral Ombredanne's operation.

the cord (fig. 1196). The scrotal and inguinal incisions are closed, the latter in layers.

(b) *Denis Browne's Operation*.—The floor of the neck of the scrotum is covered with loose, but fairly strong, fascia. By means of a ligature attached to its coverings, the testis is drawn through a slot constructed in the fascia. The ligature is then removed and no attempt is made to fix the testis in any way (fig. 1197).

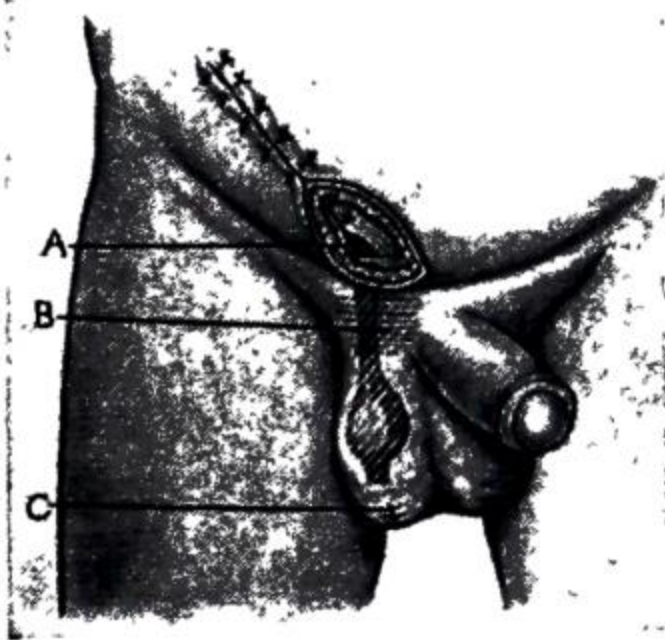


FIG. 1197.—Dennis Browne's operation. (a) Reconstruction of the external abdominal ring; (b) band of fascia under which the testis has been drawn; (c) incision in the scrotum through which the traction suture passed.

(c) *The Keetley-Torek operation* is illustrated in fig. 1198. After six months or less the testis and the scrotum are freed from the thigh. The special indication for this operation is when the patient is a youth



FIG. 1198 (right).—The Keetley-Torek operation. Some months later, when the cord has become adequately lengthened, the scrotum and testis are detached from the thigh.

or an adult, but some specialists in child surgery employ the Keetley-Torek operation in those of tender years.

**Orchiectomy** is indicated when the other testis is normal, and the cord too short to allow replacement of the incompletely descended organ in the scrotum, or when the incompletely descended testis is hopelessly atrophic or diseased.

**Orchio-cœlioplasty** (abdominal replacement of the organ). Only when the contralateral organ has been removed already and orchiopexy is found to be impossible



is this measure justifiable. Occasions arise when it is the only method of preserving a supply of internal testicular secretion and secluding an organ exposed constantly to injury.

#### ECTOPIC TESTIS (*syn.* MALDESCENDED TESTIS)

An ectopic testis may be found :

1. Anchored in the superficial inguinal pouch.
2. In the perineum.
3. At the root of the penis.
4. In the femoral triangle.

The first two positions are relatively common. The last is exceedingly uncommon.

Unlike the imperfectly descended testis, an ectopic organ often develops well, if not fully. Its main hazard is, that owing to its position, it is liable to injury.

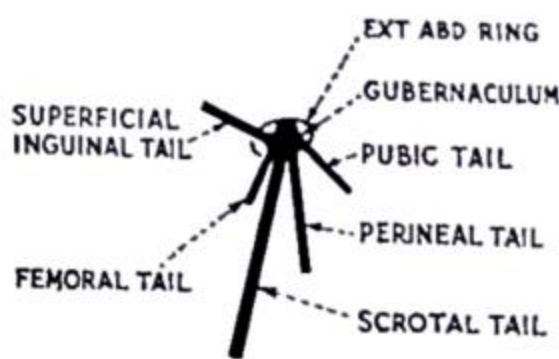


FIG. 1199.—The 'gubernacular tails' of Lockwood.

**Ætiology.**—To explain the appearance of the testis in these anomalous positions, Lockwood advanced the ingenious theory of many gubernacular tails. His theory postulates that in ectopic testis the scrotal tail becomes ruptured. As a consequence the testis, adrift from its usual mooring, follows one of the accessory rudders. Lockwood stated that the accessory gubernacula depicted in fig. 1199 could be demonstrated in the foetus, a claim that other workers have failed to substantiate.

#### INJURIES OF THE TESTIS

**Closed rupture of the testis** from blows and the like is an uncommon accident owing to the extreme mobility of the organ within the scrotum. Severe contusion and rupture are each associated with a hæmatocele which surrounds the testis, rendering the differential diagnosis impossible without exploration. Operation is advisable in these cases in order to :

1. Evacuate the hæmatoma.
2. Repair the tunica albuginea, if split, excising only that part of the testicular tissue that extrudes between the sutures. If the testis is shattered, which is unusual, orchietomy should be performed.

**Hæmatocele** (see p. 916).

**Scrotal Hæmatoma** (see p. 931).

**Traumatic Dislocation of the Testis.**—As a result of a blow the testis occasionally becomes dislocated and by reason of blood-clot anchored, usually in one of the positions described under ectopic testis (see above). Unless the dislocation is reduced early, an operation is required to replace the organ in the scrotum.

#### TORSION OF THE TESTIS (*syn.* TORSION OF THE SPERMATIC CORD)

Some would-be purists state that as twisting occurs in the spermatic cord, the term torsion of the spermatic cord should be used to denote the condition. Unfortunately for them, the statement that it is always the spermatic cord that twists is not true (see below).

Torsion of the testis (fig. 1200) is not a common condition. It occurs with equal frequency in incompletely and fully descended testes. Taking into consideration that incomplete descent is present in less than 1 per cent. of the male population, it is obvious that torsion of an incompletely descended testis occurs *relatively* more frequently than that of a completely descended testis.



**Predisposing Causes.**—Torsion does not occur in a normal fully descended testis; its anchorage prevents rotation. Therefore one of several anomalies must be present to allow torsion to occur.

(a) *Inversion of the testis* (see p. 899). This appears to be the commonest predisposing cause.

(b) *High investment of the tunica vaginalis* causes the testis to hang within the tunica like a clapper in a bell, viz. —————→

HIGH INVESTMENT OF TUNICA  
CREMASTER ATTACHED SPIRALLY  
TESTIS HANGS LIKE A CLAPPER OF A BELL



FIG. 1200. — Torsion of the testis. Note the inversion of the organ.

Very occasionally torsion is extra-vaginal.

(c) *In cases where the body of the testis is separated from the epididymis* (see p. 901), torsion of the body can occur without involving the cord. The twisting is confined to the mesentery that joins the testis to the epididymis, viz. —————→



**Exciting Causes.**—Normally the cremaster contracts *pari passu* with violent contraction of the abdominal musculature. Contractions of the spirally attached cremaster favour rotation around the vertical axis in relevant cases (M. Muschat). Straining at stool, lifting a heavy weight, and coitus are all common exciting causes, but quite often the history fails to reveal any one of them. When, as sometimes happens, the patient volunteers that the symptoms came on during sleep the validity of the statement, which cannot be disproved, is open to question.

**Clinical Features.**—The highest incidence is between fifteen and twenty-five years of age, and the second most common age period is during infancy (fig. 1201). The patient experiences sudden and agonising pain in the groin and lower abdomen, and vomits. Upon theoretical grounds one might think that the diagnosis is simple, but nothing could be farther from the truth, for it is practically impossible to distinguish *torsion of an imperfectly descended testis* from a strangulated inguinal hernia. The fact that the side of the scrotum is empty and œdematous is certainly in favour of the tender lump at the external abdominal ring being the testis with its cord twisted, but it is impossible to rule out a tense strangulated inguinal hernia until the parts have been displayed by operation. *Torsion of a completely descended testis* is

a less difficult problem. Sometimes the actual twists in the cord can be felt, thus establishing the diagnosis. At other times the condition can be mimicked exactly by a small, tense, strangulated inguinal hernia compressing the cord and causing congestion of the pampiniform plexus, viz. —————→

Torsion of the fully descended testis can also simulate closely acute epididymo-orchitis; after a lapse of six hours even the skin of the scrotum becomes reddened (fig. 1202) and the temperature is raised slightly—99° F.

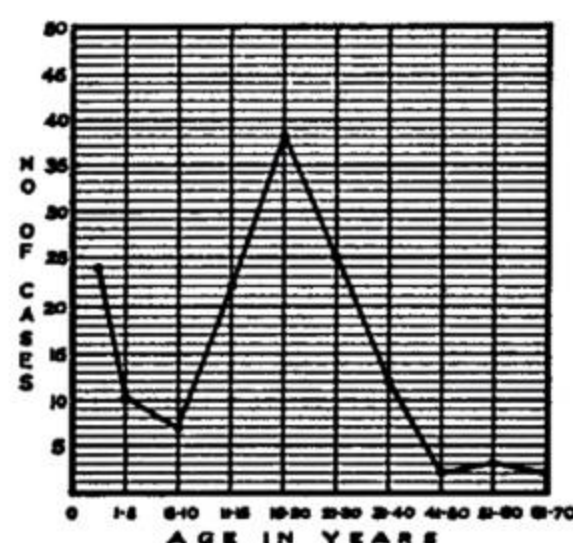


FIG. 1201.—Age incidence of torsion of the testis. (B. S. Abeshouse's statistics.)



(37.2° C.). Elevation of the scrotum relieves the pain in epididymitis, but increases it in torsion of the spermatic cord (Prehn's sign). However, elevation of the scrotum does not always increase the pain in cases of torsion; if the testis happens to become lifeless about the time it is elevated, the pain will abate. Therefore in a boy (if mumps have been excluded) and in a man (if urethritis has been eliminated), a diagnosis of torsion of the testis should be insisted upon, and almost invariably when the testis is exposed the diagnosis of torsion will be substantiated.



FIG. 1202.—Torsion of the testis of twenty-four hours' duration in a boy aged thirteen. The acutely tender right testis and the inflamed scrotum simulate acute epididymo-orchitis exactly.

Treatment:

### Treatment:

**Manipulative Treatment.**—It is true that if the patient is seen within three or four hours and the clinician is quite certain of the diagnosis, occasionally untwisting can be effected by manipulation. Usually clockwise rotation is needed for reduction on the right side, and anti-clockwise rotation on the left (fig. 1203). Analgesics that mask symptoms must not be given, nor in a successful case should the patient be sent on his way rejoicing: the testis must be fixed as soon as convenient, or it will twist again.

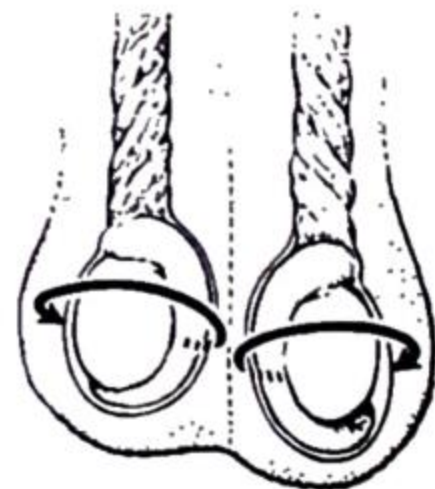


FIG. 1203.—Usually the testis twists in a direction away from the septum dartos. Therefore untwisting must be effected in the opposite direction.

**Operation.**—As a rule urgent operation is indicated. In a few early cases it may be possible to untwist the cord under vision, in which case should an improvement in the colour of the organ result, and the testis is fully descended, it can be spared, but it is highly desirable to fix the testis in an anatomically correct position. More usually orchietomy must be performed. Experience has shown that in cases where torsion occurs, the congenital abnormality that permits twisting (see p. 899) appertains to both sides. Therefore, the contralateral organ should be fixed in the scrotum (fig. 1204) before the patient leaves hospital. By failing to observe this precaution several patients have lost both testes from torsion.



FIG. 1204.—Method of anchoring the testis with non-absorbable sutures to prevent torsion.

**Recurrent torsion** with spontaneous rectification occurs. Such a case was encountered in a young soldier. On the occasion upon which we saw him—the fourth attack within six months—spontaneous rectification took place in the jolting ambulance which conveyed him from his camp. As a result of the repeated interference with its blood supply, the affected testis had become much smaller than its fellow. The excised testis was fibrotic.

**Torsion of an Appendage of the Testis.**—Vestigial structures related to the testis and epididymis (see fig. 1189) are liable to undergo axial rotation. The most



common of these structures to twist is the appendix of the epididymis (the pedunculated hydatid) (fig. 1205). Torsion of an appendage of the testis is essentially a lesion occurring before or at the age of puberty. The condition is often mistaken for acute epididymo-orchitis of unknown origin and frequently, although the symptoms are comparatively mild, they cannot be distinguished with certainty from those of torsion of the testis. Treated expectantly, the affection runs rather a painful course, accompanied often by pyrexia, but resolution occurs eventually. Immediate operation with ligation of the pedicle and amputation of the twisted appendage terminates the symptoms abruptly.



FIG. 1205.—Torsion of the appendix of the epididymis (pedunculated hydatid of Morgagni).

VARICOCELE

Varicocele—a state of varicosity of the pampiniform plexus, nearly always left-sided—is a subject in which flagging interest has been reawakened.

**Surgical Anatomy.**—The veins of the testis and epididymis form an anastomosing plexus—the pampiniform plexus—which is the most bulky constituent of the spermatic cord. As the veins pass upward through the inguinal canal they become reduced in number to between four and eight. Coalescence in the neighbourhood of the internal inguinal ring brings about further reduction in their number, and by the time the posterior abdominal wall is reached, a single, or a duplicated, testicular vein pursues its cephalad course behind the peritoneum, to empty into the renal vein on the left and the inferior vena cava on the right. Only near their termination are the testicular veins provided with valves, and not infrequently even these valves are absent, in which case valves will be found nearby in the renal veins (W. Rivington).

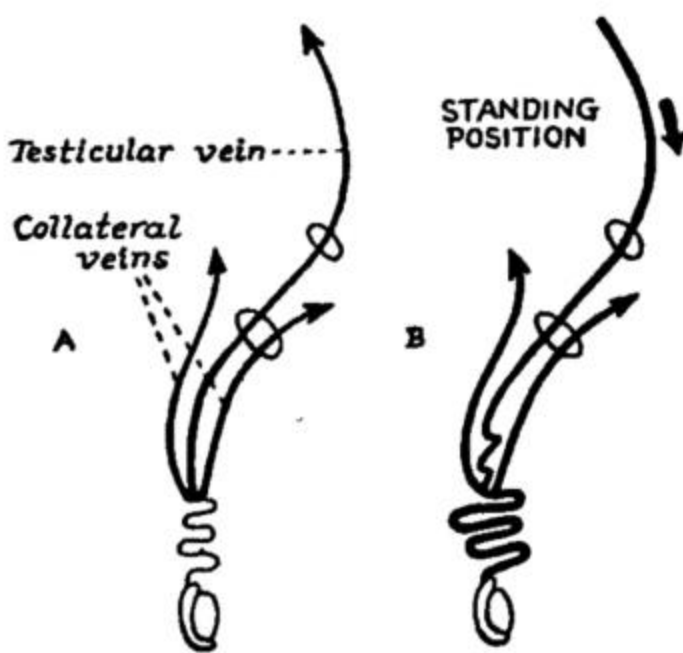


FIG. 1206.—(a) Normal drainage of the pampiniform plexus; (b) reflux along the spermatic vein in varicocele. (After J. W. Lane.)

**Collaterals.**—In addition to the main channel, collateral veins pass alongside the vas deferens to the corresponding internal iliac vein; also communications are present between the pampiniform plexus and (1) the superficial circumflex iliac vein, and (2) the pudendal veins.

**Ætiology.**—Angiographic studies in cases of varicocele have proved conclusively that there is intermittent reflux along the testicular vein (fig. 1206) from the left renal vein. Obviously reflux down the spermatic vein would be greatly increased if the renal vein was compressed

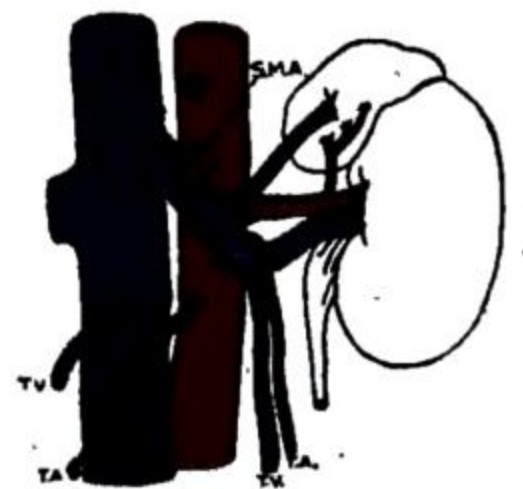


FIG. 1207.—Arching left testicular artery compressing the renal vein of the corresponding side. (After H. Nathan.)

pressed distal to its testicular tributary. That, it is alleged, is exactly what happens in cases of varicocele. H. Nathan has shown that in 16 per cent. of cases on the left and 4 per cent. on the right the testicular artery arches over the renal vein and is liable to compress it (fig. 1207). Even in cases where the testicular artery does not take this abnormal course, in visceroptotic individuals the superior mesenteric arch (see fig. 1207) can compress the renal vein (E. S. Ribeiro).

**Clinical Features.**—Between puberty and the age of thirty-five, from

Walter Rio  
Hilel Natha  
Med

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1897.  
Noth

Surgeon, The London Hospital.  
) Contemporary.

Department of Anatomy, the Hebrew University-Hadassah

Director of the Sanatorio, São Lucas, São Paulo Brazil.



5 to 10 per cent. of males have some degree of pampiniform varicosity on the left side (fig. 1208). In 85 per cent. of cases it is the left side which is affected ;

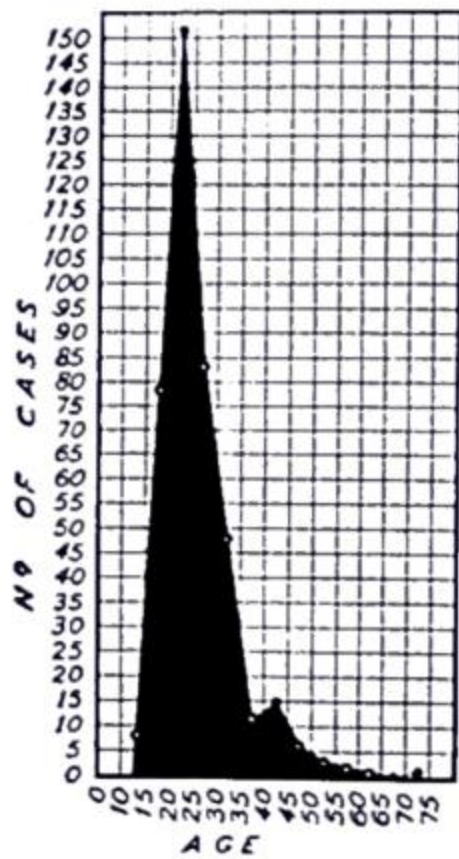


FIG. 1208.—Age incidence of varicocele. (After J. D. Barney.)

in 15 per cent. both sides are involved, but it is most exceptional for the right side to be implicated alone. Usually symptoms are entirely absent. In a proportion of cases the patient experiences a dragging pain on the left side. Those who practise in a temperate climate must not lose sight of the fact that varicocele is more frequent and more troublesome in hot climates. In all parts of the world tall, thin, visceroptotic men are frequently affected, whereas short, fat individuals are seldom so. When the varicocele is comparatively small and the symptoms are considerable, the possibility of a neurosis should engage the clinician's attention, bearing in mind

that the psychoneurotic element of the condition has been over-emphasised.

The diagnosis of a varicocele is simple. The scrotum, particularly the left side of the scrotum, hangs lower<sup>1</sup> than normal (fig. 1209), and on palpation the varicose plexus feels like a bag of worms. If, while lightly holding the varicocele between the fingers and thumb, the patient is instructed to bend forward or, as E. B. Ribeiro puts it, to bow (fig. 1210), tension within the pampiniform plexus becomes appreciably less. This sign adds weight to the belief that in the erect position the renal vein is compressed. When the patient lies down and the scrotum is elevated, the veins will be emptied by gravity and the opportunity of comparing the size of the left testis with its fellow should be taken. In long-standing cases the left testis is somewhat smaller and softer than the right, due to a minor degree of atrophy.



FIG. 1209.—A large varicocele. A left inguinal hernia is also present.



FIG. 1210.—The bow sign. (After E. B. Ribeiro.)

diagnosis of a renal neoplasm, but it occurs only in 0.04 per cent. of cases (Sir Eric Riches).

In 10 per cent. of cases there is a concomitant inguinal hernia, while in 5 per cent. of cases the varicocele is associated with varicose veins of the lower extremity.

*Varicocele as a Cause of Subfertility.*—It has been proved abundantly that

<sup>1</sup> The scrotal musculature is relaxed in the vain endeavour to cool the over-heated testes. Sir Eric Riches, *Contemporary*. Surgeon and Urologist, Middlesex Hospital, London.



a well-marked varicocele can be a cause of oligospermia. The reason for this is that a varicocele acts as a radiator at blood-heat, and the jock-strap that is so often worn conserves the heat. This would explain the fact that a unilateral varicocele can depress spermatogenesis in *both* testes. A varicocele persisting beyond the age of thirty is particularly apt to be associated with poor-quality semen.

**Treatment.**—A small varicocele should be left alone. A cold bath in the morning, and reassurance that there is nothing to worry about is all that is necessary in most instances. In the case of a moderate-sized varicocele the wearing of a fully-ventilated suspensory bandage often relieves the dragging pain, and does no harm.

Candidates for some public services must be operated upon to conform with the regulations. Patients in whom the varicocele is large and the testis hangs low are often especially benefited by operation. Unquestionably, in these circumstances operation should be performed if the patient is going to reside in a warm climate. In cases of subfertility, operation has been attended by many remarkably good results. Following operation, often the sperm count is multiplied many times.

**Operation.**—Of a number of operations for the cure of varicocele, high ligation is favoured more than any other at the present time.

*Ivanissevich's Operation.*—A 4 cm. incision is made 3 cm. above and parallel to the inguinal ligament, the mid point of the incision being above the internal inguinal ring. The aponeurosis of the external oblique is divided in the line of the incision and the fibres of the internal oblique and transversus muscles are separated as in a grid-iron incision. The extraperitoneal fat and peritoneum are displaced upwards and the testicular vessels exposed as they lie on the posterior abdominal wall, lateral to the external iliac artery which serves as a useful guide. The vein or veins are isolated and divided between ligatures, and the wound is closed in layers without drainage.

Although on the whole the results of high ligation are good, a low hanging testis remains low, unsuspected, a concomitant inguinal hernia cannot be dealt with through this incision, occasionally a vaginal hydrocele develops as a result of damage to the left testicular lymphatic vessels, now and then atrophy of the testis occurs from its main venous return being cut off, and, disconcertingly, in 5 per cent. of cases, due no doubt to incompetence of one

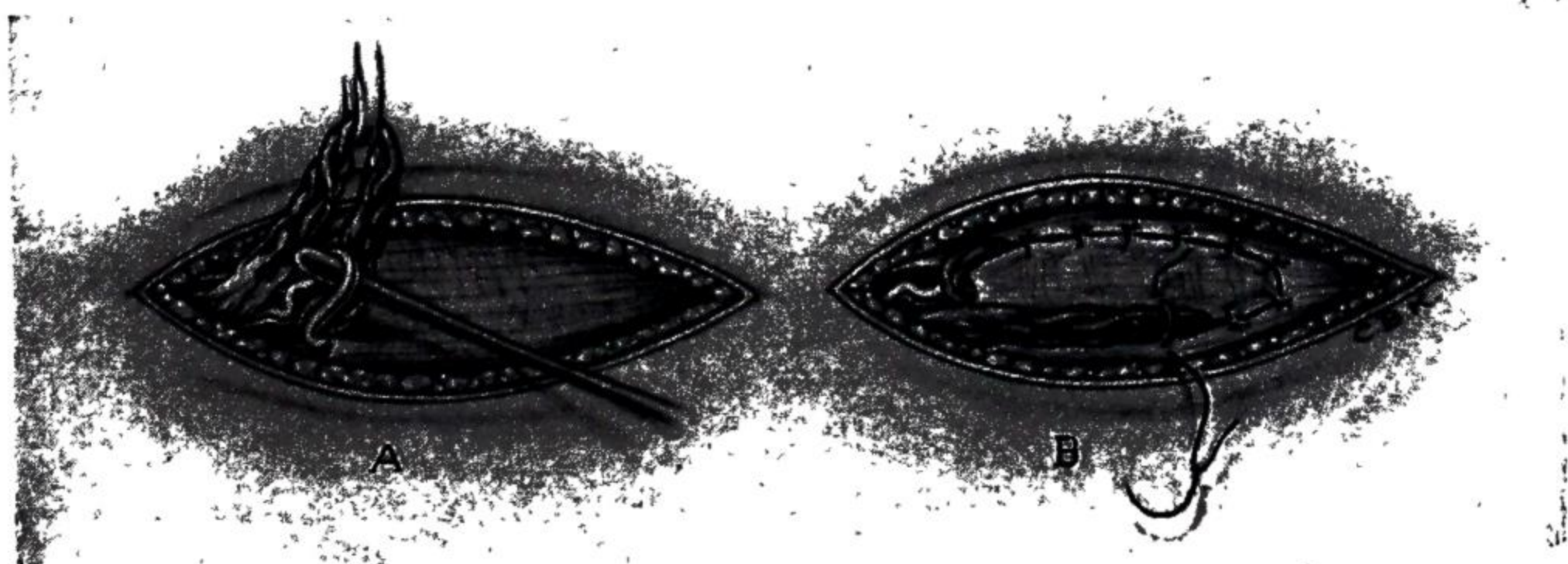


FIG. 1211.—(A) Vas with its artery separated from the cord. (B) Cord buried in a U-shaped tunnel of the external oblique aponeurosis. (After E. B. Ribeiro.)

Oscar Ivanissevich, *Contemporary*. Formerly Professor of Surgery, National University of Argentina, Buenos Aires.

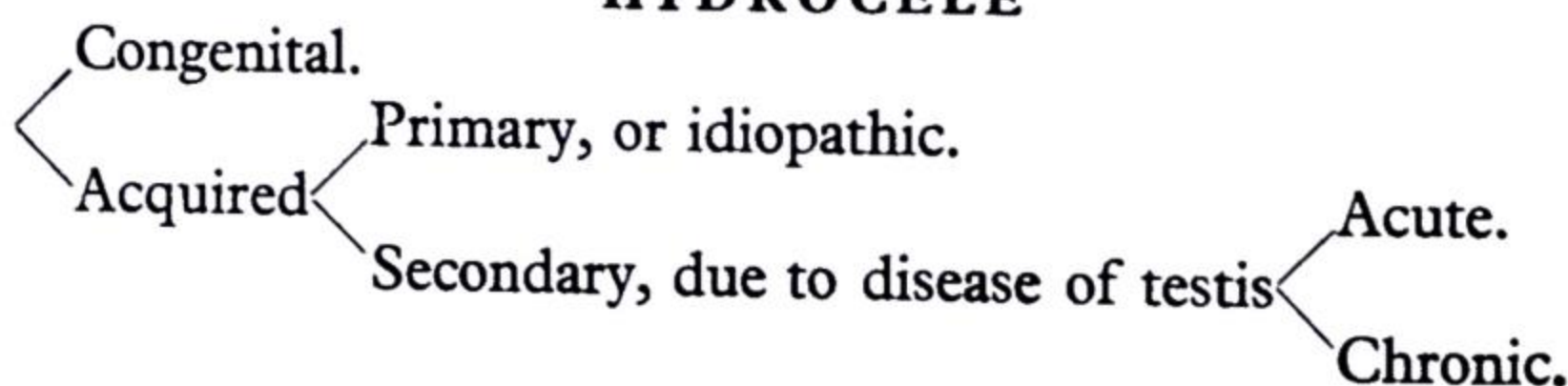


or more of the collateral veins, following the operation the varicocele remains as large as ever. Ribeiro's operation is free from these objections.

*Ribeiro's Operation.*—An incision is made similar to that for inguinal hernia, but the inguinal canal is not opened. The coverings of the spermatic cord are incised, and the structures within are freed from their fascial coverings. The vas and its accompanying artery are isolated from the pampiniform plexus (fig. 1211(A)), after which the vas is allowed to drop back. The pampiniform plexus is placed on the external oblique in a  $\cap$ -shaped manner at such a height as will suspend the testis just below the pubic spine. The  $\cap$ -shaped portion of pampiniform plexus is buried in a tunnel formed by approximating the aponeurosis of the external oblique over it with unabsorbable sutures (fig. 1211 (B)).

The tunnel must be sufficiently commodious not to constrict the pampiniform plexus. The skin edges are approximated.

### HYDROCELE



A hydrocele is a collection of serous fluid in some part of the processus vaginalis, usually in the tunica. From a practical standpoint, four anatomical varieties of hydrocele are encountered.

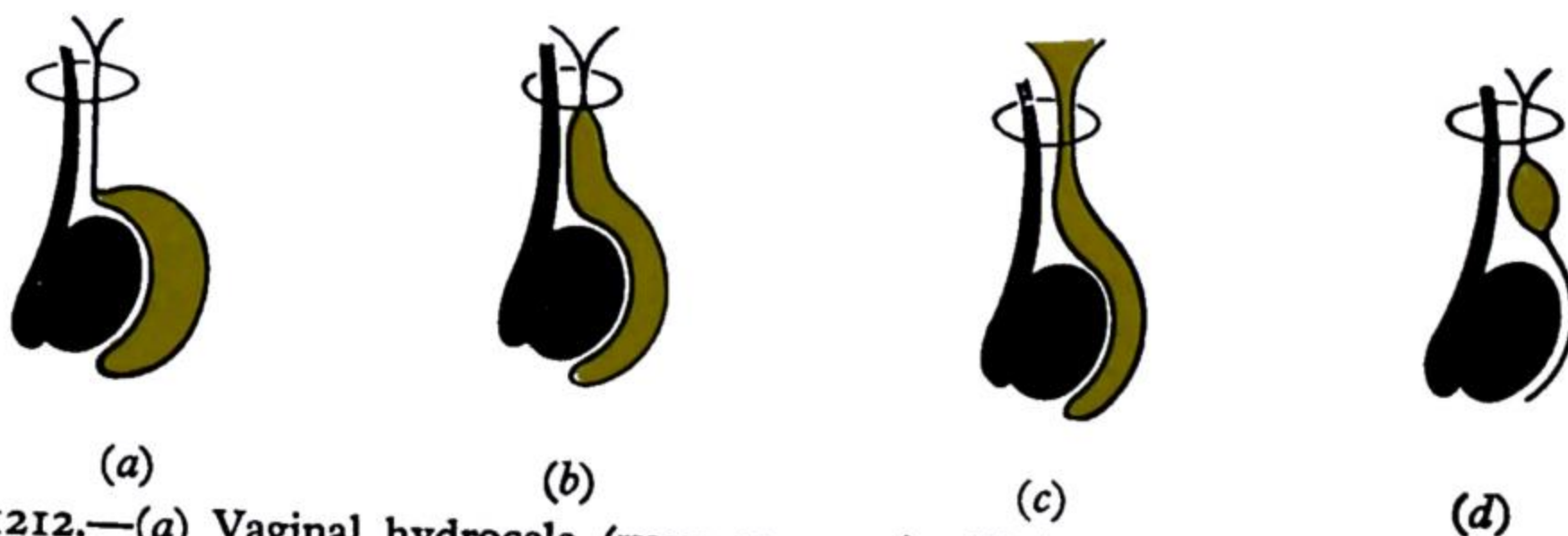


FIG. 1212.—(a) Vaginal hydrocele (very common); (b) 'infantile' hydrocele (unusual); (c) congenital hydrocele (rare); (d) encysted hydrocele of the cord (not infrequent).

**Ætiology.**—A hydrocele can be produced in three ways :

1. By excessive production of fluid within the sac.
2. By defective absorption of hydrocele fluid by the tunica vaginalis.
3. By interference with the drainage of the fluid along the lymphatic vessels of the cord.

Defective absorption appears to be the most common cause of the common variety of primary hydrocele, but the reason for the defective absorption is obscure. Damage to the endothelial wall by low-grade infection seems to be the probable explanation. A hydrocele can also appear in conjunction with some demonstrable pathological condition of the corresponding testis or its epididymis ; it is then termed a secondary hydrocele.

**Hydrocele fluid** is amber coloured, and registers a specific gravity of 1.022 to 1.024. It contains water, inorganic salts, 6 per cent. of albumin, and a quantity of fibrinogen. The last constituent confers upon the fluid a characteristic feature. If the contents of a hydrocele are allowed to run through a cannula into a receptacle, the fluid does *not* clot, but if a few drops of blood which have come into contact with cut tissues are stirred into even a large quantity of hydrocele fluid, the whole clots firmly. In old-standing cases the fluid is sometimes rich in cholesterol, and occasionally tyrosine crystals are found.



## GOLDEN DIAGNOSTIC RULES FOR ALL HYDROCELES

*Ninety-nine out of every 100 hydroceles are translucent. On examination it is possible "to get above the swelling."*

(a) **Primary vaginal hydrocele** is ten times more common than the other varieties put together. Vaginal hydrocele most often appears in middle-aged (fig. 1213) or elderly men, but it is not uncommon in early childhood (fig. 1214), or indeed at any time of life. The condition is particularly common in tropical countries. The only complaint of the patient is the swelling, and occasionally he does not seek relief until the sac has attained enormous dimensions.

About 5 per cent. of inguinal hernias are associated

with a vaginal hydrocele of the same side. Often a large hydrocele obscures a small inguinal hernia, even if the latter has been especially looked for.

(b) **Congenital Hydrocele.**—The processus vaginalis communicates with the peritoneal cavity. Usually the communicating orifice is too small for the development of a hernia. When the scrotum is elevated the fluid in the pouch disappears within the abdominal cavity, usually slowly, but it returns when the erect posture is resumed. Especially in bilateral cases, ascites or serous tuberculous peritonitis should be suspected.

(c) **Infantile hydrocele** does not necessarily appear in infants. The tunica and the processus vaginalis are distended right up to the internal abdominal ring, but the sac has no connection with the general peritoneal cavity.



FIG. 1214.—Right vaginal hydrocele in an infant. It is possible to get above the swelling which is brilliantly translucent.



FIG. 1213.—Large bilateral hydroceles of many years' duration. With tapping they used to fill up in a few weeks. Nine months after three injections to each hydrocele there was no re-accumulation of the fluid.

(d) **Encysted hydrocele of the cord** often causes some confusion in diagnosis. There is a smooth, oval swelling associated with the spermatic cord. When such a swelling abuts the external abdominal ring, it is very liable to be mistaken for an irreducible inguinal hernia. If, with gentle traction upon the testis, the swelling moves downwards and becomes less mobile, the diagnosis of hydrocele of the cord is confirmed.

**Hydrocele of the canal of Nück** is a condition comparable to the foregoing. It occurs in females, the cyst being in relationship to the round ligament. Unlike a hydrocele of the cord, a hydrocele of the canal of Nück is always wholly, or partially, in the inguinal canal.

## COMPLICATIONS OF A HYDROCELE

1. *Rupture* is usually traumatic, but may possibly be spontaneous. On rare occasions a cure results after absorption of the fluid.

*Anton Nück, 1850-1892. Anatomist, of Leiden, Holland.*





FIG. 1215.—A hernia of a hydrocele through some of its coverings.

2. *Hernia of the hydrocele sac* sometimes occurs in old-standing cases. Tension of fluid within the tunica causes herniation of a portion of the sac through some of the coverings of the testis (fig. 1215).

3. *Transformation into a hæmatocele* occurs both spontaneously and as the result of trauma (see p. 916).

4. *Calcification* of the sac wall sometimes occurs in long-standing cases.

**Treatment.**—*Tapping.*—After transillumination, the swelling is made tense. A fine trocar and cannula, or what is often better, a lumbar puncture needle is inserted into an unquestionably translucent area<sup>1</sup>. By this means the fluid is evacuated. After a varying interval the sac usually refills. Many patients are content to be relieved at regular intervals in this way.

*Tapping and injection* is often effective in thin-walled hydroceles. The fluid is evacuated by tapping, and the interior of the sac washed out with normal saline solution. Six ml. of quinine-urethane are injected and the sclerosing fluid is massaged into every ramification of the sac. A suspensory bandage is worn. The fluid usually reaccumulates. One week later the process is repeated. If necessary a third injection is given after an interval of three weeks.

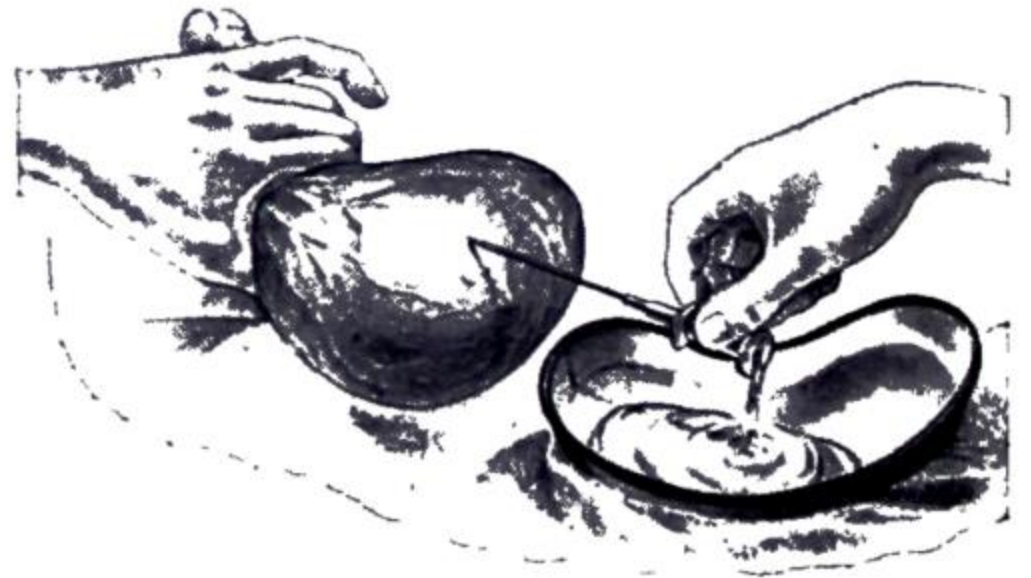


FIG. 1216.—Tapping a hydrocele.

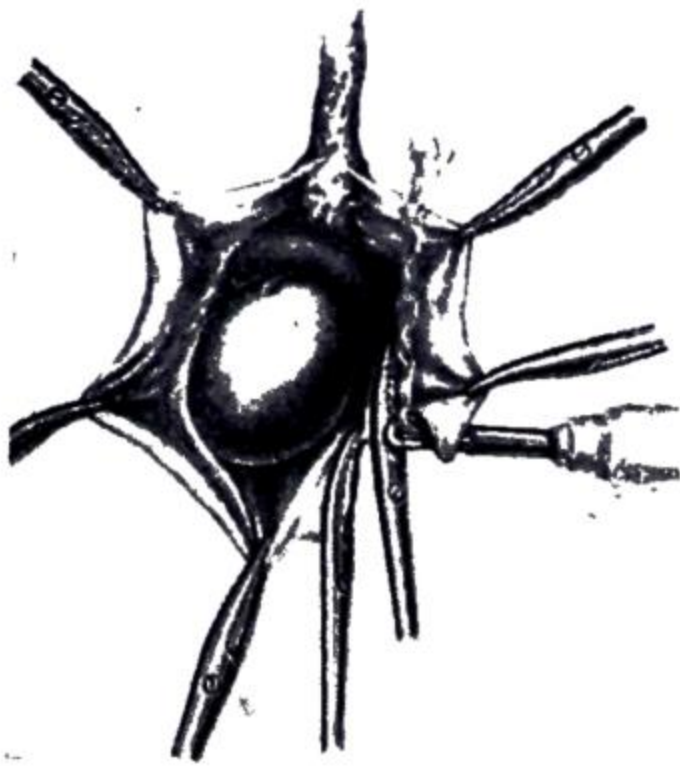


FIG. 1217.—Excision of a vaginal hydrocele.

*Subtotal excision* is the best means of ensuring against recurrence, and it is the only method available for thick-walled hydroceles. An incision is made over the most prominent part of the swelling and the hydrocele together with the testis is separated from its coverings by gauze dissection. The sac is opened with a scalpel and its contents evacuated, after which the sac is split along its length. Each half of the tunica vaginalis is excised by clipping in hæmostats and cutting, preferably with a diathermy knife, a little at a time (fig. 1217) close to its reflection on to the epididymis. Each segment held in a hæmostat is likely to contain blood-vessels, so it is ligated by transfixion. The testis is replaced and the wound is closed with dependent drainage. Dressings having been applied, the scrotum is elevated and is supported by a firm T-bandage. The drainage tube is removed after forty-eight hours.

*Partial excision with eversion* (syn. Jaboulay's operation; the bottle opera-

<sup>1</sup> Repeated tapping is liable to be followed by a little oozing into the sac. Deposits of blood on the walls of the sac in time increase its thickness, and so diminish its translucency. Infection of a hydrocele after tapping caused the death of Edward Gibbon, the historian. In this case the hydrocele seems to have been associated with a large scrotal hernia which, probably, was entered.



tion) is suitable for thin-walled hydroceles. Sufficient of the sac is excised to allow the cut edges to be united without tension behind the epididymis, so that the endothelial lining faces outwards. This operation is liable to be followed by recurrence.

*Excision of the sac in toto* can be performed only in the case of encysted hydrocele of the cord (fig. 1218) or a hydrocele of the canal of Nück.

#### Complications following hydrocelectomy:

1. **Post-operative Scrotal Hæmatoma.**—Nearly 2 per cent. of operations for hydrocele are complicated by a scrotal hæmatoma. This troublesome complication is prevented by draining the scrotum, as recommended above.

2. **Recurrence of the hydrocele** is not very uncommon, especially after Jaboulay's operation. Even when subtotal excision of the hydrocele was performed at the original operation, re-operation reveals that the recurrent hydrocele is lined by glistening endothelium.

Histologically, the wall of the secondary hydrocele sac shows patchy, newly-regenerated epithelial cells. Therefore wide excision of the tunica vaginalis in the first instance is the only means of guarding against recurrence.

**Secondary Hydrocele** is an effusion into the tunica vaginalis that accompanies certain affections of the testis. It is a frequent associate of acute and chronic epididymo-orchitis. It is nearly always present in the syphilitic affections of the testis, and occasionally complicates malignant disease of the organ. A secondary hydrocele rarely attains a large size, and in most instances its laxity does not interfere unduly with the palpation of the testis and its epididymis. Occasionally the question as to whether a hydrocele is or is not secondary to some underlying disease of the testis can only be settled after the contents of the hydrocele has been aspirated.

In the case of acute epididymo-orchitis sometimes a secondary hydrocele subsides *pari passu* with the primary lesion.

**Post-herniorrhaphy hydrocele** is a secondary hydrocele that appears after an operation for inguinal hernia in 0.2 per cent. of cases in which there was no evidence of a hydrocele pre-operatively. Probably this is due to over-zealous excision of the fat surrounding the spermatic cord, with damage to the accompanying lymphatic vessels. The lymphatic trunks of the tunica vaginalis, together with those of the testis, pass along the spermatic cord, mostly applied superficial to the blood-vessels. Their number varies from 4 to 8.

**Hydrocele of a Hernial Sac.**—From time to time the neck of a hernial sac becomes plugged with omentum or occluded by adhesions, and a hydrocele results (see fig. 920 p. 697).

**Filarial Hydroceles and Chyloceles.**—As one proceeds from temperate climates towards the Equator, the incidence of vaginal hydroceles increases. Filariasis accounts for 80 per cent. of hydroceles in some tropical countries. In most instances neither microfilariae are discovered in nocturnal samples of blood, nor is a history of filariasis elicited. Usually filarial hydroceles follow repeated attacks of filarial epididymitis, and develop rapidly or gradually and can be large or small: frequently they are bilateral. In recent cases the hydrocele fluid is similar to that found in the idiopathic variety. In cases of some standing, if the fluid is placed in a tall glass, after a few hours a film of liquid fat (chyle) will be floating on the surface. This is rich

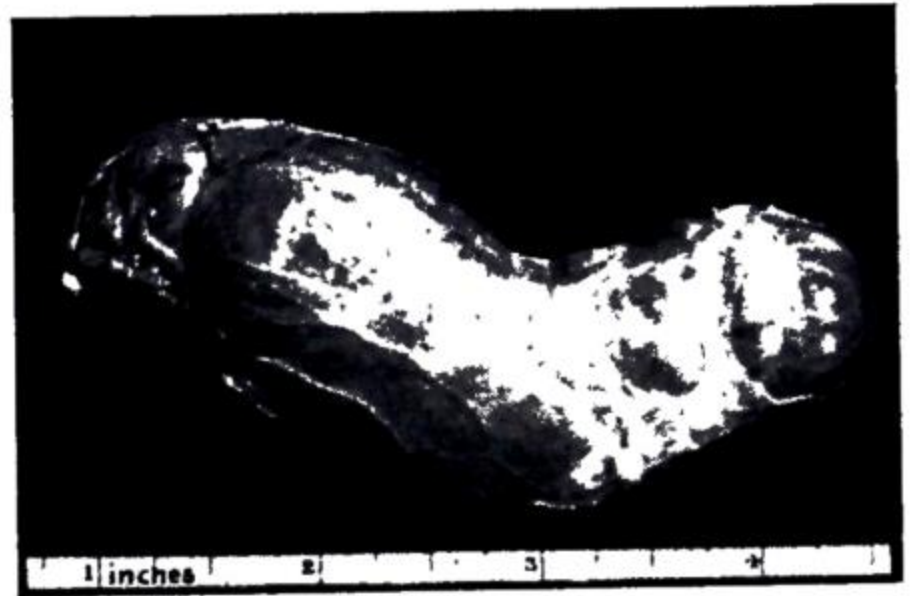


FIG. 1218.—An encysted hydrocele of the cord excised completely.



is cholesterol, and is derived from rupture of a lymph varix into the tunica. The presence of chyle is proof-positive of the filarial origin of a hydrocele. In the course of time the cholesterol tends to be deposited on the walls of a chylocele; consequently with the passage of time the swelling becomes increasingly opaque to transillumination. Adult worms of the *Wuchereria bancrofti* have been found in the epididymis removed by operation, or at necropsy on these cases. In long-standing chyloceles dense adhesions form between the scrotum and its contents. Filarial elephantiasis of the scrotum (see p. 930) supervenes in a small proportion of cases.

**Treatment.**—Acute cases should be treated by rest and aspiration. The more usual chronic cases can be cured by hydrocelectomy.

**Hæmatocele** can be either recent, or present as the clinical entity "old clotted hæmatocele."

**Recent hæmatocele** is usually the result of injury of a small blood-vessel during tapping or aspiration of a hydrocele. Prompt refilling of the sac with considerable pain and tenderness, and poor or absent transillumination, leaves no doubt as to the diagnosis. The treatment should be urgent operation, with evacuation of blood, followed by hydrocelectomy. If this course is not followed, after a prolonged period of rest, accompanied in the early stages by pain, a clotted hæmatocele will almost certainly result.

Acute hæmorrhage into a previously normal tunica vaginalis can result from a blow on the testis. The treatment should be similar to the above for the reasons given, and also because without exploration it is impossible to tell whether or not the testicle is ruptured.

**Old Clotted Hæmatocele.**—Curiously, slow hæmorrhage into the tunica vaginalis can occur spontaneously, and apparently painlessly, for most of the patients presenting with an old clotted hæmatocele give neither a history of trauma to the testis nor of pain in the organ. An old clotted hæmatocele simulates a neoplasm of the testis so closely that pre-operative differential diagnosis is virtually impossible.

**Treatment.**—Unless exposure of the organ leaves no doubt as to the innocent nature of the swelling, unquestionably orchidectomy should be performed. As a rule it is impossible to be certain of the nature of the swelling until the organ has been exposed.

As can be seen in the figure, the testicle is as to



*[Faint, illegible handwritten notes and bleed-through from the reverse side of the page.]*



**Clinical Features.**—Cysts of the epididymis usually are found during middle life and, due no doubt to their congenital origin, they are often bilateral. They are tense, as opposed to the softness of a spermatocele, and they often consist of an aggregation of a number of small cysts which on careful palpation feel like a bunch of tiny grapes (fig. 1220). Cysts of the epididymis are situated *behind* the body of the testis, and on transillumination, because of the numerous septa, their brilliant translucency is finely tessellated, giving an appearance like that of a Chinese lantern.

**Treatment.**—Owing to their multilocular nature, most cysts of the epididymis are unsuitable for treatment by injection. When large, or when symptoms are present, the aggregation of cysts should be excised in a manner similar to that described for epididymectomy which, in truth, it is.

**Cyst of an appendix of the testis** is a separate clinical entity. It forms a small globular swelling at the superior pole of the testis; is usually unilateral, and when pedunculated (fig. 1221) it is liable to undergo axial rotation (see p. 909). The treatment of this variety of cyst is removal by ligation and severance of its pedicle. Being unilocular, a large cyst of this variety responds well to treatment by injection.



FIG. 1221.—Cyst of the pedunculated hydatid of Morgagni.

**Spermatocele** is a unilocular retention cyst derived from some portion of the sperm-conducting mechanism of the epididymis.

**Ætiology.**—It is not possible to dogmatise upon the exact origin of a spermatocele. A blocked vas efferens would account for the condition; on the other hand, it is impossible to dispute a claim that a spermatocele arises from one of those vestigial structures depicted in fig. 1189, provided always that the remnant in question is connected with the sperm-conducting mechanism.

**Clinical Features.**—A spermatocele is nearly always situated in the head of the epididymis, and is therefore above and behind the body of the testis. Filled with fluid resembling barley water and containing spermatozoa, the swelling is typically softer than other cysts occurring within the scrotum but, like them, is translucent. Spermatoceles give rise to few symptoms, and are usually small and unobtrusive. Less frequently they are large enough to attract notice. Sometimes the patient presents himself because he believes he has a third testicle, but, as Sir Robert Liston remarked, "these patients flatter themselves in thinking they are unduly provided" (fig. 1222).

**Treatment.**—Small spermatoceles should be left alone. Larger ones can be aspirated and injected, or excised.



FIG. 1220.—Polycystic disease of the epididymis. (After I. Abell.)



FIG. 1222.—A large spermatocele.

Sir Robert Liston, 1794-1847. Surgeon, Royal Infirmary, Edinburgh. Later Surgeon, University College Hospital London.



## ACUTE EPIDIDYMO-ORCHITIS

In many instances inflammation remains confined to the epididymis, in which case it is referred to as epididymitis; when the infection spreads to the body of the testis the condition is known as epididymo-orchitis. In cases where the inflammation is situated mainly, if not entirely, in the body of the testis, the term orchitis is employed.

**Mode of Infection.**—As a rule, infection of the epididymis is secondary to infection of the corresponding seminal vesicle, which in turn is infected from the prostatic urethra. When the body of the testis is *primarily* infected, the infection is blood-borne.

**Clinical Features.**—The attack is inaugurated with malaise, pyrexia, and perhaps a rigor. The testicle becomes swollen and acutely tender, and a sympathetic acute vaginal hydrocele is a frequent accompaniment. In the premonitory stages, while inflammation is proceeding along the vas deferens pain may be referred to the abdomen, and on the right side this is liable to be mistaken for appendicitis. In acute epididymitis a rectal examination is neither necessary nor desirable, as it may activate the primary focus in the vesicle or prostate. Unless required for the purposes of differential diagnosis, rectal examination should be postponed until the acute stage has subsided when, in cases where the epididymis is the seat of inflammation, more often than not the prostate will be found to be enlarged and somewhat tender, as also is the seminal vesicle on the affected side.

**Acute epididymitis** due to *Esch. coli*, streptococcus, staphylococcus or pneumococcus is a fairly common clinical entity. As a rule there is no evidence of urethritis. Especially in *Esch. coli* infection, it is sometimes unaccompanied by infection of the urine (a mid-stream specimen should always be sent for bacteriological examination). In the absence of any local cause, the infection must be assumed to be blood-borne.

**Instrumental acute epididymitis** can follow any form of urethral instrumentation. It is most liable to occur when a catheter is tied into the urethra without special precautions.

**Epididymitis complicating non-gonococcal urethritis** is more frequent than it is in gonorrhœa, and unless correct antibiotic therapy (see p. 875) is given early, suppuration is usual.

**Acute gonococcal epididymitis** is much less common than formerly, as a result of the antibiotic treatment of acute gonorrhœa. Epididymitis usually commences during the second or third week of gonococcal posterior urethritis. In 90 per cent. of cases the infection is unilateral. When the epididymis becomes involved the urethral discharge lessens and pain commences in the testis. On the following day the urethral discharge ceases, but the urine is hazy with pus cells. The temperature rises to 102° to 103° F. (38.9° to 39.5° C.), and the patient feels so ill that he goes to bed. About the third day the skin of the scrotum often becomes reddened and adherent to the globus minor, but in cases where the gonococcus is the sole infecting organism suppuration does not occur. After the fifth day the symptoms commence to abate, and by the eighth to tenth day the condition subsides. Induration of the globus minor sometimes persists for months. In cases of persistent infection of the corresponding vesicle, subacute attacks of recurrent epididymitis are not infrequent.

**Epididymitis from Retrograde Passage of Urine.**—It is generally accepted that epididymitis can develop during an unusual exertion or violent strain while the bladder is full, and that it is caused by the urine being forced along the vas deferens. The degree of inflammation that results depends upon whether or not the urine is infected, or whether or not there is an active or latent infection in the prostate or seminal vesicles.



**Subacute Tuberculous Epididymitis.**—In cases where the vas is thickened and there is little response to the usual treatment, the possibility of the infection being due to tuberculosis of the epididymis, which is not rare, must receive due consideration.

**Acute epididymo-orchitis of mumps** develops in about 18 per cent. of males suffering from mumps, usually as the parotid inflammation is waning. The testis, often the right, becomes swollen and painful. Rarely, the testicular precede the salivary manifestations. Resolution, as opposed to suppuration, nearly always occurs, but in 55 per cent. of cases atrophy of the testis follows. It often takes many months for signs of testicular atrophy to become apparent. A small incision into the tunica vaginalis and drainage if undertaken early in the attack prevents this atrophy and relieves the intense pain forthwith. It is often stated that the body of the testis is alone involved. This is not so; the epididymis is also most acutely inflamed, as has been witnessed at operation in a number of instances. Especially in infants, epididymo-orchitis of mumps can occur without parotitis<sup>1</sup>.

**Epididymo-orchitis in Bornholm disease** should be considered in cases of epididymo-orchitis of undetermined ætiology when appearing in epidemic form. The testicular lesion appears especially during the second week of the illness.

**Epididymo-orchitis due to the virus of lymphogranuloma venereum.**—The infection is bilateral, and is often followed by abscess formation. The diagnosis presents little difficulty, because of the massive inguinal adenitis, but confirmation by the Frei intradermal test is required (see p. 892).

**Epididymo-orchitis due to Brucellosis** (undulant abortus and Malta fevers). Acute epididymo-orchitis is sometimes the first sign of these diseases. The diagnosis is clarified by appropriate agglutination and skin tests and cultures of the urine and blood.

**Acute post-operative epididymitis** was a serious and frequent complication of prostatectomy. It has been practically abolished by prophylactic division of the vasa deferentia (see p. 845).

**Treatment.**—The patient must be kept in bed until the acute symptoms have abated. All local treatment of the urethritis must be discontinued. The scrotum is supported on a sling formed by broad adhesive plaster attached across the thighs (fig. 1223). Upon the sling is placed a nest of cottonwool, and in this the inflamed organ rests and cooling lotions are applied. The urine is rendered alkaline, and a high fluid intake is necessary. An aperient is given, and sedation is ordered: in severe cases morphine or omnopon is required. Aspiration of a secondary hydrocele helps to lessen the pain. If this is not effective, infiltration of the spermatic cord with 10 ml. of 1 per cent. solution of procaine gives relief for twenty-four hours or more. Antibiotic treatment (penicillin, terramycin, and aureomycin are equally effective in coccal infections) should be continued for two weeks or until the inflammation has subsided. When the inflammation commences to resolve, a well-fitting scrotal bandage is applied and the patient is allowed up.



FIG. 1223.—Treatment of acute epididymo-orchitis. A splint for the testicles. Broad adhesive strapping is applied to the thighs as shown.

If suppuration occurs, drainage is necessary. Atrophy of the testis may follow as a remote complication in any case of epididymo-orchitis.

#### CHRONIC EPIDIDYMO-ORCHITIS

**Chronic Tuberculous Epididymitis.**—Nearly 90 per cent. of cases of chronic epididymo-orchitis are tuberculous, and the great majority commence insidiously.

<sup>1</sup> A complement fixation test for the virus of mumps is sometimes positive.



**Ætiology.**—Whether the lesion is blood-borne or is secondary to tuberculosis of the corresponding seminal vesicle is disputed. The frequency with which the globus minor is first attacked favours the latter hypothesis.

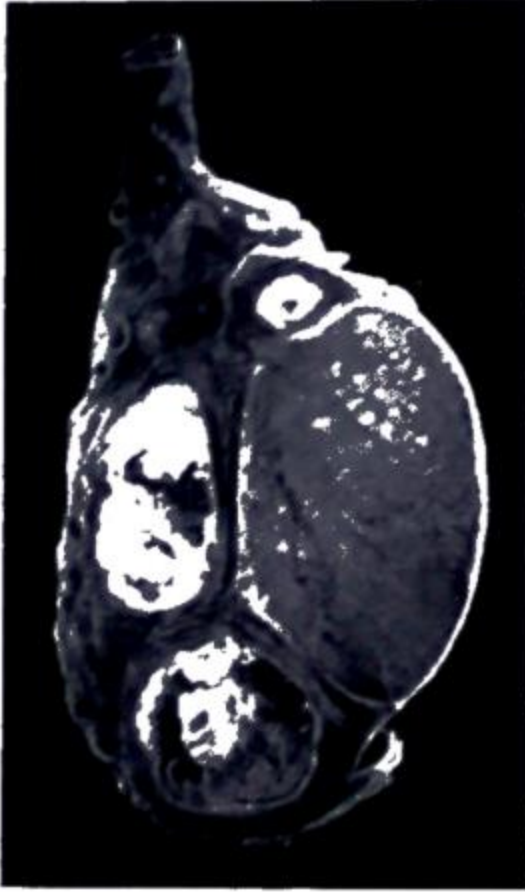


FIG. 1224.—Advanced tuberculous epididymitis.

**Clinical Features.**—A slight ache in the testis or a trivial injury, calls the patient's attention to the swelling in relation to the testis. An early manifestation is a discrete, indurated, slightly tender nodule in the globus minor—rarely in the globus major. As the disease progresses other nodules appear, and eventually the entire epididymis becomes involved, and is felt as a hard, knobby, often painless mass situated behind the testis, which feels normal. In 30 per cent. of cases a lax secondary hydrocele is present. Rarely, when the testis is anteverted, these changes are found in front of the testis. Except in very early cases, the vas on the affected side can be felt thickened, as compared with its fellow. In advanced cases it sometimes becomes beaded. Rectal examin-

ation reveals a thickened, and later an irregular, indurated seminal vesicle on the corresponding side, and sometimes of the contralateral vesicle as well. The prostate is firm and in advanced cases contains one or more discrete nodules. In 20 per cent. of cases the patient first presents himself with a 'cold' abscess in the lower and posterior aspect of the scrotum (fig. 1224), or with a discharging sinus, which may have healed and reopened several times. Untreated, after a varying time (from a few months to several years), the contralateral epididymis becomes similarly diseased. The body of the testis remains uninvolved for a long period, often years.

In under one-third of cases, tuberculous epididymitis arises as a complication of urinary tuberculosis. The symptoms are then so overshadowed by those of frequent and often painful micturition that more often than not the tuberculous epididymis is only revealed on routine examination.

In all cases of chronic epididymitis the urine should be examined for tubercle bacilli, if necessary on several occasions, and pyelography should be undertaken. The lungs must be examined clinically and radiologically. In over 50 per cent. of cases no primary focus is discovered in either the kidneys or the lungs.

**Treatment.**—When tuberculous epididymitis is secondary, the primary lesion should receive priority.

*When Active Pulmonary Tuberculosis is Present.*—If and when the major lesion is controlled by sanatorium and antibiotic treatment, the physician will direct when it is safe to perform epididymectomy.

*When renal tuberculosis is present,* the renal lesion is treated as detailed on p. 774.

In all cases the testes should be supported, and if an abscess forms it should be aspirated.



Treatment with streptomycin and associated antibiotics (see p. 774) is less effective in genital tuberculosis than in urinary tuberculosis. If the epididymitis does not respond to 6–8 weeks' sanatorium treatment, epididymectomy should be performed. When tuberculosis is confined to the epididymis or, as is more usual, to the epididymis and the corresponding vesicle, epididymectomy should be performed. While the presence of caseating nodules makes the macroscopical diagnosis tolerably certain, histological confirmation is always advisable. The diagnosis having been confirmed, the patient should have the benefit of a course of sanatorium treatment commensurate with the extent of the disease. The results of this combined treatment are excellent; following epididymectomy an infected seminal vesicle undergoes fibrosis, or sometimes calcification.

**Chronic non-tuberculous epididymitis** either follows an acute attack or is chronic from the commencement. The condition is difficult to distinguish from tuberculosis, but as a rule the epididymis in non-specific epididymitis is larger and smoother. Thickening of the vas is not a prerogative of tuberculosis, it occurs in any chronic epididymo-vesiculitis.

**Treatment.**—In most cases associated posterior urethritis, vesiculitis, or prostatitis must be eradicated. If the condition fails to resolve after six or eight weeks of conservative treatment and antibiotic therapy, epididymectomy should be performed.

**Epididymectomy.**—When there is a sinus, or on palpation the epididymis is involved extensively, permission for orchiectomy should be obtained, as it is sometimes impossible to determine whether the body of the testis is implicated before the organ has been displayed. An incision is made from the external inguinal ring to below the testis. If a sinus is present, or the skin is adherent to the globus minor, the affected skin is included in an ellipse. The testis is withdrawn and the tunica vaginalis is opened. Commencing at the globus minor, the epididymis is separated from the body of the testis by blunt dissection, aided by the diathermy needle (fig. 1225). As the globus major is approached great care is exercised: the vascular pedicle entering the testis does so between the upper pole of the testis and the globus major, but it is possible to separate the globus major from the testis without injuring the spermatic vessels. The testis, with its vessels intact, is wrapped in a swab while the vas, still attached to the epididymis, is separated from the spermatic cord as far as the external inguinal ring. The vas is then divided between hæmostats near the epididymis, which is removed. The tip of the hæmostat containing the proximal end of the vas is thrust beneath the skin of the inguinal region in an upward and outward direction for about 1 inch (2.5 cm.). A small nick is made in the skin over the tip of the hæmostat, and the latter, together with the vas, is pushed through. The end of the vas is grasped in a second hæmostat and the redundant vas is drawn on to the surface. This small incision is closed with two sutures, one of which passes through the outer coat of the vas. The protruding portion of the vas is allowed to separate at skin level, and it shrivels up and separates in about seven days. In this way infection of the scrotal wound from the lumen of the vas is prevented. The swab covering the testis is removed and any bleeding vessels are ligated, oozing points being controlled by diathermy coagulation. If hæmostasis is perfect, the scrotal wound is closed without drainage.

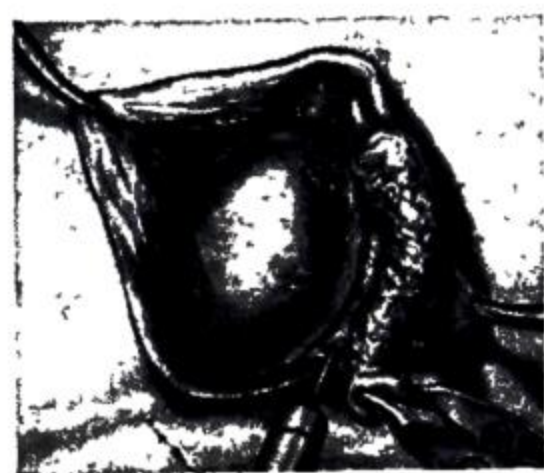


FIG. 1225.—Epididymectomy. Commencing to detach the freed globus minor from the body of the testis.



**Orchiectomy** is reserved for those cases where the body of the testis is involved. It is advisable to deal with the vas as has been described in epididymectomy.

**Syphilitic Orchitis.**—Syphilis attacks the body of the testis, and like other late manifestations of the disease, all three varieties have become uncommon, interstitial fibrosis the least so. The three varieties of syphilitic orchitis are :

(a) *Bilateral orchitis* occurs in congenital syphilis during infancy or childhood (see p. 32). The condition is now rare.

(b) *Interstitial fibrosis* is bilateral, symptomless, and leads to gradual destruction of the seminiferous tubules. The testes are not enlarged. They are harder than normal, and there is a gradual loss of testicular sensation. Fibrosis of the testes is excelled only by meso-aortitis as the best macroscopical post-mortem evidence of syphilis. In bisecting the testis, irregularly distributed streaks of fibrosis are seen traversing the parenchyma.

(c) *Gumma.*—The condition is nearly always unilateral. The body of the testis enlarges slowly and painlessly. At this stage it feels extremely hard. Testicular sensation is lost, and there is nearly always an associated secondary hydrocele (fig. 967). Later there is softening anteriorly and the skin of the scrotum becomes inflamed, and a gummatous ulcer forms. The Wassermann reaction is strongly positive and the response to anti-syphilitic treatment is usually prompt. If the response to such treatment is not rapid and unquestionable it is better to perform orchiectomy than risk the possibility of overlooking a neoplasm with a coincidental positive Wassermann reaction.

**Leprous Orchitis.**—Over 25 per cent. of male lepers have testicular atrophy due to fibrosis engendered by the direct action of the *Mycobacteria lepræ*, and in 20 per cent. of those so affected the orchitis is associated with gynæcomazia.

#### NEOPLASMS OF THE TESTIS

The lymphatics of the testis run in the spermatic cord to the internal abdominal ring, and from thence cephalad and medially with the testicular blood-vessels in close apposition to the psoas muscle. There are no connections with the inguinal nodes or with the contralateral channels in the pelvis. The lymphatic vessels continue in the middle line throughout the remainder of their course in the abdomen and the mediastinum, although enlarged nodes (due to metastasis from a tumour of the testis) may appear laterally, notably in the juxta-aortic and para-aortic nodes situated in the region of the origin of the spermatic blood-vessels (fig. 1226). At about the level of the 10th thoracic vertebra the lymphatics of the testes enter into the formation of the thoracic duct, which extends through the mediastinum to the left supraclavicular fossa, where it drains into the left innominate vein.



FIG. 1226. — The lymphatics of the testes. (After Rouvier.)

#### MALIGNANT NEOPLASMS OF THE TESTIS

About 99 per cent. of neoplasms of the testis are malignant. It is indeed disconcerting that a testicle bearing such a tumour, contained as it is in a bag of skin bereft of fat, and thus more readily accessible to the examining fingers than a tumour of any other organ in the body, only too often escapes detection until it has metastasised. In this connection, perhaps the worst error is to plunge a trocar and cannula into the enlarged testis in the belief that it is a hydrocele, for want of applying the test of translucency. This has been done more often than the reader is inclined to believe.



**Clinical Features.**—Various clinical types are met with :

1. **Typical.**—It is unusual for the patient to seek advice until four to six months have elapsed after the first symptom, which is enlargement of the testicle. In the meantime the tumour has been growing slowly, painlessly, and relentlessly. In over 20 per cent. of cases there is a history of injury. It is generally conceded that injury merely calls attention to the testicular enlargement, and in no way initiates the neoplasm. A sensation of weight is complained of when the testis has reached two or three times its normal size. Local pain is present in half the cases of more than six months' standing.

On examination the body of the testis is found to be enlarged, hard, smooth, and heavy. Later one or more softer bosses may be palpable. In no other disease is testicular sensation lost so early or so completely, but the greatest gentleness must be exercised in eliciting this sign for fear of disseminating the neoplasm. For this reason the sign must not be repeated, in fact, the testis should be gently palpated by only one, or at the most two, students or practitioners. A secondary hydrocele is present in 10 per cent. of cases ; it is usually lax, and seldom obscures the enlarged testis. Should aspiration of fluid be deemed necessary a fine needle is employed, especial care being taken not to prick the tunica albuginea. The epididymis is normal at first ; later it becomes so flattened or incorporated in the growth that it is imperceptible. The spermatic cord remains normal for a considerable time. It then becomes thickened, due to cremasteric hypertrophy and enlargement of its veins. The vas is never thickened. Rectal examination reveals no abnormality in the prostate or seminal vesicles.

Next the sites of possible metastases (fig. 1227) should be examined. The abdomen is palpated for secondary retroperitoneal deposits, their most usual situation being just *above the umbilicus* on the same side, the opposite side, or both sides. In powerful men it is extremely difficult to detect enlarged para-aortic lymph nodes by palpation. The left supraclavicular region should be examined.

2. **The predominant symptoms are due to metastases:** (a) the patient complains of abdominal or lumbar pain, and on examination a mass is discovered in the region of the pancreas.

(b) Usually pulmonary metastases from a tumour of the testis give rise to few, if any, symptoms. On rare occasions the patient presents on account of pain in the chest, dyspnoea, and perhaps hæmoptysis.

In either case the enlargement of the testis may not have been noticed by the patient, and is discovered only by a clinician who makes a very thorough clinical examination.

3. **More Exceptional Cases.**—The course of the disease is variable ; as a rule metastasis occurs within six months of the tumour becoming palpable. The extreme variations are :

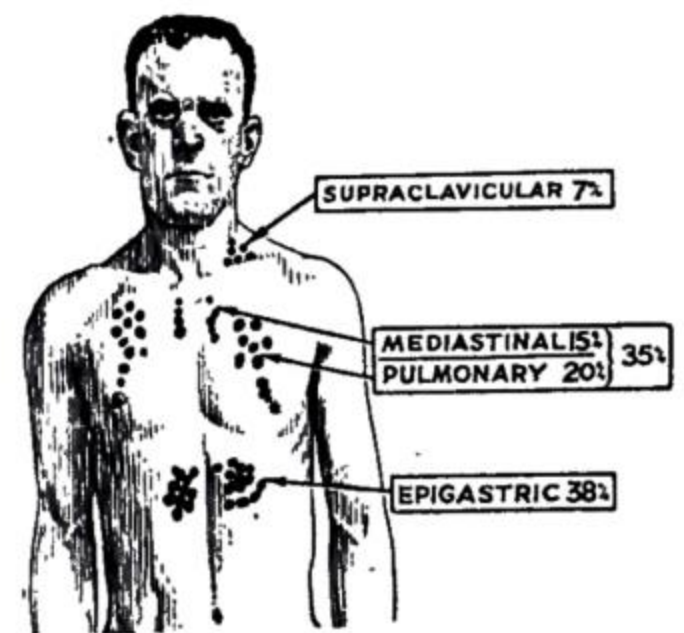


FIG. 1227.—Distribution of lymphatic metastases in teratoma of the testis. (R. S. Ferguson's figures.)



(a) *The Slowly Growing Type.*—In a few cases the neoplasm grows very slowly, the patient having noticed an increasing enlargement of the testis for two or three years.

(b) *The Hurricane Type.*—At the other end of the scale radio-resistant metastases from a highly malignant tumour bring about a fatal termination in a matter of weeks.

**Radiography.**—The aid of radiography should be invoked in every case, and even in every suspected case, of neoplasm of the testis.

(a) *Radiographs of the Thorax.*—Mediastinal metastases are discovered in this way. Secondary pulmonary deposits from a testicular neoplasm appear as round, clear-cut shadows, usually multiple, but occasionally single. Multiple tumour nodules in the lungs of a man below 45 years of age are nearly always due to either a testicular neoplasm or a papilliferous carcinoma of the thyroid.



FIG. 1228.—Bowling outwards of the left ureter and a filling defect of the right ureter, due to massive neoplastic infiltration of the lumbar lymph nodes secondary to a malignant tumour of the right testis. (Professor Carl Krebs, Aarhus, Denmark.)

choriocarcinoma, and the lowest reading (less than 500 mouse units/L) by seminomas and adult teratomas. Very few laboratories have facilities for this quantitative estimation, and for practical purposes a positive Aschheim-Zondek test implies that the tumour is a choriocarcinoma, or contains choriocarcinomatous elements—a comparatively rare event.

**Retrograde Simple<sup>1</sup> Orchiectomy for Neoplasm.**—Through an inguino-scrotal incision, the inguinal canal is opened to display the spermatic cord, which is divided at the level of the internal inguinal ring. The spermatic cord and the testis are removed from above, downwards, by separating them from their attachments. The wound is closed. Depending upon the pathological report, usually orchiectomy is an insignificant part of the treatment, and can be looked upon as a procedure *par excellence* for obtaining a biopsy specimen: that is why in this instance the unusual course of describing clinical features before pathology has been taken.

<sup>1</sup> Simple, as opposed to radical, orchiectomy.

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Bernhardt Zondek, *Contemporary*. Gynaecologist, Rothschild Hadassah Hospital, Jerusalem.

(b) *Excretory Pyelography.*—The presence and extent of retroperitoneal metastases often can be estimated accurately by the displacement and compression of the ureter they produce (fig. 1228). A large mass sometimes causes a pressure deformity of the kidney. Repeated radiographs after irradiation will indicate whether or not the tumour is radio-sensitive.

**The Aschheim-Zondek Pregnancy Test.**—The hormone output varies inversely with the degree of cellular maturity of the tumour. The test should be carried out on a 24-hour specimen of the urine and the quantitatively adapted test is of considerable value; thus the highest reading (from 10,000 to 200,000 mouse units/L) is registered by



**Pathology.**—Tumours of the testis constitute about 2 per cent. of malignant tumours in the male. They are classified most satisfactorily into three groups :

- |                                   |              |
|-----------------------------------|--------------|
| 1. Seminoma . . . . .             | 49 per cent. |
| 2. Teratoma . . . . .             | 50 per cent. |
| 3. Interstitial tumours . . . . . | 1 per cent.  |

The percentage of the first two sub-divisions varies in different series. Those series emanating from hospitals for Service personnel show a higher percentage of teratomata. The reason for this is that patients in such hospitals are likely to be of a younger age-group than found in the community at large; the peak incidence (fig. 1229) of teratoma being between 21 and 25 years of age, while that of seminoma is between 31 and 35. Armed with this knowledge, it is possible for the clinician to forecast the pathological report.

1. **Seminoma**, so named by Chevassu, commences in the mediastinum of the testis, and as it increases in size the neighbouring testicular tissue is

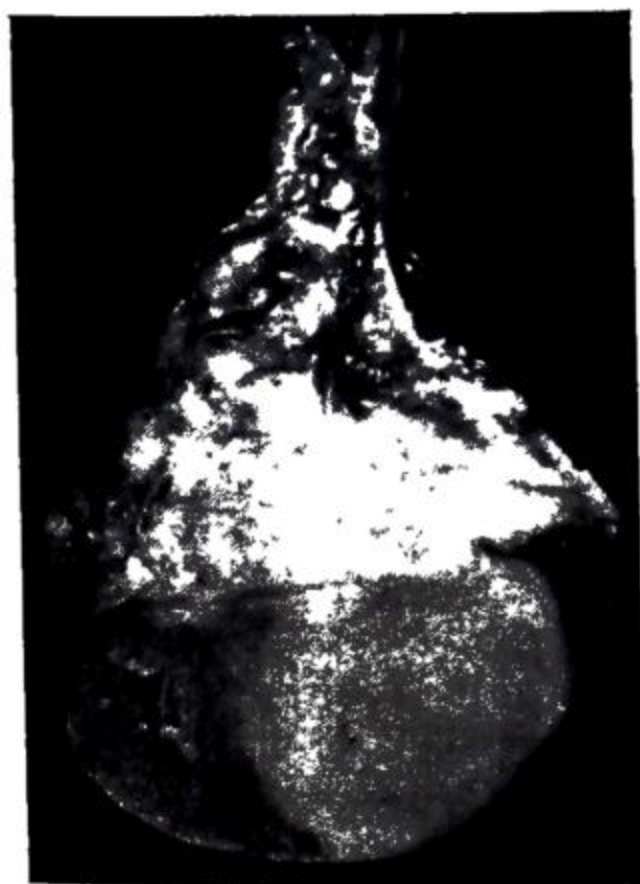


FIG. 1230.—Seminoma of the testis. (Dr. Keith Simpson, London.)

compressed (fig. 1230). Macroscopically the enlarged testis is hard and smooth, and on section homogeneous and pink or cream in colour. Occasionally fibrous septa give it a lobulated appearance. In rapidly growing tumours areas of necrosis are sometimes present.

**Histologically** it is composed of rounded, slightly oval, cells with clear protoplasm and large rounded nuclei containing acidophile nucleoli. The cells are arranged in sheets separated by a fine fibrous stroma. Derived from the seminiferous tubules, the cells resemble spermatocytes.

A seminoma metastasizes almost exclusively by the lymph vessels; only occasionally does it disseminate by the blood-stream and give rise to secondary deposits in the lungs.

Seminoma occurs in adult dogs, and is histologically indistinguishable from the seminoma occurring in man, but its degree of malignancy is much lower.

2. **Teratoma** arises in the rete testis from toti-potent cells; accordingly, elements of ectoderm, mesoderm, or endoderm are often represented. Usually one of these predominates and attains malignancy. The tumour

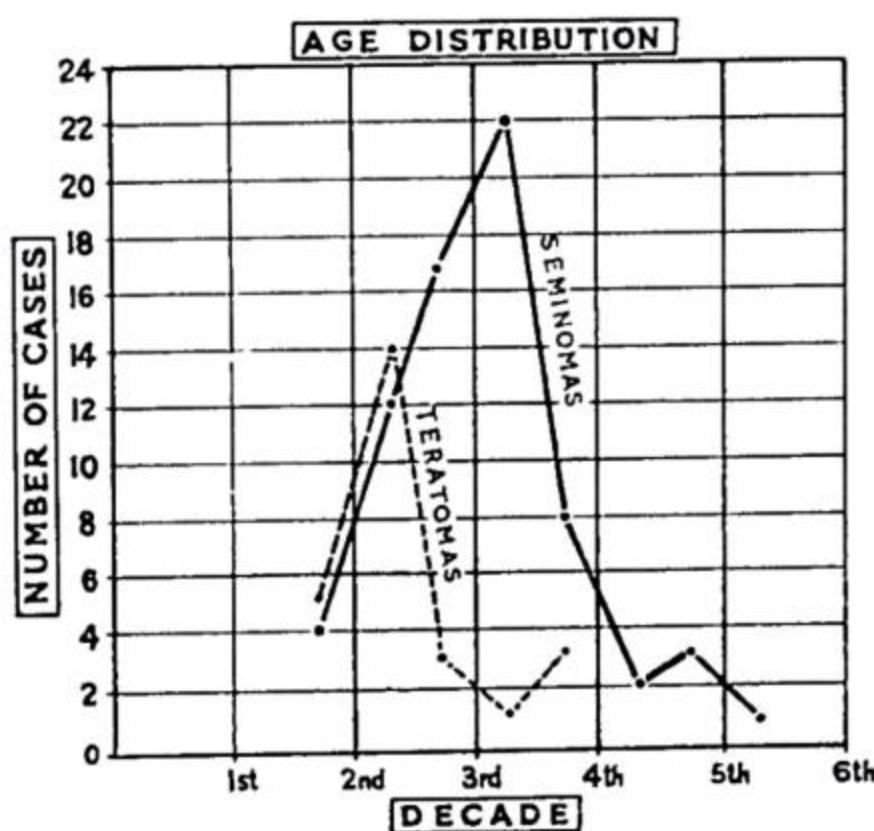


FIG. 1229.—The age incidence of teratomas and seminomas of the testes. (T. M. Prossor's statistics.)



varies in size from that of a marble, less than 1 inch (2.5 cm.) in diameter, to that of a coconut, and even when large, as it is moulded by the tunica vaginalis, the shape of the testis is more or less retained.



FIG. 1231.—Teratoma of the testis containing solid and cystic areas. (Dr. Keith Simpson, London.)

The most usual variety is yellowish in colour and shows cystic spaces (fig. 1231) containing gelatinous fluid. Cartilaginous nodules are often present.

While it is not incorrect to classify all tumours of the testis other than seminomata as belonging to Type 2, to subdivide these teratomata, which present such kaleidoscopic variations in their cellular structure as well as their grade of malignancy and their response to radiotherapy, is of great advantage.

**Embryonal Carcinoma** (25 per cent)<sup>1</sup>.—The type of cell shows considerable variation from tumour to tumour, or in the same tumour. In parts the general arrangement of cells is sometimes not unlike that of a seminoma, but if clumps of cells are differentiated into glandular and papillary structures the tumour should be classified as an embryonal carcinoma. These tumours are so radio-resistant that they are rarely controlled by the amount of radiation that a patient can tolerate. The five-year survival rate after all forms of treatment is about 30 per cent.

**Choriocarcinoma** (3 per cent.) resembles the architecture of the placental villi, and is composed of cytotrophoblastic cells. In some cases it is associated with the production of chorionic gonadotrophin and gynæcomazia. In its purest form, choriocarcinoma spreads by the blood-stream as well as by lymphatics while the primary tumour is small, and it is often described as the most malignant tumour known. It is completely radio-resistant, and death results within a few months. However, a choriocarcinoma is frequently associated with teratoid tissue in the form of a teratochoriocarcinoma, and at least thirty-seven patients (including one medical practitioner) with this hybrid choriocarcinoma have survived five years following radical orchiectomy (L. G. Lewis).

**Teratocarcinoma** (17 per cent.) comprises pleomorphic cells with differentiated structures. In 5 per cent. of cases there is a mixture of teratoma and seminoma; in 15 per cent. there is a mixture of embryonal carcinomatous, seminomatous and choriocarcinomatous elements. A few of these tumours are radio-sensitive. The five-year survival after all forms of treatment is approximately 40 per cent.

**Adult Teratoma** (5 per cent.)—The best-known variety of this type of tumour is a dermoid cyst. If a teratoma has no histologically recognisable malignant components, it is termed adult, but it cannot be considered to be benign, because such growths have metastasised. Radiotherapy is of doubtful value in these cases, but many patients have survived following simple orchiectomy. With radical orchiectomy the outlook is improved, the five-year survival rate being over 80 per cent.

**Spread.**—Although any malignant tumour of the testis may metastasise through veins, nearly always lymphatic spread occurs first. With the exception of choriocarcinoma, the cells of which are likely to escape into the blood-stream before testicular enlargement has been discovered, the lymph nodes become sufficiently enlarged to be palpable before there is recognisable dissemination by way of the blood-stream.

**3. Interstitial Cell Tumour.**—A tumour of the testis arising in the interstitial cells of Leydig occurs frequently in bulls, rams, horses, and especially dogs. It is

<sup>1</sup> These approximate percentages refer to all varieties of tumours of the testis.

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Franz von Leydig, 1821–1908. Professor of Histology, Bonn.



essentially a tumour of the ageing dog. Conversely, in man interstitial tumour of the testis is rare, occurs at an early age or the prime of life, and arises either in the cells of Leydig or those of Sertoli.

A Leydig cell tumour masculinises; a Sertoli cell tumour feminises. For clinical reasons these tumours are well classified as those occurring before and those occurring after puberty.

*Prepubertal tumour* is characterised by an excessive output of androgen, which is responsible for sexual precocity and extreme muscular development. This results in an infant Hercules, in all respects similar to the condition produced by an adrenal cortical tumour (see p. 262), except that on palpation a swelling of the testis can be elicited. Exceptionally the tumour is bilateral, but it must always be remembered that in this condition the contralateral normal testis frequently becomes hypertrophied. In so far as the neoplasm is concerned, removal of the testis is curative; in some cases the symptoms regress, in others (where the contralateral testis is hypertrophied) the regression is incomplete.

*Post-Pubertal Tumour.*—In a high percentage of cases the tumour arises in the cells of Sertoli, and consequently the output of feminising hormone becomes excessive. Gynæcomazia, loss of libido, and aspermia result: in such cases the Aschheim-Zondek test is positive. As a rule the tumour is innocent, and orchietomy is curative. If the pathological report indicated that the tumour is atypical, X-ray therapy should be given.

**Treatment of Neoplasms of the Testis.**—Once the pathological report has been received the main treatment of the patient can commence.

**Radiotherapy.**—Most, but not all, seminomas are highly radio-sensitive. Most, but not all, teratomas are radio-resistant. Over 80 per cent. of patients suffering from seminoma of the testis without pulmonary metastases survive more than five years after simple orchietomy followed by radiotherapy.

From its inception, radiotherapy of tumours of the testis has been based on the assumption that retroperitoneal lymphatic metastases occurred whether or not they are palpable. When possible, such irradiation should be given by a million-volt X-ray unit. The powerful rays emanating from this machine permit the desired deep dose to be given in a shorter time, with greater certainty, with less injury to superficial tissues, and with less general reaction than is possible with a machine of lower voltage. When there is no clinical or radiological evidence of metastases the radiation is confined to the area between the scrotum and the 10th dorsal vertebra, with suitable screening of the remaining testis. The iliac and lower para-aortic lymph nodes are irradiated first; six weeks later the rays are concentrated upon the upper para-aortic nodes. The maximum tumour dose varies between 4,000 and 4,500 r.

In more advanced cases radiotherapy is given through one inguinal, four abdominal, two mediastinal and two left supraclavicular portals. In order to control the vomiting of radiation sickness, so common in patients receiving radiotherapy in high dosage, the administration of chlorpromazine is helpful.

**Dangers of Irradiating the Renal Area.**—If high doses are given, at least one-third of the renal area must be excluded from irradiation, because of the danger of renal damage. An over-irradiated kidney becomes sclerosed and its arterioles greatly thickened; as a consequence, hypertension results. In unilateral cases nephrectomy is indicated.

**Pulmonary Metastases.**—Sometimes irradiation results in regression, but



almost invariably this is followed by fresh deposits. Frequently the dose of X-rays converts a condition that was symptomless into one accompanied by severe discomfort and respiratory deterioration. Therefore it is doubtful if the X-ray treatment of pulmonary metastases is worthwhile (R. Cox).

**Radical Orchiectomy.**—Embryonal carcinoma and teratocarcinoma are so radio-resistant that they are rarely, if ever, controlled by the amount of radiation that the patient can tolerate. It is in these cases that the supplemental benefits of operation are called for, in spite of the difficulties presented and the considerable bulk of opinion to the contrary. Provided, of course, that there are no demonstrable secondary deposits in the thorax or a large fixed mass in the epigastrium, and the patient is in other respects fit to undergo an extensive operation, the best time to choose is after the patient has recovered sufficiently from the effects of radiotherapy, which helps to devitalise metastases, if present (A. Dean). Under the anæsthetic the epigastrium is palpated, and if no large mass is felt (which would render the operation not worthwhile) a short mid-line upper abdominal laparotomy incision is made, just large enough to admit the hand. Provided no enlarged lymph nodes are felt higher than the 10th dorsal vertebra, the case is operable.

**Block Dissection of the Ilio-lumbar Lymph Nodes.**—The abdomen is closed and an anterior incision is made following the course of the lower third of the spermatic vessels, commencing at the lower end of the cut spermatic cord. The modern operation consists of a clean dissection of all lymphatics and fat in a single sheet—the entire lymphatic field—a laborious procedure requiring perfect exposure. Having dissected the iliac lymphatics and followed and freed the spermatic vessels as far as convenient, the dissected tissues are left *in situ pro tem.* while the wound is closed with drainage, and the patient turned upon his face.

Excellent visualisation is afforded by the Nagamatsu kidney incision (see p. 783), with resection of an inch (2.5 cm.) of the 10th and 11th ribs, and removal of the 12th. Retrieving the mobilised spermatic vessels, together with their freed attachments, the dissection proceeds upwards, following the spermatic vessels to their origin and termination respectively, and from thence clearing the aorta and vena cava to the diaphragm. Thus the whole lymphatic field is excised *en bloc.* The lumbar wound is closed. Although extensive, the operation carries a low mortality. One of my patients is in good health 13 years after radical orchiectomy for an embryonal carcinoma of the testis.

**Testicular tumours in children** most commonly appear during the first year of life, and are exceedingly rare after the third birthday. The tumours at this time of life are teratomata, many of these belonging to the subgroup of embryonal carcinoma, in which event, in spite of treatment, the patient dies within a few months. Now and then the tumour proves to be an adult teratoma when, following orchiectomy alone, the prognosis is exceptionally good. On rarer occasions still, the tumour proves to be an interstitial cell tumour (see p. 926), in which case, following orchiectomy, the prognosis is also excellent.

**Tumours of the Epididymis.**—Mesothelioma is a unique innocent tumour that usually springs from the globus minor: most examples have been about the size of a cherry. Sarcoma, and very rarely carcinoma, arise in the epididymis, and those who put their trust in the aphorism that swellings of the epididymis are invariably inflammatory may one day rue it. If the swelling in question does not respond to rest and antibiotic therapy quickly, it should be treated by epididymectomy or, if obviously malignant, by orchiectomy.

#### THE SPERMATIC CORD

**Subacute funiculitis** is endemic in many tropical countries; occasionally the condition takes on true epidemic characteristics. The lesion is a streptococcal cellulitis of the spermatic cord with secondary thrombophlebitis of the pampiniform plexus.

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Archie L. Dean, *Contemporary.* Urologist, Memorial Hospital, New York.

George Rio Nagamatsu, *Contemporary.* Urological Surgeon, Flower and Fifth Avenue Hospitals, New York.



The clots extend in the veins up to the internal inguinal ring, and sometimes along the testicular vein. Occasionally, on the right side clot invades the inferior vena cava, when pulmonary embolism is liable to occur.

**Clinical Features.**—The condition is characterised by varying pyrexia, and pain in one or other testis. Isolated clots can be felt as tender nodules in the pampiniform plexus. These nodules are clearly separable from the vas which, however, is often thickened. It is the non-attachment of the nodules to the vas that makes the condition readily distinguishable from subacute tuberculous epididymitis. When an isolated clot is situated abutting the posterior border of the body of the testis the diagnosis can be difficult, and exploration to rule out a testicular neoplasm is more than justified. If the clotted vein is clearly visualised, unwarranted orchiectomy can be avoided.

**Treatment.**—With rest in bed, support of the testis and antibiotic therapy, resolution can be expected in nearly all cases. Occasionally the thrombosis results in late testicular atrophy.

**Tumours of the spermatic cord** are seldom described, but are not very uncommon, especially lipoma, which is mistaken for an irreducible inguinal hernia. Among other tumours, leiomyoma, which sometimes becomes sarcomatous, follows lipoma in order of frequency: unlike a lipoma, which is situated mainly in the intra-inguinal portion of the cord, usually a leiomyoma is intra-scrotal. One-third of the tumours of the spermatic cord are malignant.

#### THE SCROTUM

**Prepenile scrotum** is an exceedingly rare congenital condition. The scrotum, suspended from the mons pubis, is situated anterior to the penis.

**Idiopathic gangrene of the scrotum** (*syn.* Fournier's gangrene) occurs rather more frequently in tropical zones than in the rest of the world, where it is a distinctly rare condition. The three cardinal characteristics of this disease are: (1) sudden appearance of scrotal inflammation in the midst of apparently good health; (2) rapid onset of gangrene (fig. 1232); (3) total absence of any of the usual causes of gangrene.

The first symptom, pain in the scrotum, comes on with dramatic suddenness, even awakening the patient from sleep. Within a few hours the scrotum becomes tense, reddened, and from twelve to seventy-two hours later gangrene sets in. At first only the scrotum is involved: still unchecked, if the patient survives, the cellulitis spreads along those planes so well known in superficial extravasation of urine (see p. 872). Sometimes the entire scrotal coverings slough, leaving the testes hanging exposed, bared to their tunica, though remarkably free from gangrene. The bacteriology of this remarkable disease shows an overwhelming preponderance of infections by hæmolytic streptococci. The cause of the scrotal gangrene is still a matter for speculation. It seems probable that the infection is blood-borne; once within the scrotal subcutaneous tissues the streptococci produce a violent inflammation that results in obliterative endarteritis of the arterioles supplying the overlying skin. It is the suddenness of the onset that strongly suggests a vascular disaster of infective origin.



FIG. 1232.—Fournier's gangrene.  
(Mr. Max Pemberton, London.)



**Treatment.**—In some cases large doses of penicillin have proved beneficial; however, the causative organism, a hæmolytic streptococcus which sometimes can be grown aerobically, is, like the hæmolytic streptococcus that causes progressive gangrene of the abdominal wall (see p. 674), more sensitive to bacitracin than to any other antibiotic. Therefore, if it is available, pending the opportunity to submit pus to the bacteriologist and while awaiting his findings, systemic bacitracin 400 units per kilo of body-weight, repeated at six-hourly intervals, is the antibiotic of choice.

Unless the case is a very early one, and this treatment produces improvement with six to eight hours, the scrotum should be incised. If gangrene has commenced, wide excision of all sloughing areas saves time, rids the patient of scrotal tissue that is doomed, provides the freest possible drainage, and stops the spread of gangrene. Exceptionally the testes must be implanted into the thighs as described in the treatment of filarial elephantiasis.

**Prognosis.**—During the past ten years the mortality has fallen from over 30 per cent. to under 10 per cent.



FIG. 1233.—Elephantiasis of the scrotum, burying the penis. (Professor M. Bahadur Khan, Hyderabad, India.)

**Filarial elephantiasis of the scrotum** is confined to those who dwell, or have dwelt, in tropical and subtropical countries, and is due to obstruction of the lymphatic vessels of the pelvis by *Wuchereria bancrofti*, with superadded infection and lymphangitis. The earliest manifestation is an attack of funiculitis with the development of a secondary hydrocele. Repeated attacks cause the scrotum to remain œdematous and the scrotal skin and subcutaneous tissue greatly thickens. In long-standing cases the scrotum becomes immense, and the penis is buried within it (fig. 1233).

**Treatment.**—There is no medical treatment for the condition. The principle of operative treatment is the construction of new lymphatic pathways. This can be accomplished by cellular-cutaneous bridges of generous size uniting the scrotum to the thigh, as in the Keetley-Torek operation, thus permitting the scrotal lymph to be absorbed via the uninvolved thighs. In very advanced cases excision of all involved skin (fig. 1234), together with implantation of the testes into the thighs and skin grafting of the bared shaft of the penis, if necessary, is the only curative treatment. It should be especially noted that the *inner layer* of the prepuce is rarely involved: it should therefore be spared and in many instances it can be utilised to cover the bare shaft of the penis (C. Bowesman). In all cases concomitant hydroceles are dealt with by hydrocelectomy at the time of the operation.

**Non-filarial elephantiasis** can be acquired in non-tropical as well as tropical climates, and it is consequent upon sclerosis of lymphatic vessels due to lymphogranuloma venereum. Non-filarial elephantiasis never reaches the extravagant proportions of tropical elephantiasis. There is no effective medical treatment: the scrotum-thigh cutaneous tunnel operation described above is recommended.

**Sebaceous cysts** are common in the skin of the scrotum. They are usually small and multiple (fig. 1235). Sometimes a large sebaceous cyst suppurates, and when it does so the odour emitted is particularly obnoxious.

Charles Bowesman, Contemporary. Lately Surgeon, Kumasi, Ghana.



FIG. 1234—Position of patient during removal of an enormous scrotal mass.



Occasionally a suppurating scrotal sebaceous cyst is mistaken for a carcinoma of the scrotum, which calls to mind Cock's peculiar tumour (see p. 941).

**Cavernous hæmangioma of the scrotum** is not particularly rare. X-ray therapy is contra-indicated because of its sterilising effect. Excision of that part of the scrotum bearing the dilated veins is absolutely satisfactory.

#### MALE INFERTILITY

The causes are as follows :

1. **Impotence** due to (a) malformations or loss of the penis ; (b) psychic causes.

2. **Oligospermia or aspermia** due to small (fibrotic) or soft (partially atrophic) testes resulting from mumps (quarter of cases), varicocele (see p. 910), cryptorchism, over-exposure to X-rays, and occasionally other varieties of bilateral epididymo-orchitis.

3. **Aspermia due to faulty sperm-conducting mechanism.**—Leading examples are (a) urethral fistula, (b) tight urethral stricture, (c) obliteration by scar tissue of both common ejaculatory ducts or both vasa deferentia. Fifteen per cent. of all cases of infertility are due to gonorrhœa.

**Investigation** includes : (a) three sperm counts at weekly intervals, and an adjudication of the average. An average volume of 3 ml. of semen is good evidence that there is no deficiency in circulating androgen ; (b) testicular biopsy.

**Treatment.**—**Hormone therapy** in cases without a cause remediable by operation. High doses of testosterone (200 mg. once a week) for fifteen weeks is occasionally followed by 'rebound' improved spermatogenesis when the drug is withdrawn. For reasons unknown, a better rebound has accrued from the administration of œstrogens.

**Operative treatment of varicocele** has proved encouraging (see p. 911).

**Vaso-epididymal Anastomosis.**—In the selection of patients for this procedure the following criteria should prevail :

1. Aspermia must be demonstrated on three separate occasions.
2. The secretion from the seminal vesicle must be present in the ejaculate. Its absence indicates a block in the region of the pelvic portion of the vas, which would render the operation useless.
3. Testicular biopsy must show that the aspermia is not due to defective spermatocytes.
4. The patient should be under forty years of age.

**Operation.**—The vas is divided at least 1 inch (2.5 cm.) above the portion considered to be obliterated, and in order to make certain of its patency, the proximal end is catheterised with a suitably-sized piece of silkworm gut. The silkworm gut is removed and the free end of the vas is split for a short distance. The silkworm gut is then re-inserted. End-to-side anastomosis is carried out with fine blood-vessel silk, the flaps resulting from the bifurcation being carried into the lumen of the epididymus, as shown in fig. 1236 (A). The silkworm gut catheter is brought out between the epididymis and the body of the testis, as shown in fig. 1236 (B),

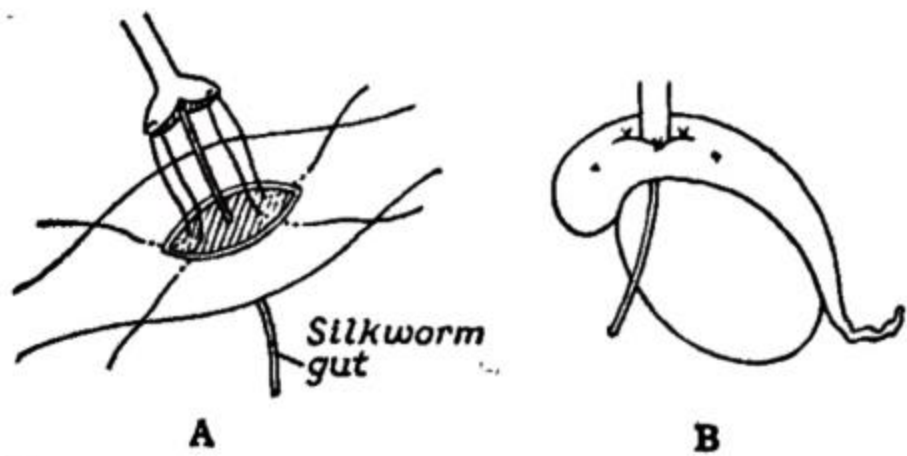


FIG. 1236.—End-to-side vaso-epididymal anastomosis. (After S. Popelka et al.)

and it is well to bring this splint through a minute puncture in the scrotum and withdraw it only after several days, when the anastomosis can be presumed to have united. Following this method, over 50 per cent. of cases showed copious sperm in the ejaculate.

Edward Cock, 1805-1892. Surgeon, Guy's Hospital, London.



FIG. 1235.—Sebaceous cysts of the scrotum.



**Carcinoma of the Scrotum.**—In the early part of the last century carcinoma of the scrotum was rife amongst chimney sweeps<sup>1</sup>. With improved working conditions<sup>2</sup>, this occupational disease ceased to exist in as far as chimney sweeps were concerned, but with the mechanisation of the cotton industry, lubricating oil from the spinning jenny soaked the crutch of the mule spinner's trousers, and proved more carcinogenic than soot. Now that a

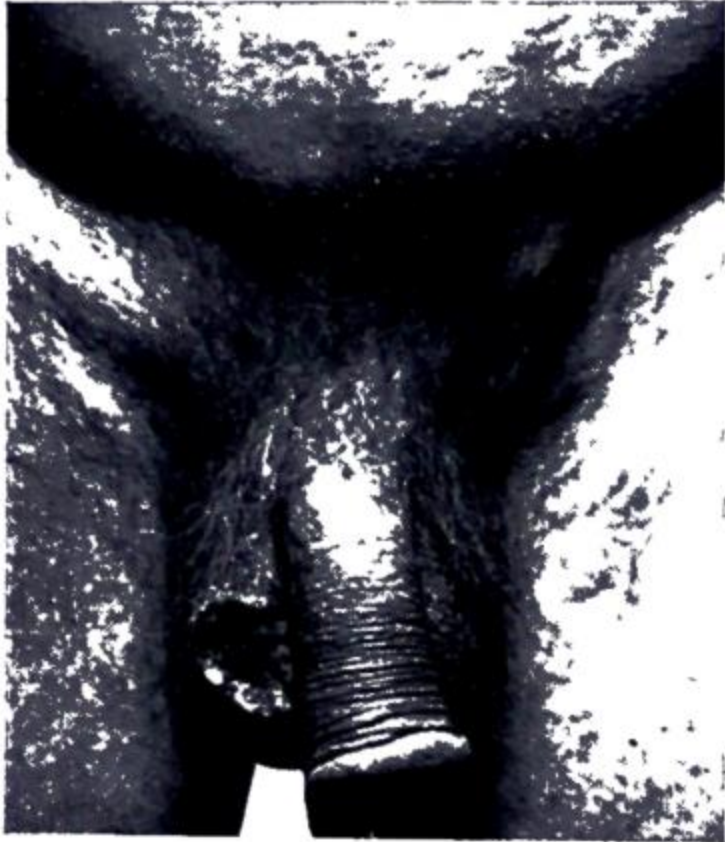


FIG. 1237.—Carcinoma of the scrotum with bilateral metastases in the inguinal nodes. (Department of Medical Photography, Cardiff Royal Infirmary.)

lubricating oil free from impurities has been substituted it is hoped that carcinoma of the scrotum will no longer attack<sup>3</sup> mule spinners in particular. A few cases still occur in tar and shale oil workers, but in the majority of cases encountered at the present time there is no known ætiological factor.

**Clinical Features.**—The growth commences in a wart or an ulcer (fig. 1237). As it advances it may involve the underlying testis.

**Treatment.**—The growth, together with a considerable margin of healthy tissue, is excised. If, as is often the case, the inguinal lymph nodes are enlarged and do not subside with antibiotic treatment, a block dissection of these nodes should be carried out, usually on both sides.

There is no evidence that X-ray therapy causes regression of either the primary tumour or the inguinal metastases. Unless excision, and when necessary radical excision, is carried out early, the prognosis is bad.

<sup>1</sup> Chimney-sweep's cancer was first described by Percival Pott, 1714–1788, Surgeon, St. Bartholomew's Hospital, London.

<sup>2</sup> "Many chimney-sweeps die in youth; few live to the age of 50. Surely this shocking and unnatural occupation ought to be abolished!" (C. Turner Thackrah: *The Effects of the Principal Arts, Trades and Professions*, London, 1831).

In those days the chimney-sweep's apprentice *went up* the chimney.

<sup>3</sup> As it takes up to 20 years for the result of exposure to carcinogens to become manifest, as yet the outcome is uncertain.



## CHAPTER XXXVII

## THE SKIN

MCNEILL LOVE

## CALLOSITIES, CORNS, AND WARTS

A **callosity** is a localised hyperkeratosis due to prolonged pressure or friction. They are commonly occupational, e.g. a gardener's hands or the fingers of a violinist. In other cases they form over bony prominences, such as a hammer-toe. A callosity presents itself as a horny plaque which is yellowish-brown in colour. It is symptomless unless it occurs on the sole, in which case a callosity is often tender and causes discomfort on walking. If removal is desirable, the callosity can be shaved with a sharp scalpel or razor-blade and painted with collodion containing salicylic acid and ether (10 per cent. of each). A single dose of superficial X-rays (400 to 600 r)<sup>1</sup> is often effective after paring if the simple measures fail.

A **corn** (clavus) differs from a callosity in being more localised, and a horny plug of epithelial cells projects downwards into the corium. Pain is caused by the pressure of the horny plug on the sensory nerve endings. Hard corns occur over bony prominences, and are encouraged by ill-fitting boots. Soft corns result from maceration by sweat, and are found in the interdigital clefts. Plantar warts (verrucae) are sometimes mistaken for soft corns, but warts are relatively soft and vascular.

Most corns yield to the chiropodist, provided that footwear is suitable. Skilled treatment is important in patients with diabetes or a poor peripheral circulation, as secondary infection may precipitate gangrene. Salicylic acid in collodion (20 per cent.) applied for a few nights, followed by soaking in hot water, is often effective in removing a corn. In obstinate cases the corn should be submitted to a single dose of superficial X-rays (1,000 r).

A **wart** (verruca) is a localised overgrowth of the epidermis and papillae due to a virus and is therefore infective. *Verruca vulgaris*, the common wart, frequently occurs on the hands or knees (fig. 1238), particularly in children. They may grow as large as a pea, and are commonly multiple. The innumerable treatments recommended as 'cures' indicate the uncertain effects of these remedies. As warts often disappear spontaneously, any treatment which is in use at the time will gain an undeserved reputation. The application of caustics, such as glacial acetic acid, phenol, or copper

<sup>1</sup> The radiations of X-rays, radium, and radio-active substances produce ionisation within the medium through which they pass. In a gas this increases the electrical conductivity, and the amount by which this is raised is used as the measurement of quantity. The röntgen, or 'r' unit, is a physical one, and is that amount of radiation required to produce one electrostatic unit of charge as it passes through a unit volume of air at 0° C. and 760 mm. mercury pressure.



sulphate, all have their advocates. Curetting and cauterisation of the crater is the radical treatment of individual warts, but further crops may appear. X-ray treatment is often successful in large doses, but is not without risk of necrosis.



FIG. 1238.—  
Warts on the knee.

*Verruca filiformis* is a common disfigurement which appears on the eyelids, face, or neck in adults. It presents itself as a pointed excrescence, pinkish in colour, and some 3 to 4 mm. in length. They can be removed with a fine-pointed galvano-cautery or snipped off with scissors and the base touched with phenol or 80 per cent. trichloroacetic acid applied on a sharpened matchstick.

*Verruca plantaris* occur in the sole and are usually multiple. They may be so tender as to render standing or walking exceedingly uncomfortable. They should be dealt with by curettage, cauterisation, or superficial X-ray therapy. Radium should be avoided, as the resultant scar is sometimes tender, and necrosis of tissue may occur.

Venereal warts, moist warts, or condylomata acuminata are discussed on p. 28.

#### ACUTE INFECTIONS

**Boil** (*syn.* Furuncle).—A boil is an acute staphylococcal infection of a hair follicle with perifolliculitis, which usually proceeds to suppuration and central necrosis. A painful and indurated swelling appears which gradually extends. After two or three days the centre softens and a small slough is discharged with a bead of pus, and in the large majority of cases the condition then subsides. A 'blind boil' is one which subsides without suppuration.

A *stye* (*syn.* hordeolum) is due to infection of an eyelash follicle. Infection of a *perianal hair follicle* (perianal abscess) and consequent suppuration is likely to result in a blind external fistula. Furunculosis of the *external auditory meatus* is extremely painful, as the skin is attached to the underlying cartilage, and swelling is accompanied by considerable tension.

#### Complications of Boils :

- (i) Cellulitis, which sometimes spreads extensively, especially in debilitated subjects.
- (ii) Infection of the lymph nodes draining the affected part.
- (iii) Secondary boils, due to infection of neighbouring hair follicles or sebaceous glands.

**Treatment** consists in improving the general health of the patient, since boils are frequently associated with overwork, worry, debility, examinations, or other undermining influences. Incision is unnecessary, as a smear of liquid phenol on the presenting pustule will hasten necrosis of the overlying



skin so that pus can then escape. Should softening occur around a hair follicle, particularly an eyelash (stye), removal of the appropriate hair allows the ready escape of pus. Antibiotics, combined with chemotherapy if necessary, usually results in rapid improvement. Painting the surrounding skin with antiseptics, such as non-irritating dyes,<sup>1</sup> discourages the development of secondary boils. Local and general exposure to ultra-violet light is often advantageous, and fractional doses of superficial X-rays (50 to 100 r) are valuable.

**Carbuncle.**—This is an infective gangrene of the subcutaneous tissues, due to staphylococcal infection. It is uncommon before the age of forty, and males suffer more frequently than females.

A carbuncle often occurs on the nape of the neck, as in this situation the skin is coarse and ill-nourished, and in some cases abrasions caused by a stiff collar encourage invasion by organisms (fig. 1239). Carbuncles are especially liable to occur in diabetic subjects, and the appearance of a carbuncle sometimes leads to the discovery of this disease. A blood-sugar curve will distinguish true diabetes from the transient glycosuria associated with the carbuncle.

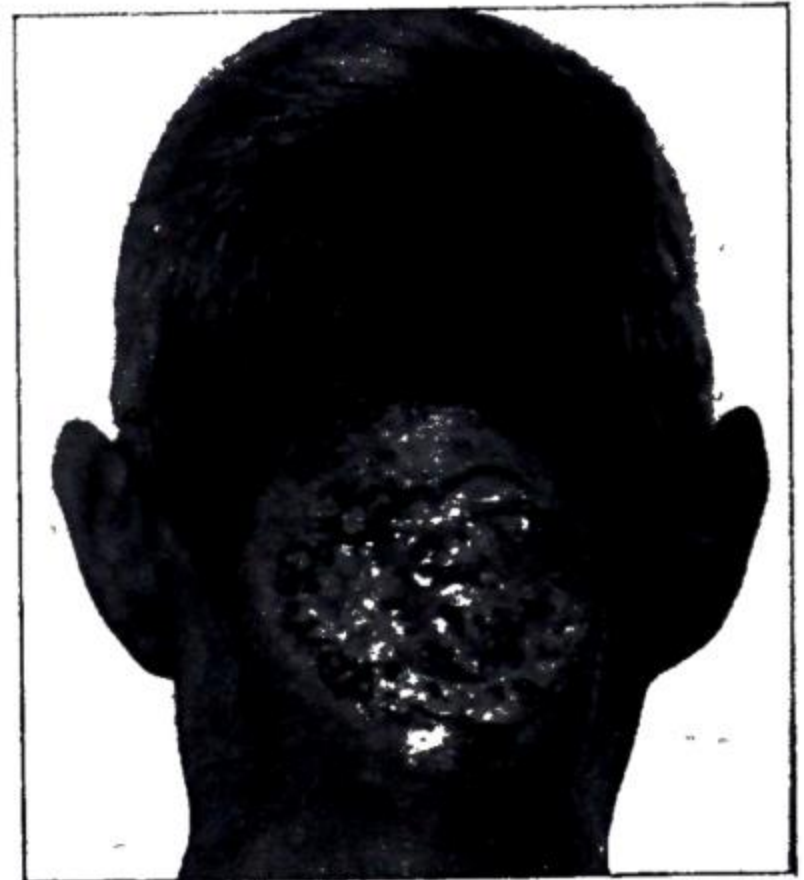


FIG. 1239.—Carbuncle of the neck.

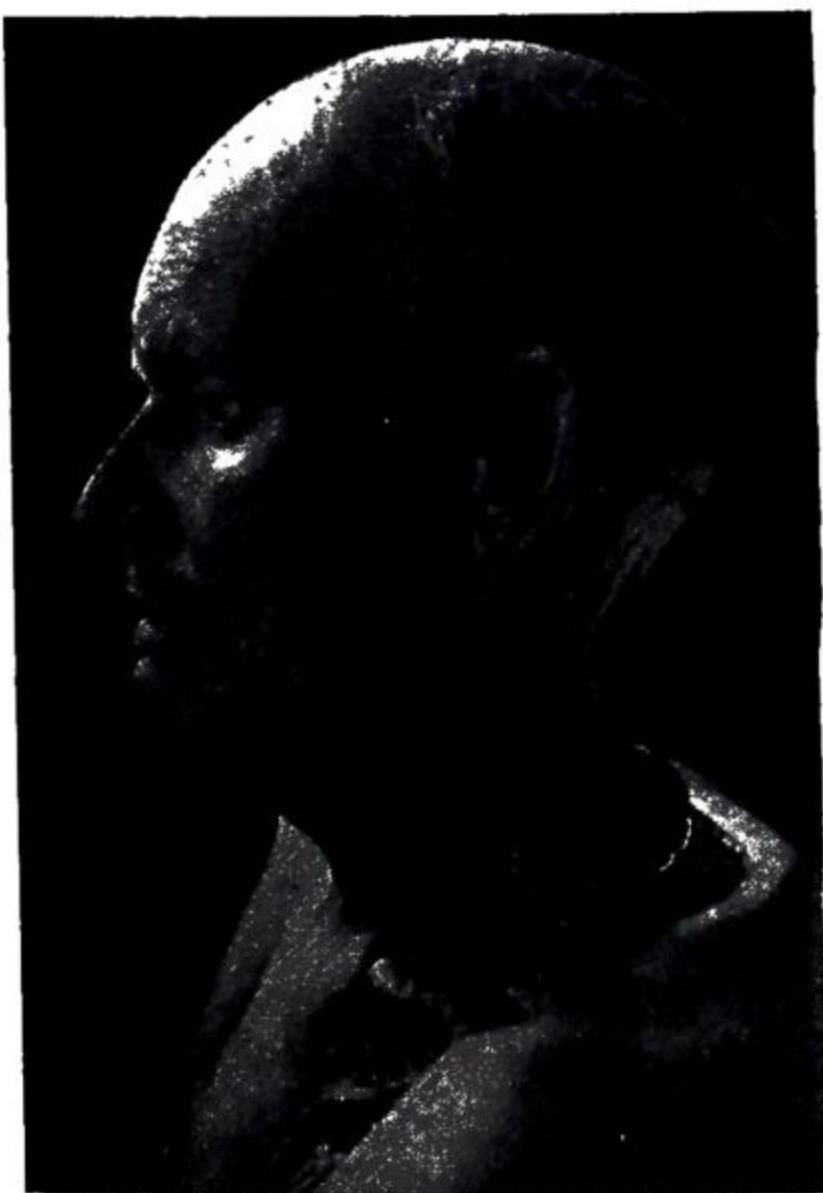


FIG. 1240.—Extensive destruction of skin and subcutaneous tissue resulting from a carbuncle.

The patient complains of tenderness and stiffness at the site of origin of the carbuncle. The subcutaneous tissues become painful and indurated, and the overlying skin is red. Unless the condition is aborted by prompt treatment, extension will occur, and after a few days areas of softening appear. The skin then gives way and thick pus and sloughs discharge. Infection sometimes extends widely, and fresh openings appear in the skin and coalesce with those previously formed (fig. 1240).

A carbuncle on the cheek or upper lip is particularly dangerous, owing to the risk of cavernous sinus thrombosis, via the facial and ophthalmic veins, or the deep facial vein and the pterygoid plexus (p. 136).

**Treatment.**—Penicillin is usually a specific remedy, and many carbuncles are

<sup>1</sup> A suitable paint is composed of mercuric chloride 1 per cent., malachite green 1 per cent., industrial methylated spirit 80 per cent., water q.s.

*Carbunculus* in Latin, *Anthrax* in Greek, is the word for charcoal. The Ancients saw in these conditions burning sores upon the skin—hence they likened them to charcoal.



aborted if penicillin is used adequately in the early stages. The sensitivity of the organism to other antibiotics should be determined, and a change made if necessary. The application of infra-red rays or short-wave diathermy usually result in localisation of the infection, and relieve the pain. A paste composed of anhydrous magnesium sulphate (24 parts) and glycerine (11 parts) exercises a valuable osmotic effect if sinuses persist or sloughing has occurred.

These methods of treatment have rendered excision of a carbuncle, formerly much in vogue, rarely necessary, and surgical intervention is reserved for cases in which the carbuncle spreads rapidly in spite of treatment. Either the whole carbuncle, or else the portion which is gangrenous, is excised, preferably with a diathermy knife, and the wound is packed with gauze soaked in 1 : 1,000 flavine.

Attention is directed to improving the resistance of the patient by such means as heliotherapy, vitamin C in large doses, and tonics including iron.

Small carbuncles are effectively treated by covering them firmly with 'Elastoplast,' which is untouched for some days.

#### TUBERCULOSIS OF THE SKIN

As with other manifestations of the disease, cutaneous tuberculosis is becoming less common owing to Public Health regulations, and improved health and nutrition of the population. Scrofuloderma, or necrotic tuberculosis over an abscess, lymph node, or bone lesion, is now almost a curiosity.



FIG. 1241. — Early lupus vulgaris showing cutaneous nodules.



Established case, showing typical butterfly distribution.



Advanced lupus vulgaris. Carcinoma has developed on the upper lip.

**Lupus vulgaris** usually occurs between the ages of ten and twenty-five, the face being the site of election for its commencement. One or more cutaneous nodules appear, with congestion of the surrounding skin. On



applying pressure with a glass tongue depressor or slide the nodules are seen to be the colour of apple jelly. Extension occurs very slowly, and if allowed to progress eventually affects the bridge of the nose and cheeks, a distribution which resembles a butterfly. Ulceration is likely to occur sooner or later (fig. 1241). The resulting ulcer tends to heal in one situation as it extends to another. The corresponding lymph nodes are liable to become affected by superimposed secondary infection, or less commonly by tubercle bacilli. The mucous membranes of the mouth and nose are sometimes attacked, either primarily or by extension from the face. Infection of the nose may be followed by necrosis of underlying cartilage.

**Treatment** is directed towards improving the general health, and the administration of streptomycin. Supplementary treatment with caustics or the Kromayer lamp is of value in resistant cases. Epithelioma is prone to occur in a lupus scar (p. 939).

**Lupus verrucosus** (*syn.* *verruca necrogenica*) is a tuberculous lesion of the skin, in which a circumscribed area becomes irregularly nodular and indurated. The corresponding lymph nodes are frequently affected, and present the usual features of tuberculous nodes. When the condition is very localised it resembles a wart, and the terms 'anatomical tubercle' and 'butcher's wart' have been applied. Treatment is conducted on the same lines as for lupus vulgaris, but if response is tardy the patch of affected skin may be excised together with the regional lymph nodes if they appear to be involved.

**Tuberculin Tests.**—As with suspected tuberculous disease in any part of the body, skin tests are of some value (especially if negative in adults or positive in children) in establishing a diagnosis. Protein products derived from the tubercle bacillus are either injected intradermally (Mantoux) or inoculated through a scratch (von Pirquet). If positive, a reaction occurs in either test in forty-eight hours, and lasts from one to four weeks.

**Bazin's disease** (*syn.* *erythema induratum*) is due to localised areas of fat necrosis which particularly affects adolescent girls who have fat legs and a tendency to chilblains. Symmetrical purplish nodules appear, especially on the calves, and gradually break down to form indolent ulcers, which leave in their wake pigmented scars (fig. 1242). The condition slowly responds to rest, general treatment, and firm elastic bandages. Vitamin K and nicotonic acid may improve the condition by causing vasodilatation.



FIG. 1242.—Bazin's disease.

#### NEW-GROWTHS

*Papillomata* are common tumours (p. 40).

*Hereditary hæmorrhagic telangiectasis* is a rare familial disease. It is characterised by widespread development of telangiectases which tend to bleed. Hæmorrhages from the gastrointestinal tract may lead to errors of diagnosis, but the cutaneous lesions and family history should prevent mistakes. Bleeding from accessible tumours is controlled by cautery or radium.

*Robert Koch, 1843-1910, Professor of Bacteriology in Berlin, discovered the tubercle bacillus in 1882.*  
*Ernst L. F. Kromayer, 1862-1933. Professor of Dermatology, Halle University, Germany.*  
*Charles Mantoux, Contemporary. Physician, Le Cannet, France.*  
*Clemens Freiherr von Pirquet, 1874-1929. Professor of Children's Diseases, Vienna.*  
*Pierre Antoine Ernest Bazin, 1807-1878. Dermatologist, Hôpital St. Louis, Paris.*



**Basal-cell carcinoma** (*syn.* rodent ulcer) commences in the basal cells of the skin or in the cells of the sebaceous glands. It rarely occurs before middle age, and is commoner in males. Over 90 per cent. occur on the upper two-thirds of the face (p. 138), and those which present themselves elsewhere are often neglected by the patient in the early stages. At first the growth appears as a pearly nodule, with one or two venules on the surface. It may extend slowly, healing with an atrophic scar as the margins extend, but sooner or later the central part breaks down and a small circular or oval



FIG. 1243.—An advanced stage of rodent ulcer.

ulcer appears. As the ulcer extends, surrounding skin is destroyed, and finally the deeper tissues and bone are invaded, and air sinuses or even the dura mater are exposed (fig. 1243).

A typical rodent ulcer presents the following features. The edge is raised or beaded, but not everted, as is the case with an epithelioma. The floor is granular, and is occasionally covered by a thin layer of epithelium which extends over it from the adjacent margin. This attempt at healing is merely temporary. The base is less indurated than in the case of an epithelioma, but secondary infection adds to the degree of induration. Metastases do not occur, and lymph nodes are

only enlarged as a result of secondary infection.

Microscopic section reveals masses or columns of epithelial cells which tend to spread in a lateral direction rather than downward, as in a carcinoma. The cells vary in size and shape; usually the peripheral cells are columnar, and arranged in a more or less definite layer. The central cells are smaller and polyhedral, and although a few prickly cells are sometimes seen, cell nests are practically absent, owing to lack of keratinisation. Degeneration of central cells results in the formation of small cystic spaces.

**Treatment.**—Excision yields good results, but if the ulcer occurs on the face, this line of treatment is not advisable as an unsightly scar may result. Should the lesion be situated on the trunk, limbs, or forehead, excision removes the ulcer in a satisfactory manner and the wound heals rapidly.

Formerly small ulcers or suspicious nodules were destroyed by carbonic acid snow, but this method has been replaced by radiotherapy. For small lesions, superficial X-rays (3,000 r single dose), radium or radon (6,000 r in three to four days) are equally good. For large ulcers, daily fractional X-rays (10 × 600 r) may be used. Radium plaques are convenient for the treatment of small superficial lesions but fractional low-voltage X-ray therapy is at present considered to be the most satisfactory technique.

If bone or cartilage is involved, surgical removal of the diseased tissue is usually advisable, as radiotherapy is likely to cause necrosis.

**Squamous-celled carcinoma** (*syn.* epithelioma) presents itself either as a malignant papilloma or a malignant ulcer, but there is no essential difference between the two types. Growth is rapid and in a few months the



lesions are as large as the basal-celled type after several years. It usually occurs on exposed surfaces, especially in men whose occupation entails contact with irritating substances, such as dyes or tar (fig. 1244) or whose skin is subjected to prolonged exposure to sun and wind, e.g. farmers and sailors. Occasionally it is seen in children who are so sensitive to light that they develop xeroderma pigmentosa, and in albino negroes in the tropics. Cancer of the scrotum is described on p. 932. Epithelioma occasionally develops on chronic varicose ulcers, and malignant metaplasia produces a raised edge (fig. 34). Hypertrophic areas of leucoplakia in the mouth, on the lips, vulva, or in the perianal region should be regarded as epitheliomatous, and a biopsy is therefore necessary. Scars of old lupus are especially prone to malignant change, which is encouraged by the irritation of the otherwise remedial light or X-ray therapy (fig. 1245).



FIG. 1244.—Squamous-celled carcinoma.

A carcinoma which develops in a scar (*syn.* Marjolin's ulcer) (fig. 1245) presents the following characteristics :

- (i) It grows slowly, as the scar is relatively avascular.
- (ii) It is painless, as scar tissue contains no nerves.
- (iii) Secondary deposits do not occur in the regional lymph nodes, as lymphatic vessels have been destroyed. When the ulcer eventually invades normal tissue surrounding the scar, it extends at a normal rate, and lymph nodes are then liable to be involved.

A typical carcinomatous ulcer is irregular in outline, the edges are raised and everted. The base is indurated, and sooner or later becomes attached to the deeper structures. A sanious discharge occurs, which is increased in amount with the advent of secondary infection. The regional lymph nodes are involved, and the deposits in them are liable to undergo mucoid degeneration, to which secondary infection is often added.



FIG. 1245.—X-ray scar of the neck in which carcinoma has developed (Marjolin's ulcer).

**Treatment.**—If the situation of the ulcer allows such a procedure, wide excision is indicated; the corresponding lymph nodes are removed either at the same time or at a subsequent operation.

In situations where excision is likely to lead to deformity, such as the orbital region, radiotherapy yields excellent results. The regional lymph nodes are



removed if possible, but, if fixed, some degree of regression is obtained by radiotherapy. If radiotherapy is suitable, either radium or X-rays give good results, but short-distance low-voltage X-ray therapy (contact therapy) is preferable for small lesions, as its application is simple and its effect localised. Also the time required for treatment is short, hospitalisation is avoided, and

many patients can be treated with a minimum of expense.

Whether surgery or radiotherapy should be employed depends on the condition of the patient and the size and attachments of the tumour. It is important that the treatment is adequate, otherwise the activity of the tumour may be stimulated and metastases encouraged.

**Bowen's Disease** is an intradermal precancerous condition. A brownish induration with a well-defined edge appears in the skin. Microscopically large clear cells similar to those found in Paget's disease of the nipple are in evidence. Sooner or later carcinoma develops, and wide excision is then necessary (fig. 1246).

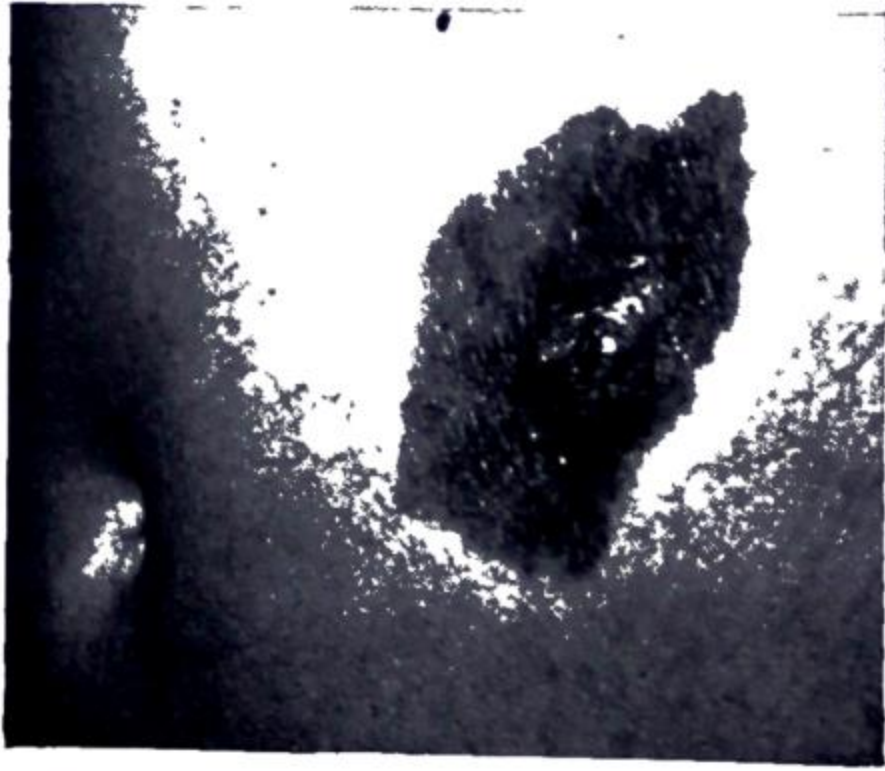


FIG. 1246.—Bowen's disease of the abdominal wall, in which epithelioma has developed.

#### SEBACEOUS GLANDS

**Sebaceous adenomata** arise in connection with a sebaceous gland or glands. These are usually seen on the face or scalp (fig. 1247), and occur as slowly growing, pink or flesh-coloured well-defined tumours, which are firm in consistency. Not uncommonly they are multiple.

Removal is indicated if the adenoma is unsightly, troublesome, or increasing in size.

A **sebaceous cyst** (*syn.* a wen) follows obstruction to the mouth of a sebaceous duct, and is therefore a retention cyst. It commonly occurs on the face or scalp (p. 944), but can occur anywhere except the palms and soles, which are devoid of sebaceous glands.

A typical cyst (fig. 1248) appears as a hemispherical swelling, firm or elastic in consistency, and with no definite edge. It is more or less adherent to the skin, especially if it has been previously inflamed or is subjected to pressure.

The punctum of the obstructed duct can sometimes be seen on the summit of the cyst, and sebaceous material may be expressed from the duct. An uncomplicated cyst contains yellowish-white material composed of fat and epithelial cells, of a putty-like consistency.



FIG. 1247.—A sebaceous adenoma.

John T. Bowen, 1857-1941. Professor of Dermatology, Harvard University.  
 Sir Astley Cooper, 1768-1841. Surgeon to Guy's Hospital; was knighted for successfully removing an infected wen from the head of King George IV at Brighton in 1821.



## Complications

(i) *Infection*.—The cyst becomes enlarged and painful, and the overlying skin is red. After a few days the inflammation usually subsides, but recurrence is the rule. Recurrent attacks of infection cause the cyst wall to become adherent to surrounding subcutaneous tissue, and consequently more difficult to remove. The contents of an infected cyst become semi-liquid and often very foetid.

(ii) *Ulceration*.—An infected cyst occasionally breaks down and discharges its contents. A foul ulcerated surface remains, which superficially resembles a carcinoma, and to which the term Cock's 'peculiar tumour' was formerly applied (fig. 1249).

(iii) *Sebaceous Horn*.—The contents of a cyst sometimes slowly escape from the duct orifice and dry in successive layers on the skin. This 'horn' is firmly attached at its base, and may grow several inches in length (fig. 1250).

**Excision** of a sebaceous cyst is accomplished either by transfixion or dissection.

*Transfixion* is simple if the cyst is not adherent. Either the cyst is incised or a bistoury is pushed beneath the cyst so as to emerge on the opposite side (fig. 1251).

The cyst and overlying skin are then divided. The contents are expressed and the cyst wall seized with artery forceps and avulsed, assisted by a few caresses with a scalpel.

*Dissection* is necessary for cysts which have been previously inflamed or which are ulcerated. An incision is made over the cyst, the wall is defined, and if possible the cyst is dissected from



FIG. 1248.—Sebaceous cyst of leg.



FIG. 1249.—Cock's 'peculiar tumour' on the upper eyelid.

overlying skin are then divided. The contents are expressed and the cyst wall seized with artery forceps

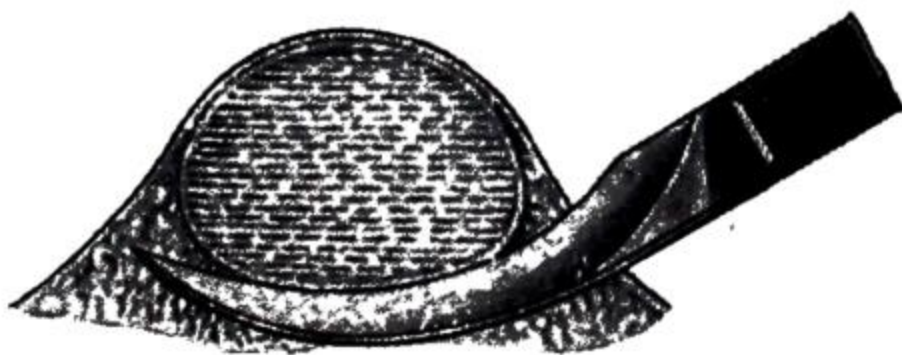


FIG. 1251.—Transfixion of sebaceous cyst.



FIG. 1250.—Sebaceous horn. (The owner, the widow Dimanche, sold watercress in Paris.)



adjacent tissue and removed intact. Unless the wall is completely removed recurrence is probable.

**Implantation Dermoid** (*syn.* Implantation Cyst).—These are due to the transplantation of squamous epithelial cells to the subcutaneous tissues by penetrating wounds, usually of a punctured nature. They are classically found in the fingers of women who sew assiduously (fig. 1252). A painless, cystic swelling gradually develops, which is lined by squamous epithelium, containing débris that has undergone mucoid degeneration. They should be excised if causing inconvenience.



FIG. 1252.—Implantation dermoid.

#### AFFECTIONS OF THE NAILS

**Paronychia** is an infection of the nail folds which is apt to extend beneath the nail-bed (see Chapter xlv). It may be pyogenic or mycotic in origin, and in the newly born is sometimes associated with pemphigus neonatorum or congenital syphilis.

**Ingrowing toe-nail** usually results from encasing sweaty feet in tight boots. The condition is encouraged by careless trimming of the nail edges. As a result, the lateral spikes of the nail plate cause ulceration of the nail folds, and infection develops in the pocket thus formed. The established condition is surprisingly painful, and the patient can only limp. In the early stages relief of pressure, removal of the lateral edges of the nail-plate, cauterisation with liquid phenol, and meticulous daily packing of the lateral groove with a wisp of gauze soaked in a mild antiseptic, such as 1 : 1,000 flavine, usually prove successful. More advanced cases require wedge resection of the nail, overhanging skin, and nail-bed (fig. 1253).



FIG. 1253.—Wedge resection operation for ingrowing toe-nail.

**Onychogryphosis** is an overgrowth of a toe-nail, usually that of the big toe. It occurs in elderly people, especially if bed-ridden. Infection around the nail is an occasional complication. If necessary the nail and nail-bed are removed. The condition is often associated with circulatory deficiency.

**Subungual melanoma** arises as a bluish or black discoloration under the nail-plate (fig. 54).

**Subungual exostosis** is considered in Chapter xlvii.



## CHAPTER XXXVIII

## THE HEAD

GEOFFREY KNIGHT

## THE SCALP

THE **scalp** consists of four layers—skin, subcutaneous tissue, epicranial aponeurosis (into which is inserted the occipito-frontalis muscle), and a subaponeurotic areolar layer. The scalp is well supplied with blood-vessels, and the walls of the arteries are adherent to the fibrous tissue in the subcutaneous layer. Therefore scalp wounds bleed freely, as the muscular coat of a divided artery cannot retract readily when the vessel is severed.

**Wounds of the scalp** are treated by adequate shaving of the surrounding scalp. The wound is then excised, hæmostats being applied to the galea and allowed to fall back over the skin edge. The scalp is closed in two layers, galea to galea and skin to skin, with interrupted black-silk sutures. In the case of tissue loss, a useful method of closing the gap consists in making a reversed 'S' incision, by which means most defects in the scalp can be closed (fig. 995). This leaves the pericranium exposed at the ends of the incision. Healing occurs by granulation from the pericranium, which should be protected with tulle gras and subsequent epithelialisation of the granulated area.

Owing to its rich blood supply wounds of the scalp heal readily. Many cases are on record where the scalp has been avulsed almost completely, but after cleansing and suturing into position, union has occurred in a satisfactory manner.

A **Hæmatoma of the scalp** may be subcutaneous. When situated under the epicranial aponeurosis, the clot spreads extensively and is only limited by the attachment of the aponeurosis around the base of the calvarium. A hæmatoma under the pericranium is limited by the suture lines which border the underlying bone, to which the pericranium is attached.

**Infection of the scalp** is limited in a similar manner. In the subaponeurotic areolar layer infection is circumscribed only by the attachment of the epicranial aponeurosis, and may extend from the superior curved line of the occipital bone behind to the supraorbital ridge in front, and laterally be bounded by the zygomatic arch, temporal ridge, and upper border of the mastoid process. Because extensive infection is possible, the subaponeurotic areolar tissue is termed the 'dangerous area,' since intracranial infection

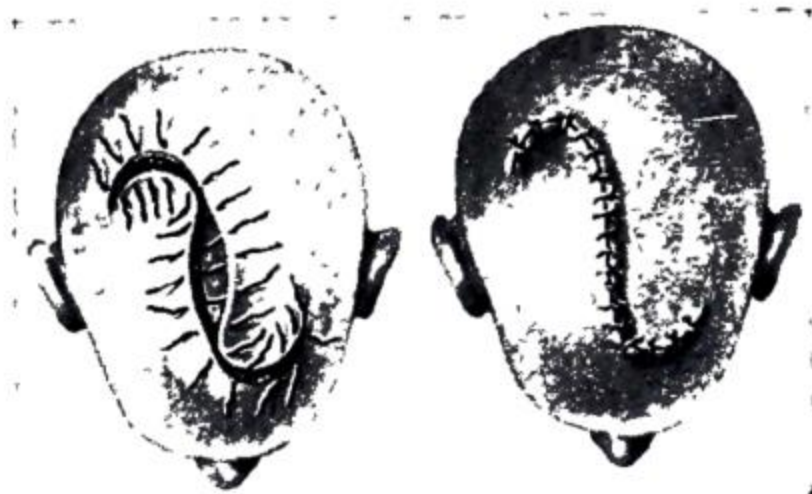


FIG. 1254.—Letter S scalp plastic incision.



(see p. 968) is liable to occur via the emissary veins. Treatment is by chemotherapy and deep-drainage incisions parallel to the main vessels and nerves.



FIG. 1255.—Sebaceous cysts of the scalp.

**Sebaceous cysts** (*syn. wens*) are often multiple (fig. 1255). If neglected, cysts may grow as large as hen's eggs, and when pressure interferes with the blood supply to the overlying scalp the skin becomes bald.

Infection is not uncommon, and when this occurs the contents are peculiarly putrid. Should the cyst break down, an ulcer results, formerly known as Cock's 'peculiar tumour,' which remotely resembles an epithelioma, but the edges are not everted, nor is the base indurated (p. 941).

**Lipomata** arise from the fatty tissue incorporated with the areolar layer, and lie under the epicranial aponeurosis.

Pressure atrophy of the underlying bone follows in long-standing cases, and on pushing aside the lobulated edge of the tumour, the margin of a saucer-like depression in the bone is readily palpable.

**Cirroid aneurysm** is rare and difficult to treat. Capillary nævi are sometimes seen in the overlying skin, beneath which abnormal arteries communicate directly with the distended veins. The condition most commonly affects the superficial temporal artery and its branches, and as it increases in size, the underlying bone becomes thinned and the hair over the tumour falls out. Radiography may show perforations in the skull which indicate that part of the tumour is intracranial. The tendency is for these tumours to enlarge slowly, and there is a risk of serious hæmorrhage.

**Treatment** consists in extirpation of the tumour in the early stages (ligation of one or both external carotid arteries is sometimes advisable as a preliminary step to local excision). If its size forbids such radical treatment, then the main vessels are ligated, but this is often unsuccessful, as a large tumour on the surface usually possesses intracranial connections which maintain the blood supply.

A **dermoid cyst** occurs most frequently over the external angular process (fig. 138). Although congenital, it may not appear until the child is some years old. It may communi-

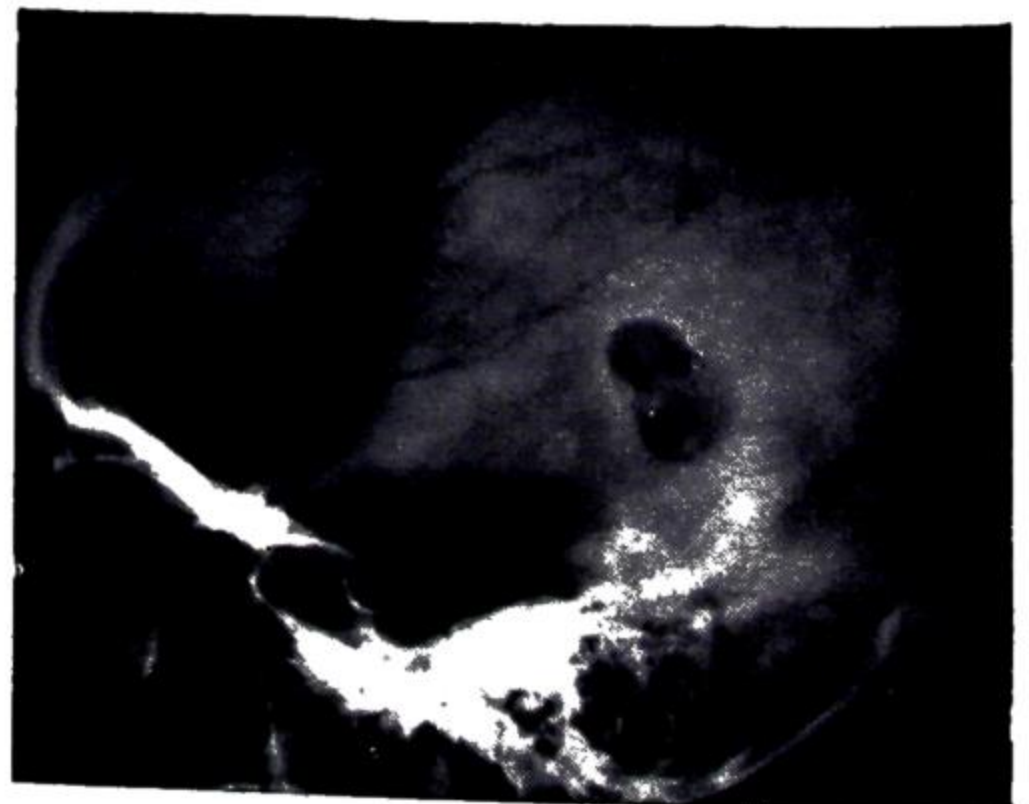


FIG. 1256.—Lateral X-ray showing dermoid cyst of the diploë. The inner table has been penetrated by intracranial extension.



cate with an intracranial dermoid by a narrow neck, which passes through the underlying bone. In this case an impulse can sometimes be detected on coughing. X-ray shows a bone defect with a sclerotic margin (fig. 1256).

**Treatment.**—Surface cysts are excised locally. If there is evidence of intracranial extension, the cyst is approached by osteoplastic craniotomy, as the intracranial portion may be larger than the superficial.

**Papillomata** are common and cause discomfort on combing the hair. Constant irritation of this nature encourages malignant changes.

**Fibrosarcoma** has already been described (p. 48).

**Epithelioma** of the scalp is not common and presents no special features.

**Melanomata** may be unrecognised, owing to the small growth being hidden by hair. If malignant changes supervene, the appearance of secondary deposits should lead to the discovery of the tumour.

#### THE SKULL

**Microcephaly** may be associated with agenesis of the brain and imbecility, or result later from premature synostosis in a normal child.

**Oxycephaly** (*syn.* steeple-head, Gk. *oxus* = sharp) is a condition in which the skull is egg-shaped, following premature obliteration of sutures. Most cases develop increased intracranial pressure.

**Treatment.**—*Cranioplasty* by the formation of Gigli saw cuts between burr holes and wrapping the bone edge in tantalum foil allows normal skull expansion and cerebral development to proceed.

**Meningocœle.**—*Clinical Features.*—Protrusions of a pouch of dura mater through a congenital defect in the skull are usually situated at the root of the nose or over the occipital bone. Rarely, trans-phenoidal projections protrude through the base of the skull into the naso-pharynx and have been mistaken for nasal polypi: attempted removal has resulted in meningitis. A meningocœle is present at birth, and forms a tense rounded swelling which is translucent and sometimes pedunculated, and which yields an impulse when the child cries or coughs. In the case of a small meningocœle, growth of the skull may occlude the neck of the sac; in this case a cyst remains which is non-pulsatile and unaffected by coughing.

An *encephalocœle* is a similar condition, but some portion of the brain is also extruded (fig. 1257). Should this cerebral extrusion contain part of a ventricle, it is known as a *hydroencephalocœle*. In this condition, and in an *encephalocœle*, vascular pulsation is usually present. In many instances the child is still-born or succumbs at an early age. Some degree of idiocy or deformity may be associated with a large *encephalocœle*.

**Treatment.**—The skin surface should be protected with padding and tulle gras to prevent ulceration and infection. If at the age of a month or more the child shows normal development, operation is performed under local anæsthetic, the child being tied to a cross and given a feeding bottle during operation. A curved incision is fashioned in one margin of the sac,



FIG. 1257.—An *encephalocœle*. A *myelocœle* is also present.



so that when the wound is sutured the incision will not overlie the bone defect. The neck of the sac is defined (transfixed and ligated) and the sac and excess skin removed. Muscle and fascia are brought together over the bone defect. Many cases are found to have a small encephalocœle at the base. This is removed with the sac, without harmful effect, as the tissue is functionless.

**Skull Fractures.**—See Cranio-cerebral Injuries (p. 960).

#### INFLAMMATION OF CRANIAL BONE

Osteomyelitis occurs as a result of :

- (i) *Direct infection*, such as a compound fracture.
- (ii) *Local extension* of infection from the frontal sinus or mastoid antrum. The diploe is sometimes infected as a result of cellulitis of the scalp.
- (iii) *Blood-borne* infection by circulating organisms is practically unknown, except when rarely it follows bruising of the bone in young children.

Acute osteomyelitis of the skull is a serious condition. Infective thrombosis of emissary veins, extradural abscess, subdural abscess, brain abscess, and meningitis are grave complications (see p. 968).

**Treatment** consists in the immediate administration of antibiotics. This is extremely effective in controlling both acute and chronic osteomyelitis. Hence the wide excisions of both tables of the skull at one time practised in the acute stage are no longer required.

Chronic sequestra are sterilised under antibiotic treatment, and then excised. Bare areas in the scalp overlying are treated by skin grafting.

**Tuberculous disease** of the skull is uncommon, but occasionally occurs in association with tuberculous lesions elsewhere. As with other bones, the infection commences either in the pericranium or in the medulla, i.e. the diploe. The diseased bone should be removed widely, otherwise abscesses are likely to form and erode the scalp. Streptomycin treatment is also given.

**Syphilitic pericranitis** in civilised countries is now a rare affection. Localised swellings occasionally occur which are slightly tender and fixed to the bone. Under suitable treatment disappearance is usual, although a small bony swelling occasionally remains.

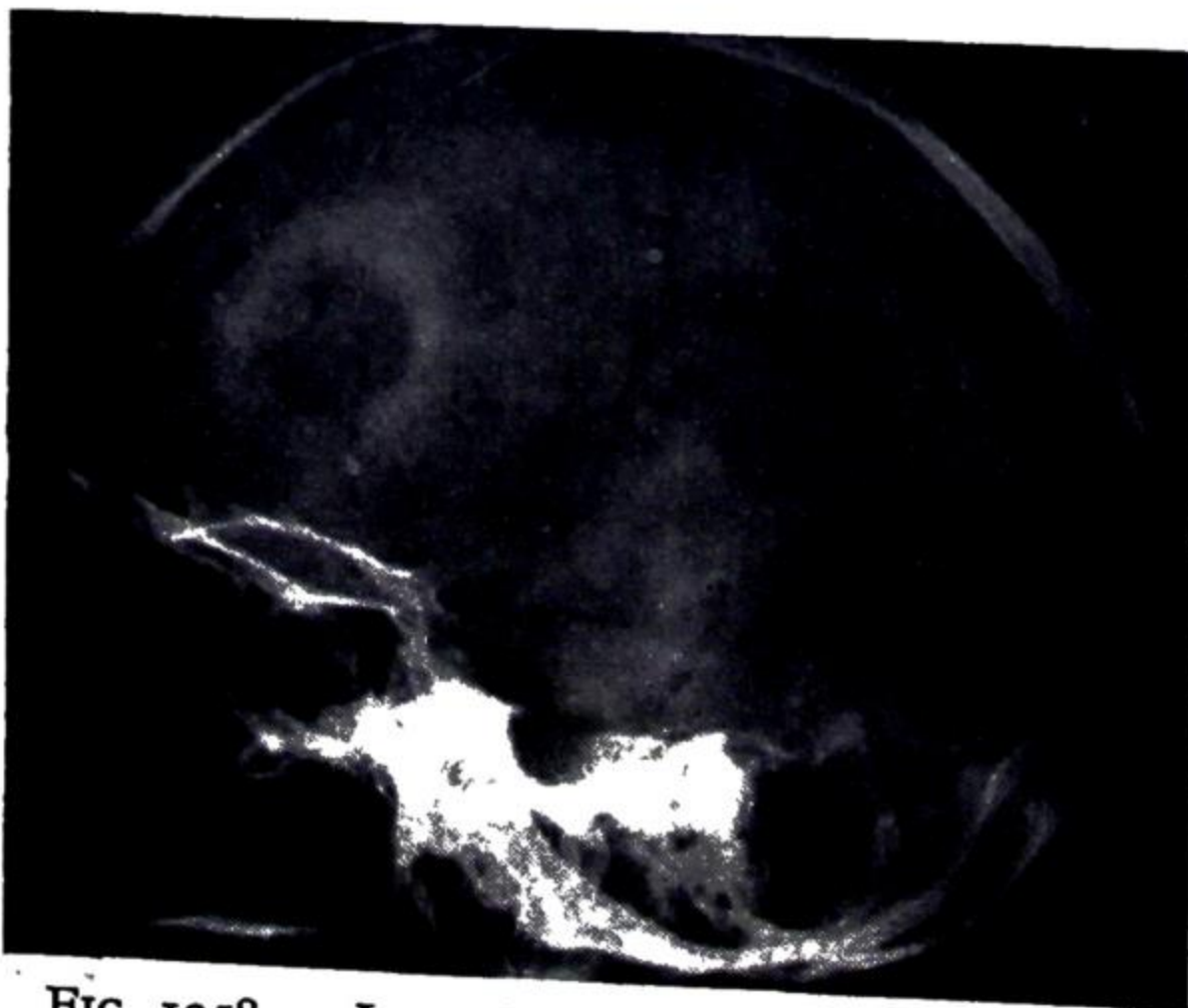


FIG. 1258. — Lateral X-ray showing irregular clear area produced by a malignant secondary deposit from carcinoma of the breast.

#### NEW-GROWTH OF THE SKULL

**Innocent tumours** are rare. An *ivory* osteoma occasionally arises in the region of an air sinus.

**Malignant new-growths** resemble those of other bones. *Pericranial sarcoma* forms a tumour, the consistency of which depends upon its vascularity and rate of growth. Thus it may be pulsatile or of an almost bony hardness. *Osteoclastoma* occasionally develops in the diploe.



The commonest malignant tumour is *secondary carcinoma*. The suprarenal, breast, and thyroid are most often the seat of the primary growth.

Hypernephromas produce rapidly growing vascular tumours, which pulsate when the outer table is eroded. Secondary deposits usually produce a single clear area on the skull X-ray with irregular margin (fig. 1258). Deposits from carcinoma of the breast are often multiple.

### CRANIO-CEREBRAL INJURIES

Head injuries are injuries of a composite structure in which, according to the mechanism, either the brain, the skull, or intracerebral vessels may be injured separately or together. Except in exceptional circumstances, some degree of brain injury, either minor or major, is inflicted at the moment of impact, and the effects of skull fracture or intracerebral hæmorrhage are superimposed upon a basic cerebral injury, the degree of which determines the immediate clinical picture and often the outcome of the case.

In studying the mechanism of intracranial injuries, it will be found that the direction and plane of the injuring force and its velocity are, in general, as important as the magnitude of the forces involved. The serious complications of intracranial hæmorrhage in particular are produced by relatively minor forces acting in a certain plane.

#### INJURIES OF THE BRAIN

**Mechanism and Pathology.**—All degrees of brain injury resulting in loss of consciousness, concussion, contusion, or laceration of the brain are

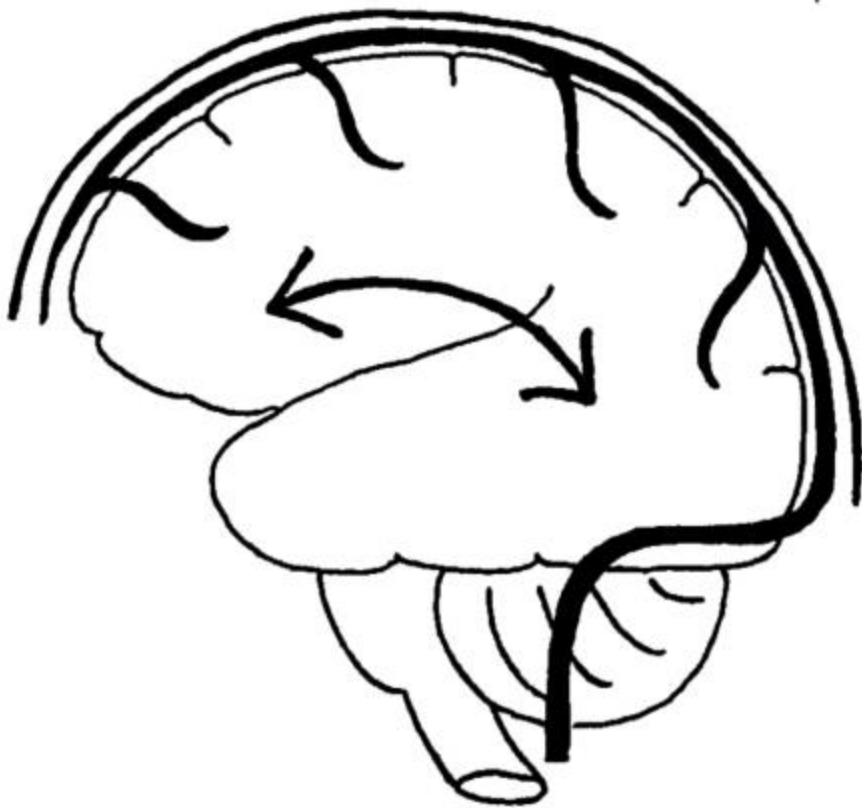


FIG. 1259.—Suspension of the brain in the slings formed by the superior cerebral veins.

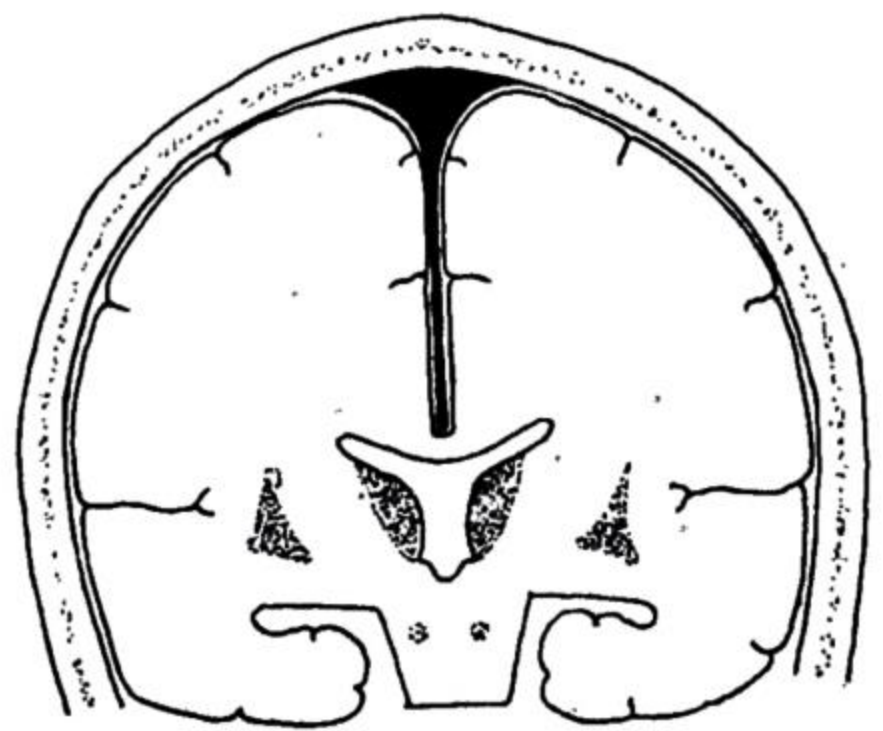


FIG. 1260.—The midline septum of the falx.

produced by one mechanism, namely displacement and distortion of the cerebral tissues occurring at the moment of impact.

The brain is not a perfect fit within its membranes; it is capable of a certain degree of antero-posterior riding movement within the spaces of the cerebrospinal fluid in which it is suspended by slings formed by superior



cerebral veins. Lateral displacement of the brain inside the skull is restricted by the midline septum of the falx.

Blows on the front or back of the head therefore lead to the maximum

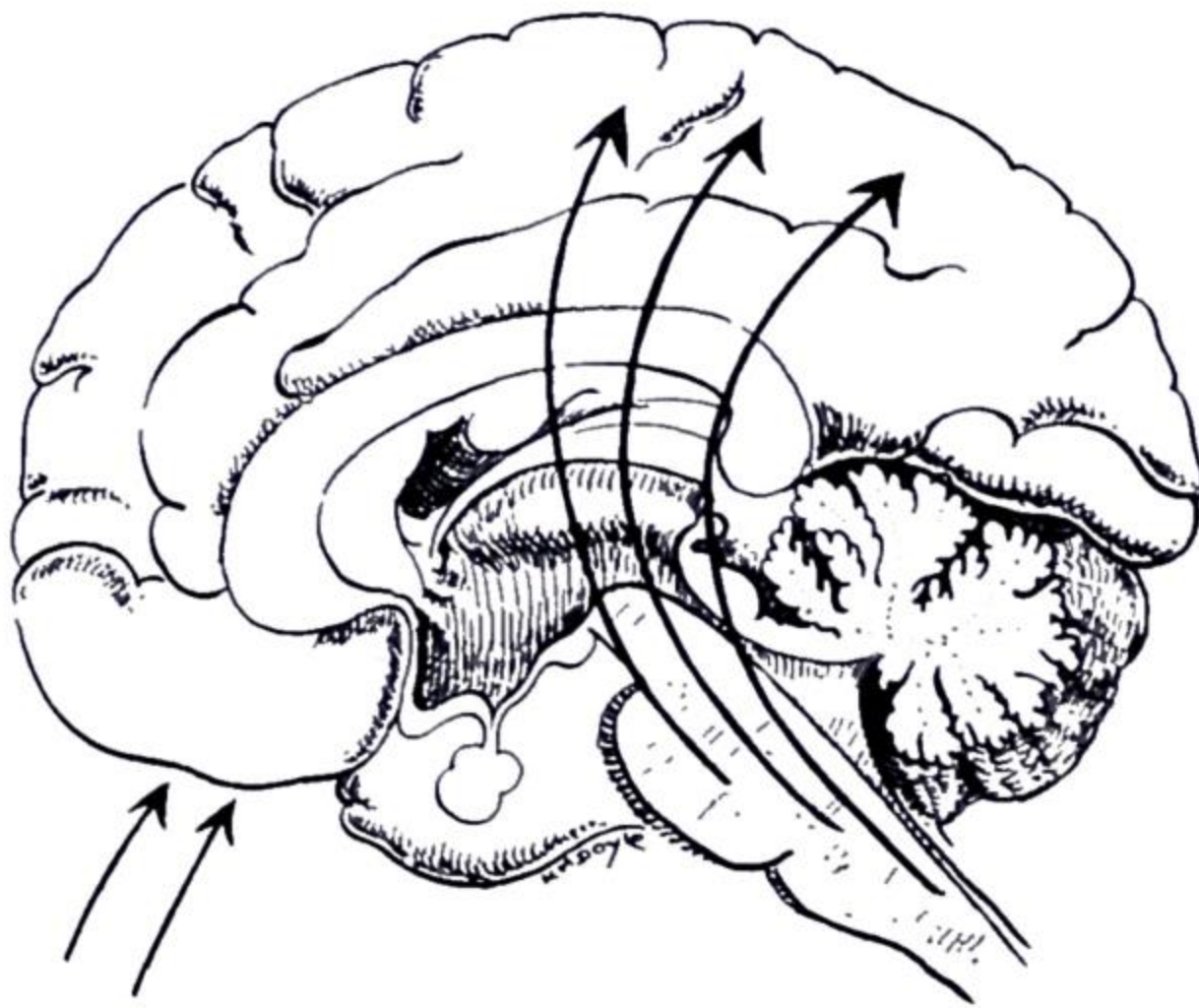


FIG. 1261.—Lines of force acting on the hypothalamus and brain stem as the result of posterior displacement of the hemisphere.

displacement of the brain, with proportionately severe cerebral injuries, the cerebral hemispheres being displaced in relation to the brain stem and hypothalamic region; in this displacement one hemisphere may be distorted in relation to the other, with the resulting stretch and strain on the junctional tissues of the commissures and corpus callosum. Laterally directed blows severe enough to fracture the skull cause less cerebral displacement, and

therefore less associated diffuse injury of the brain.

The lines of force set up by cerebral distortion act chiefly upon the region of the third ventricle and hypothalamus and brain stem. The severity of

these forces is demonstrated by the fact that in deaths from boxing injuries, the medulla is sometimes found to be torn across. At first sight it is difficult to understand how stretch exerted upon the brain stem can disturb consciousness, unless it is realised that consciousness is not maintained exclusively by the cerebral cortex, but is also maintained by the basal areas and hypothalamus. After removal of both cerebral hemispheres at a level immediately above the thalamus (Goltz's dog experiment), an animal is deprived of all volition, but it can stand, and will respond to any stimulus by a show of violent and uncontrolled rage, a reaction which is curiously similar to that seen in post-traumatic delirium following brain injury. Since im-

perfect consciousness is maintained following a lesion at this level in the brain, it follows that for consciousness to be completely lost, a lower level of

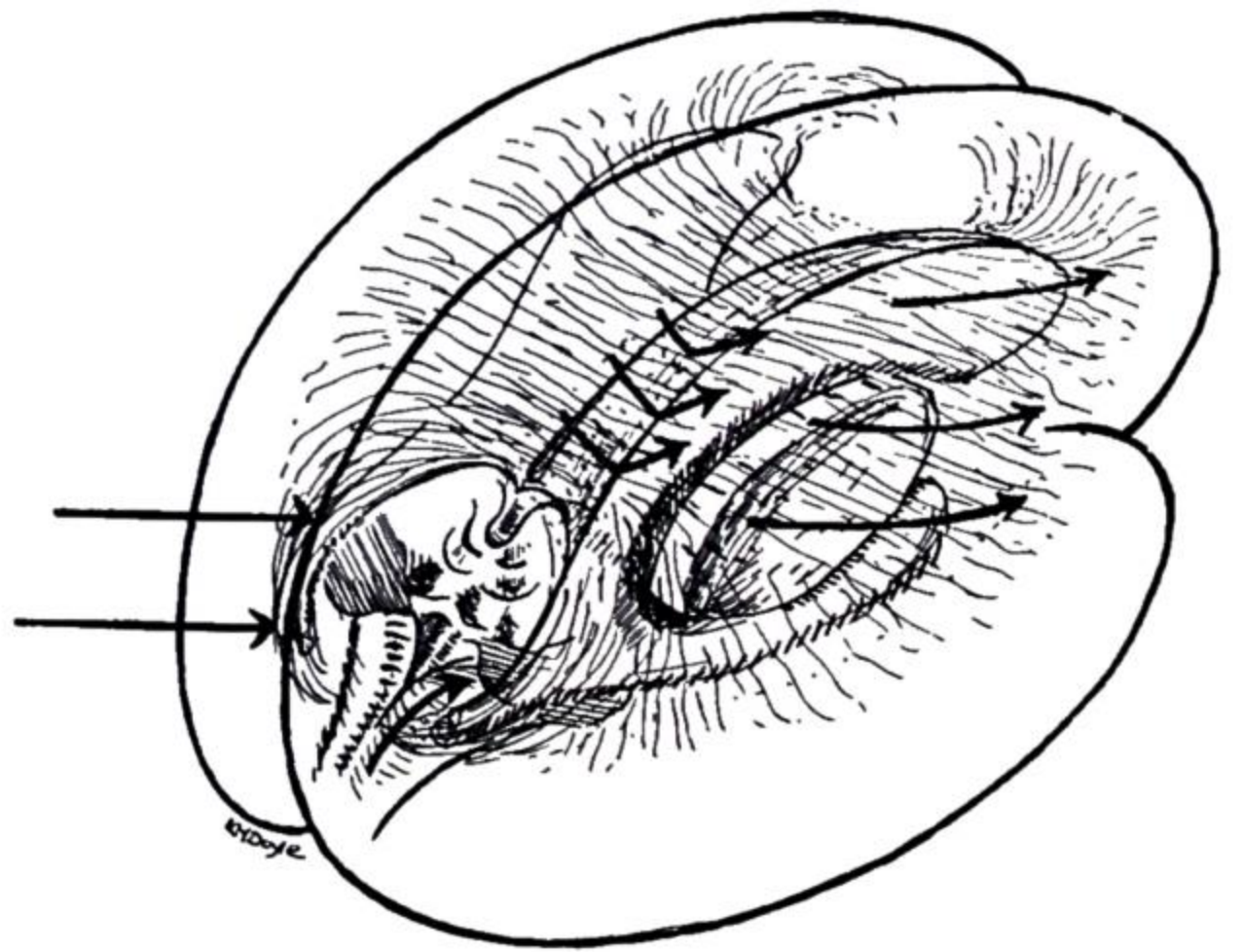


FIG. 1262.—Lines of force acting on the corpus callosum and one peduncle as the result of anterior displacement of one hemisphere.



the brain stem must be affected, and patients are, in fact, rendered completely unconscious by the effect of distortion acting upon the brain stem itself.

In all cases the instantaneous loss of consciousness which occurs at the moment of injury, whether short or long lasting, is produced by paralysis of conduction in the brain stem following distortion, and this occurs quite independently of any change in intracranial pressure whatsoever.

The clinical terms which are used to describe brain injury, concussion, contusion, and laceration of the brain merely indicate minor and major degrees of this process and do not imply any individual difference in pathology.

**In cerebral concussion** the stretch is slight. There is a brief temporary physiological paralysis of function without organic structural damage, which results in a transient loss of consciousness, followed by complete and perfect recovery.

**In cerebral contusion** the stretch is severe. There is some breakage of fibres. Unconsciousness is more prolonged, the initial recovery is imperfect, or death may result from the effects of the lesion on the vital areas of the brain stem acting independently of any change in intracranial pressure; indeed, many fatal cases die with an abnormally low intracranial pressure.

In severe cases of cerebral contusion there is an additional sliding movement of the grey matter in relation to the white, which results in damage to nerve cells and axons.

*Histological Changes.*—In fatal cases there may be no visible surface injury, but section reveals rupture and degeneration of axons and pyknosis of nerve cells. Ring hæmorrhages produced by bleeding into the perivascular spaces of Robin-Virchow are produced by rupture of vessels at the points of maximum stress in the region of the commissures, corpus callosum, and deeply in the third ventricle and substantia nigra in the brain stem. Cloudy swelling is seen in the choroid plexuses, and results in reduction of cerebrospinal fluid formation and the low intracranial pressure found in many fatal cases. Degeneration following rupture of axons accounts for the post-contusional state associated with defective memory and personality change in patients who survive.

**In cerebral laceration** the internal changes are the same as those seen in contusion, but the brain surface is torn, with effusion of blood into the cerebrospinal fluid owing to laceration against bony ridges and the edges of dural septa during brain displacement. Lacerations are common on the inner aspect of the hemisphere against the falx, on the under aspect of the frontal lobe, and tip of the temporal lobe, producing traumatic anosmia. They are less common at the occipital poles, producing blindness or hemianopia. Frequently these surface injuries are situated at a point diametrically opposite the site of impact and are produced by *contre coup displacement* of the brain.

**Clinical Features.**—*Cerebral concussion* may produce either a momentary loss of consciousness or a short period of unconsciousness and cerebral shock of minutes only, which is then followed by a complete and perfect recovery

*Charles Philippe Robin, 1821-1885. French Physician.*  
*Rudolf Ludwig Karl Virchow, 1821-1902. German Pathologist.*



with no residual signs. No treatment is required other than rest and analgesics for headache, provided that there is no associated evidence of skull fracture (see p. 960).

**Cerebral contusion** is diagnosed when unconsciousness is prolonged, if the patient recovers to a state of imperfect consciousness, such as confusion, irritability, or delirium, or if physical signs of focal damage are revealed on examination. During the initial period of unconsciousness the patient is pale, with shallow respiration, the pulse is increased in rate and feeble. The temperature is subnormal, musculature is relaxed, the reflexes are diminished. Following this state of *cerebral shock*, which is also seen for a short while in concussion, a *phase of reaction* develops, the respirations become deeper, the pulse increases in tension, and the face becomes flushed; the patient frequently turns on to his side. *In serious cases, however, deep coma persists from the moment of injury*; dilated and inactive pupils, Cheyne-Stokes' respiration, and irregular pulse indicate a brain-stem lesion which will probably prove to be fatal.

On recovery of consciousness, patients complain of headache or photophobia, and often vomit and exhibit confusion, irritability, or delirium, indicating focal damage to the cortical or hypothalamic levels of the brain (fig. 1263).



FIG. 1263.—Cerebral irritation. The patient has turned on his back.

**In cerebral irritation** the body assumes a position of flexion; interference of any kind is resented verbally or even physically; the patient remains curled up in bed with knees drawn up and the arms flexed. The temperature tends to be slightly but irregularly raised, and the pulse is normal in rate and low in tension, unless the condition is complicated by compression. Improvement is indicated by a tendency for the patient to turn on the back and to show an increasing tolerance to his surroundings.

Recovery may be apparently complete, but in these cases it is doubtful if the potential capabilities ever return to normal. More commonly some symptoms persist, such as irritability, depression, lack of concentration or judgment, and amnesia with reference to the accident or to events immediately before or afterwards. In very severe cases dementia or other forms of insanity necessitate seclusion in a mental hospital.

Physical signs of surface bruising, such as anosmia, paralysis, aphasia, or hemianopia, may be detected on recovery of consciousness, but not before. If the brain surface is torn, patients may suffer from stiff neck, pain in the

*John Cheyne, 1777-1836. Physician-General to the Forces in Ireland.*

*William Stokes, 1804-1878. Physician to the Meath Hospital, and Regius Professor of Medicine, Dublin.*



legs, and retention of urine, from the irritation of blood in the cerebrospinal fluid.

**Secondary pathological changes leading to a rise in intracranial pressure** occur at an interval after injury ; these may be sufficient to produce a superimposed compression of the brain and include :

(a) Local swelling in the region of surface bruises, retention of fluid in the lateral ventricles, blockage of the basal cisterns and arachnoid granulations by effused blood, with defective absorption of cerebrospinal fluid, or ;

(b) Massive intracranial hæmorrhage, extradural, subdural, or intracerebral.

These additional factors may produce a fatal cerebral compression in a patient whose neuronal injury could otherwise have been survived.

**Analysis of the mortality of head injury**, by Geoffrey Jefferson, shows that deaths in the early stages are usually produced by the effect of the neuronal lesion alone representing an immediate mortality which is irreducible, but that in deaths occurring after twenty-four hours there are many cases of unrecognised cerebral compression.

**The treatment of closed head injury** consists of :

(1) Immediate clinical examination to determine the severity of the neuronal lesion and establish a base line for observation.

(2) Nursing care to counteract the effects of the neuronal lesion by posture, attention to airway, nasal feeding, and catheterisation when required.

(3) Continuous observation to detect the onset of œdema or intracranial hæmorrhage and the necessary measures to deal with these complications (see p. 954).

(4) The treatment of skull fracture, and its complications, if present (see p. 960).

*Clinical Examination.*—The head is examined for evidence of surface bruising or fracture. An X-ray of the skull is essential in all cases from the medico-legal aspect, if not from the clinical. The neck is tested for stiffness. Cervical spinal injury may be present in head injury. The central nervous system is examined in so far as the state of consciousness permits. Particular attention is paid to the level of consciousness, the duration of unconsciousness, the size, equality, and reaction of the pupils, the movement or paralysis of either side of the body. *Physical signs are carefully noted, so that the subsequent appearance of new signs can be checked.*

*Nursing Care.*—*The patient must be placed in a position where regular observation can be maintained by the nursing staff.* Seclusion in a dark room is only justified in a patient who has recovered consciousness and complains of photophobia (abnormal sensitivity to light).

*Posture.*—*The unconscious patient* must be nursed on his side, so that mouth secretions escape ; patients may drown in their own secretion, become cyanosed, and deeply unconscious if allowed to remain on their backs (this may be fatal during transport over long distances). Careful attention is given to the airway to be sure the tongue is not swallowed. If the patient is bubbling, the throat must be cleared by suction. The patient is turned regularly. Physiotherapy and postural drainage in Coleman's position<sup>1</sup> for



an hour at a time help to prevent pneumonia supervening (fig. 1264). Tracheotomy is occasionally required to keep the airway clear in cases of brain stem lesion when reflexes are lost and unconsciousness is prolonged.

*The delirious patient* should not be forcibly restrained; restraint provokes aggression. A cot bed covered with netting beneath which the patient may roam at will is the best solution.

*The conscious patient* should be propped up or lie flat, according to which relieves his high- or low-pressure headache.

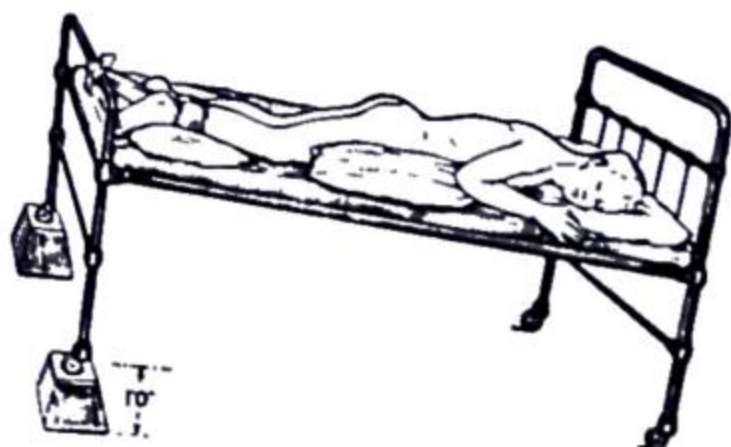


FIG. 1264.—Coleman's postural drainage for the unconscious. The position is maintained by pillows, and bandages anchor the ankles to the foot of the bed.

*Elderly patients* with chest injuries or complications must be treated propped up.

*Catheterisation* is performed if necessary; a full bladder induces restlessness.

*Nasal tube feeding* is required if unconsciousness is prolonged.

*Continuous observation* is maintained from the outset, including a half-hourly record of the pulse and regular observation of the state of consciousness, of the size and reaction of the pupils, and the power of movement on the two sides of the body.

*Progressive slowing of the pulse and deterioration of consciousness* from co-operation to confusion, etc., indicates cerebral compression, from any cause either œdema or hæmorrhage.

A deterioration of consciousness, together with the appearance of new localising signs—e.g. pupil changes or paralysis occurring at an interval after injury—indicates focal compression by hæmorrhage and should be regarded as an absolute indication for immediate burr-hole exploration, at the site indicated.

In doubtful cases where the patient is deteriorating but there are no new signs, a lumbar puncture is occasionally helpful as a diagnostic measure to determine the pressure by manometry and to establish whether the pressure is abnormally high or abnormally low.

*Lumbar Puncture.*—A raised pressure with crystal clear fluid is strongly suggestive of hæmorrhage outside the membranes, for in cerebral laceration the fluid is bloodstained and the pressure usually high. In serious brain stem lesions the pressure is often abnormally low. If focal hæmorrhage can be excluded a phase compression due to secondary œdema is treated by dehydration therapy.

*Dehydration Therapy.*—An increase in the osmotic tension of the blood diminishes cerebrospinal fluid formation at the ventricles, and also increases absorption at the lacunæ, with reduction of intracranial pressure. Six ounces (180 ml.) of 60 per cent. mag. sulph. is given slowly as a warm rectal infusion twice daily, and retained for twenty minutes to extract fluid from the circulation. The fluid intake is restricted to 2 pints (1,000 ml.) in twenty-four hours.

In more serious cases 50 ml. of 50 per cent. sucrose may be given slowly intravenously four times in twenty-four hours; the effect lasts six hours. Neither of these measures should be continued for longer than three days,



owing to the risk of altering the sodium-potassium balance by prolonged dehydration.

*Therapeutic lumbar puncture* on alternate days is employed to remove 4 or 5 ml. of the most heavily bloodstained fluid in cases of cerebral laceration with gross extravasation.

*Hypothermia.*—The survival of serious brain stem lesions may be prolonged by the induction of hypothermia by the use of ice bags, regular cold sponging, and ice blankets. This serves not only to lower the rise in temperature or hyperthermia, often seen in brain stem lesions, but also by diminishing the oxygen requirements of damaged tissue, increases the prospect of survival.

*Drugs.*—The fewer and the simpler, the better. Paraldehyde is sometimes required to control restless cases. Bromide should not be used, particularly in the elderly, as this is liable to provoke delirium.

Conscious patients require little more than aspirin for headache and occasionally barbiturates for insomnia.

*Convalescence.*—Minor contusions recover speedily, but in serious cases prolonged convalescence is needed. Account should be taken of the severity of the injury as measured by the duration of the post-traumatic amnesia; also the mental make-up of the patient and the amount of concentration associated with his occupation, in assessing the duration of convalescence. Supervised rehabilitation is required. This includes physical activity, occupational and mental exercises with psychological encouragement to help the patient overcome the handicap of symptoms resulting from the loss of cerebral neurons which constitute the post-contusional syndrome.

**Cerebral Compression.**—The detection and treatment of lesions producing cerebral compression is the most important factor in reducing the mortality from head injuries. Operations for the elevation of depressed bone and the dehydration treatment of œdema form part of this subject, but the most important factor is recognition and early treatment of traumatic intracranial hæmorrhage. *Cerebral compression produced by these causes gives rise to a deterioration in the level of consciousness, slowing of the pulse, and slowing of respiration with the appearance of new localising signs.*

### Differential Diagnosis

	<i>Contusion</i>	<i>Compression</i>
General condition	Unconscious, gradually regains consciousness, with, perhaps, cerebral irritation.	In a classical case concussion, then lucid interval, followed by increasing drowsiness and coma.
Appearance	Pale, with shallow respirations.	Flushed, respirations become stertorous and slow.
Pulse	Increased in rate and feeble.	Slow and 'bounding.' Later rapid and feeble when cardiovascular centre begins to fail.
Pupils	Moderately dilated, equal, react sluggishly.	On side of injury, pupil contracts, and later dilates. The opposite side follows.



Where there is an extensive area of indriven bone, evidence of compression is likely to follow the injury immediately. In other cases, such as compression produced by collecting hæmorrhage, concussion occurs first, followed by a period of improvement, after which the patient becomes drowsy and lapses again into unconsciousness. Thus an unconscious footballer was carried off the field of play, but recovered sufficiently to finish the match. Headache and drowsiness supervened, so that he retired to bed at an early hour, and later was found to be dead from middle meningeal hæmorrhage. Similar tragedies have occurred in police-stations, particularly as a head injury sometimes causes temporary excitement. Persons alleged to be

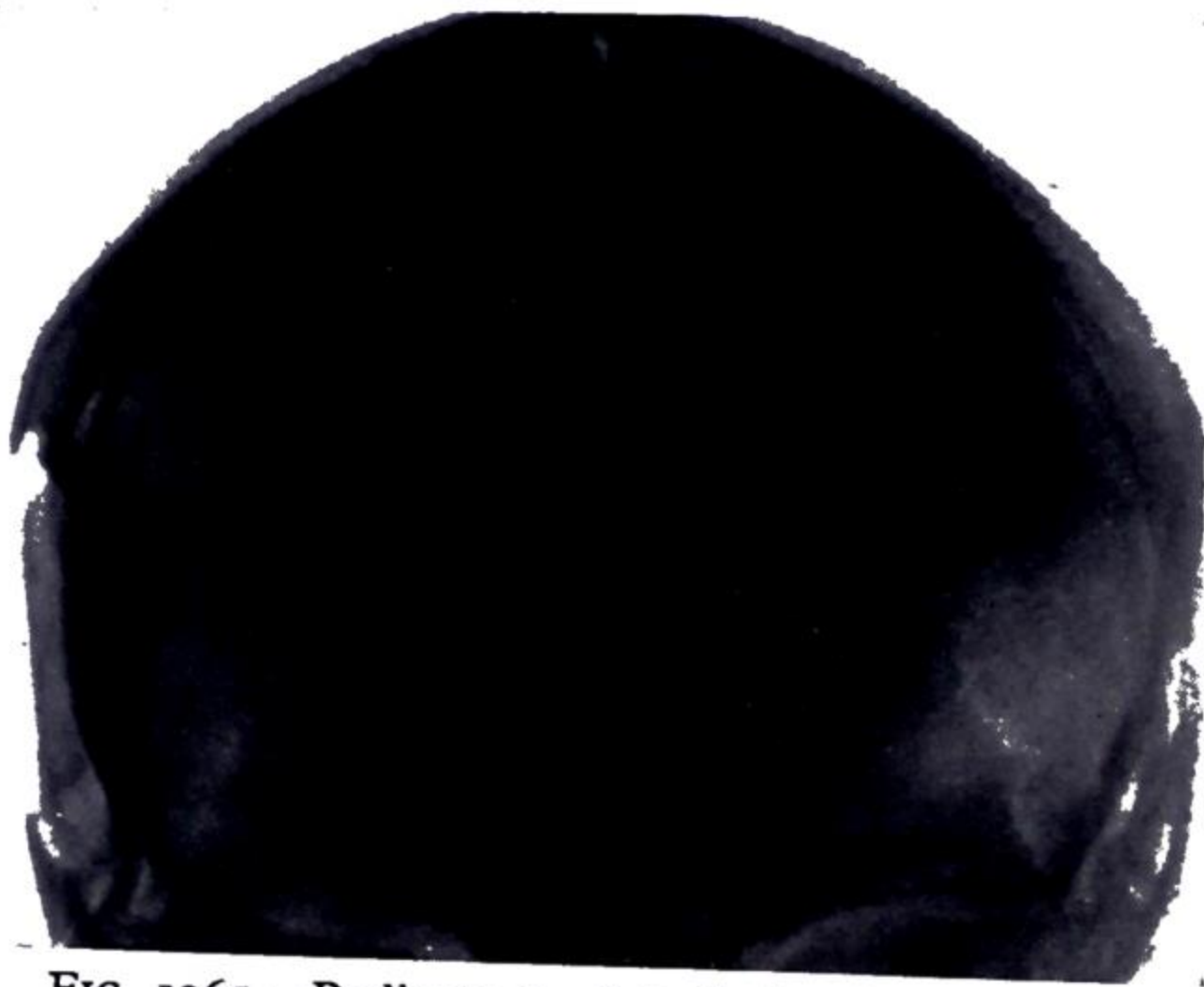


FIG. 1265.—Radiograph of skull showing inward displacement of the right temporal plate. This caused urgent symptoms of cerebral compression in the early stages after injury.

drunk have been locked in cells, and the unconsciousness and stertorous breathing of compression mistaken for a drunken stupor. Therefore all cases of even minor concussion must be under observation for twenty-four hours, particularly if there is any bruising in the temporal fossa.

If cerebral compression is due to middle meningeal hæmorrhage, a boggy swelling is usually palpable in the temporal region, as the majority of cases are

due to direct injury associated with fracture of the subjacent skull. Recognition of the resulting extracranial extravasation is valuable confirmatory evidence when middle meningeal hæmorrhage is suspected.

With patients under observation, a deterioration in the level of consciousness, with the appearance of new localising signs not observed at the original examination, must always be taken as an absolute indication for exploration of the area indicated by the localising signs. The formation of a burr-hole opening under local anæsthesia is a less dangerous matter than a lumbar puncture when pressure is high, and it is sometimes the only method of recognising or excluding a dangerous complication. Similar signs are occasionally produced by an œdema spreading from adjacent bruises; but this cause should never be assumed until the possibility of hæmorrhage has been disproved.

**Traumatic intracranial hæmorrhage** is of three types: (1) Subcortical; (2) Extradural; (3) Subdural.

**Subcortical hæmorrhage** is produced by arterial bleeding either extending from an area of surface laceration or produced by rupture of a central artery. The bleeding may terminate rapidly and fatally by rupturing



into the ventricles, causing hyperthermia and death by *intraventricular hæmorrhage*; it may, however, form a clot under the cortex.

**Clinical Features.**—In the frontal lobe this produces cerebral compression associated with generalised epileptic fits and few signs. In the temporal lobe—cerebral compression, fits, and hemiparesis. Symptoms are usually observed within the first twenty-four hours after injury, or the onset may be delayed for a further ten days if the artery ruptures late as a result of softening near a surface bruise (delayed apoplexy of Bollinger). Chronic clots may simulate a cerebral tumour months after the injury.

**Treatment.**—Fluid clots may be aspirated through a ventricular cannula. Solid clots may be turned out or removed by suction after exposure of the cortex through a small osteoplastic flap or a large trephine opening.

**Extradural hæmorrhage of arterial origin** results from injuries to anterior or posterior branches of the middle meningeal artery. The cause is a laterally directed injury, often relatively trivial, such as a blow from a golf or cricket ball which strikes the thin bone of the temporal plate, inflicting a fracture which drives the dura inwards and snaps the meningeal artery at a point where it leaves the bony canal in the pterion to cross to gain attachment to the dura mater. In the elastic skull of children the injury may occur without fracture, but in all adults comprising 90 per cent. of cases X-ray reveals a fracture line crossing the middle meningeal groove.

*The detection of this fracture is an absolute indication for the admission of the patient for observation.*

From the torn vessel blood passes in three directions :

(1) Outwards through the fracture line to form a boggy swelling under the temporal muscle, the finding of which is a further indication for the *admission for observation of a conscious patient.*

(2) Downwards into the middle fossa.

(3) Upwards over the motor cortex.

**Clinical Features.**—Usually a laterally directed blow of small magnitude causes a short initial period of concussion, followed by a 'characteristic lucid interval,'<sup>1</sup> during which the hæmorrhage is collecting intracranially and also forming a superficial swelling under the temporal muscle. The importance of this sign cannot be overestimated, and one may frequently forecast the development of the complication on the basis of this sign alone. The next change is in the level of consciousness. The patient becomes confused and irritable, and at this stage is in danger of being arrested if found wandering and smelling of alcohol; therefore, beware of the patient brought to Casualty in a confused state with a bruise in the temporal region. Confusion changes to drowsiness, and at this stage pressure of the clot on the motor cortex produces cerebral anoxia, causing twitching, followed by paralysis of the face, then the arm, then the leg, on the opposite side of the body as the clot spreads upwards over the motor cortex. At the same time inward displacement of the temporal lobe causes the inner portion of the

<sup>1</sup> When the complication develops in a patient who never recovers consciousness, it would be detected only by clinical signs.



lobe to press against the third nerve above the edge of the tentorium (fig. 1266(B)), causing constriction, rapidly followed by dilatation of the pupil on the side of the hæmorrhage. If the pressure is not relieved, displacement of the brain stem at the tentorial opening forces the opposite crus against the rim of the tentorium, producing further hemiplegia, which this time occurs on the side of the hæmorrhage (see fig. 1266(A)).

Finally, impaction of a mid-brain cone produces decerebrate rigidity and fixed dilatation of *both* pupils, at which stage the case is probably too late to remedy by operation.

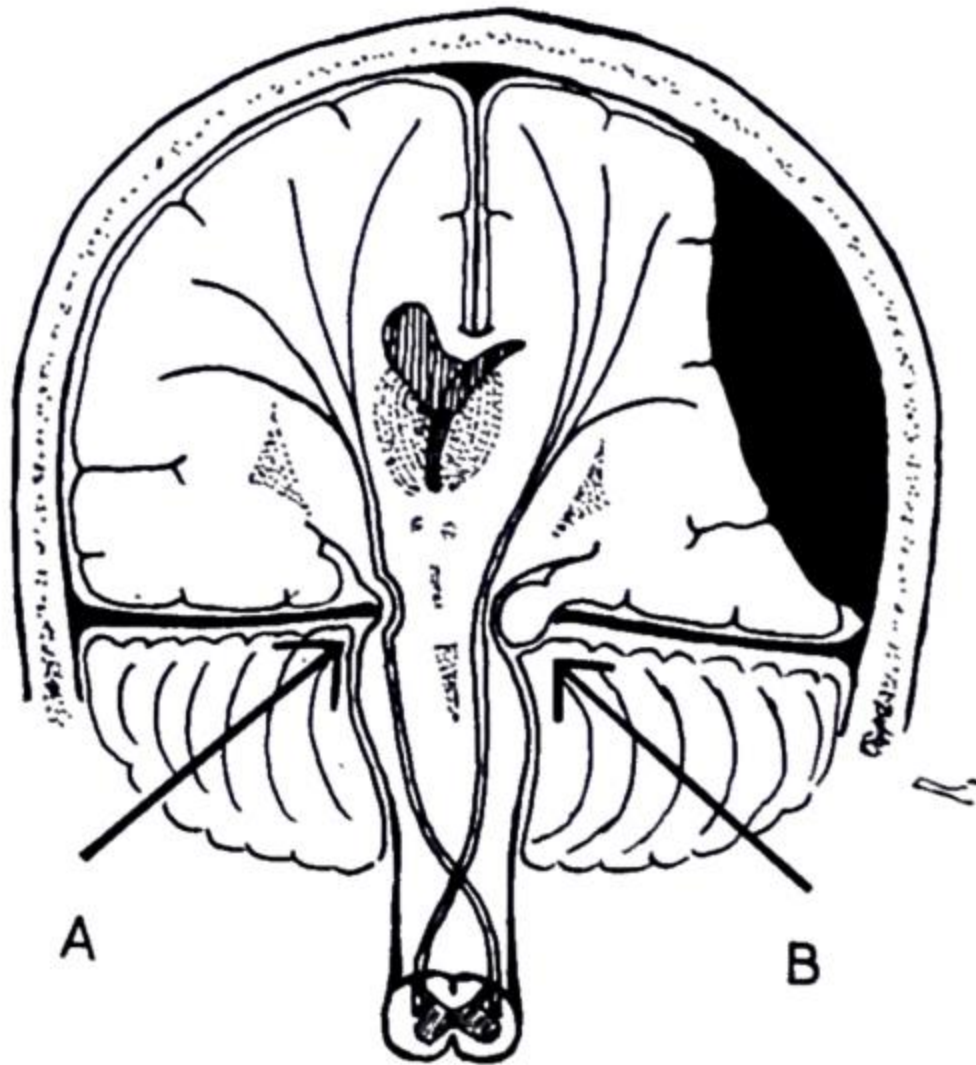


FIG. 1266.—(A) Impaction of the opposite crus against the opposite rim of the tentorial opening. (B) Displacement of the inner edge of the temporal lobe (uncus) descending into the tentorial opening (mid-brain cone). (G. B. Northcroft.)

In the presence of these confusing signs, the side of operation is determined by :

- (a) The site of bruising in the temporal muscle.
- (b) The side of skull fracture.
- (c) The side of the initial dilatation of the pupil.

#### Posterior Branch Bleeding.—

Here the clot is situated at a distance from the motor cortex, the surface bruising is situated farther back, or there may be a steady arterial hæmorrhage from the ear when the fracture line involves the middle ear. The level of consciousness deteriorates, and the patient passes into a stage of cerebral irritation or stupor with a dilated pupil from pressure inwards on the third nerve, but there

may be no motor paralysis for several days, or the paralysis appears on the same side of the body as the hæmorrhage as the result of brain shift and impaction of the contralateral crus. The site of operation is determined by the site of the fracture, surface bruising, and dilatation of the pupil.

**Treatment** is an urgent matter. Patients may stop breathing within half to one hour of the onset of the first sign ; therefore the dangers of transport must be assessed carefully. If possible, operation should be performed in the hospital where the complication is recognised, especially if the case is progressing rapidly.

If the site of the hæmorrhage is definitely established, half the head may be shaved. If there is any doubt or the possibility that an alternative exploration for a subdural hæmatoma may be required, the whole head should be shaved, as subdural hæmatomas are often bilateral.

A point is marked on the scalp 2 inches (5 cm.) behind the external angular process and 2 inches above the zygoma, corresponding approximately to the anterior branch of the artery. A curved-hook incision (fig. 1267(A)) is now formed and the anterior and posterior skin flaps are reflected forwards and backwards to expose the temporal muscle ; the advantage of this incision is that it is easily extended backwards if it is



necessary to explore the posterior branch more fully. On division of the temporal muscle, blood-clot will be found between the muscle and the fracture line. A burr hole or trephine opening is now made beside the fracture. The bone is opened, and a suction apparatus is essential in order to clear the field. The opening in the bone is enlarged with nibbling forceps as required. Frequently the bleeding-point is seen lying on the dura (fig. 1267 (C)) and may be secured by underrunning with a fine curved needle or coagulated with diathermy. Occasionally a torn vessel may be seen bleeding from the bony canal, which is plugged with Horsley's bone wax, which stops the hæmorrhage. Alternatively blood may continue to pour in from the back of the opening, indicating that the posterior branch has been involved, and the bone excision must be extended in this direction until the bleeding-point is found. Occasionally an

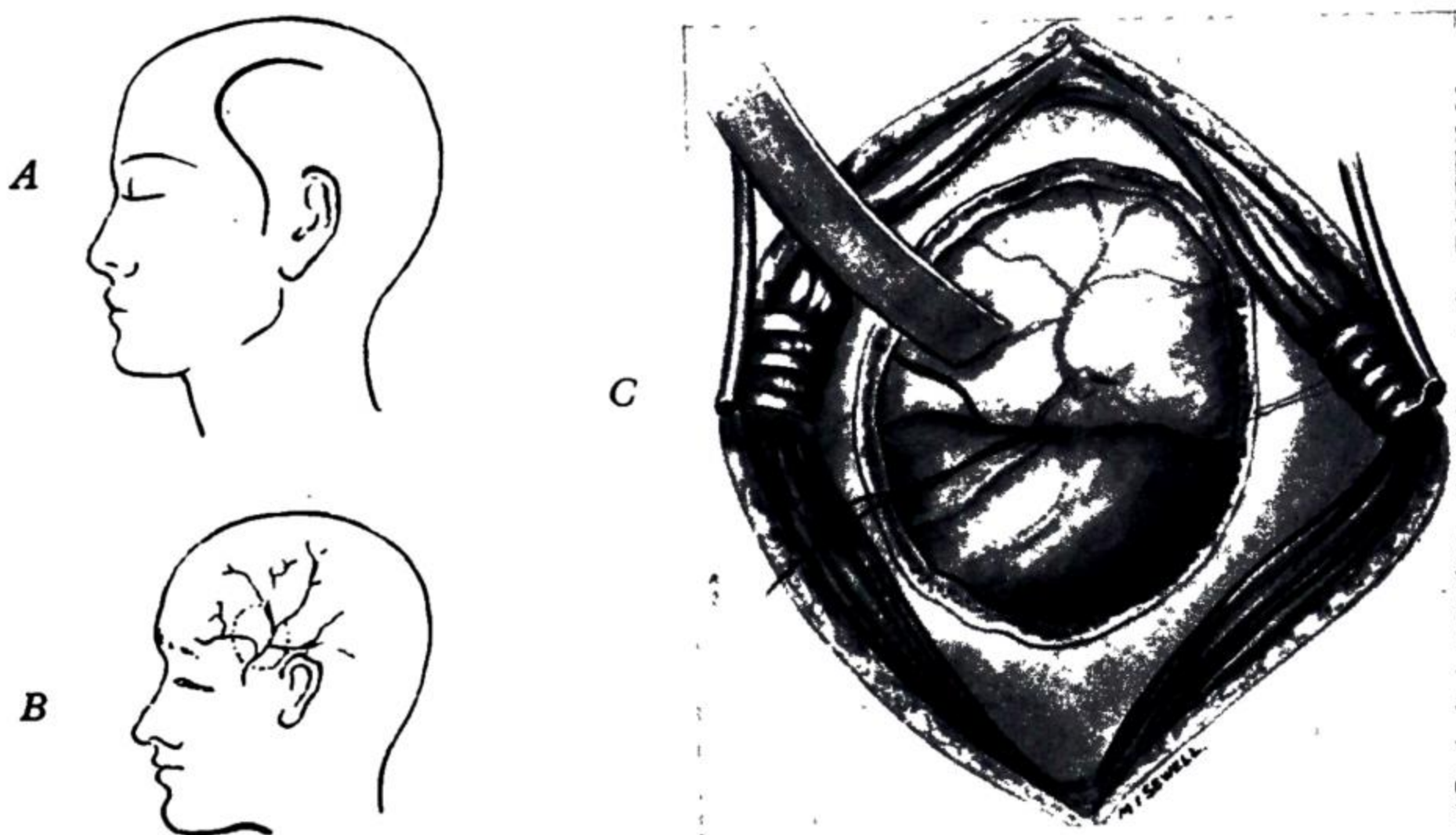


FIG. 1267.—(A) Curved hook incision used to expose artery. (B) Position of bone opening. (C) Exposure of artery which is underrun by a dural stitch.

artery is ruptured near the foramen spinosum, where it must be arrested with diathermy. When the artery has been secured, bleeding continues from veins in the margins of the compression area if the dura has been seriously displaced. Venous bleeding is controlled by placing muscle, fibrin foam, or oxycel over the bleeding-points and stitching the dura back firmly against the skull. Troublesome capillary oozing may continue from the dura, and it is often wise to drain for the first twenty-four hours.

*Post-operative Treatment.*—The patient should be kept lying flat in order to encourage the brain to re-expand. If the level of consciousness does not improve rapidly and the patient shows signs of persistent coning with dilated pupil, a diagnostic lumbar puncture should be performed. If the pressure is abnormally low, sterile saline should be injected intra-theccally in order to raise the pressure to the normal level of 120.mlm. of cerebrospinal fluid or slightly above and produce a free rise and fall on Queckenstedt's test. This may necessitate an injection of 90 or 100 ml. of saline; when successful it will occasionally relieve cone formation and result in rapid restoration of consciousness. It probably does so by floating the brain stem up into its normal position, thus straightening out the vessels supplying the stem.

**Extradural hæmorrhage of venous origin** is produced by fractures which injure the major sinuses. Injury of the superior longitudinal sinus produces a massive subgaleal hæmatoma, together with evidence of clot compression, causing deterioration of consciousness with generalised epilepsy if the clot lies over the frontal areas,

*Sir Victor Horsley, 1857-1918. Surgeon to the University College Hospital, London. Died from heatstroke while on active service in Mesopotamia.*



or unilateral or bilateral leg weakness with extensor plantar responses if the clot is over the upper end of one or both motor cortices.

**Extradural hæmorrhage of the posterior fossa** is produced by injury to the transverse sinus. Surface bruising appears behind the ear. There is a deterioration of consciousness occurring at an interval of days after the injury. Signs of cerebellar compression are few; often there is merely a reduction of tone and reduction of reflexes on the side of compression.

**Treatment.**—Clots of this type are evacuated after elevation of the causative fracture, hæmorrhage from the sinus is arrested by holding a muscle graft firmly against the aperture whilst it is secured by an overlying letter-‘N’ stitch.

**Subdural hæmorrhage** is a far more common complication than extradural hæmorrhage, and is produced by rupture of the veins passing from the cerebral hemispheres to the venous sinuses as the result of displacement of the brain inside the skull. Usually the superior cerebral veins are ruptured, producing hæmorrhage over the convexity of the hemispheres; very rarely veins passing from the temporal lobe to the sphenoid or petrosal sinuses may produce clots which collect on the under-aspect of the brain. This complication, which is potentially fatal, is at least six times as common as middle meningeal hæmorrhage and is produced particularly by blows of small magnitude applied to the front or back of the head which may be insufficient to produce even transient concussion, but which are sufficient to move the brain suddenly. Cerebral atrophy renders this displacement

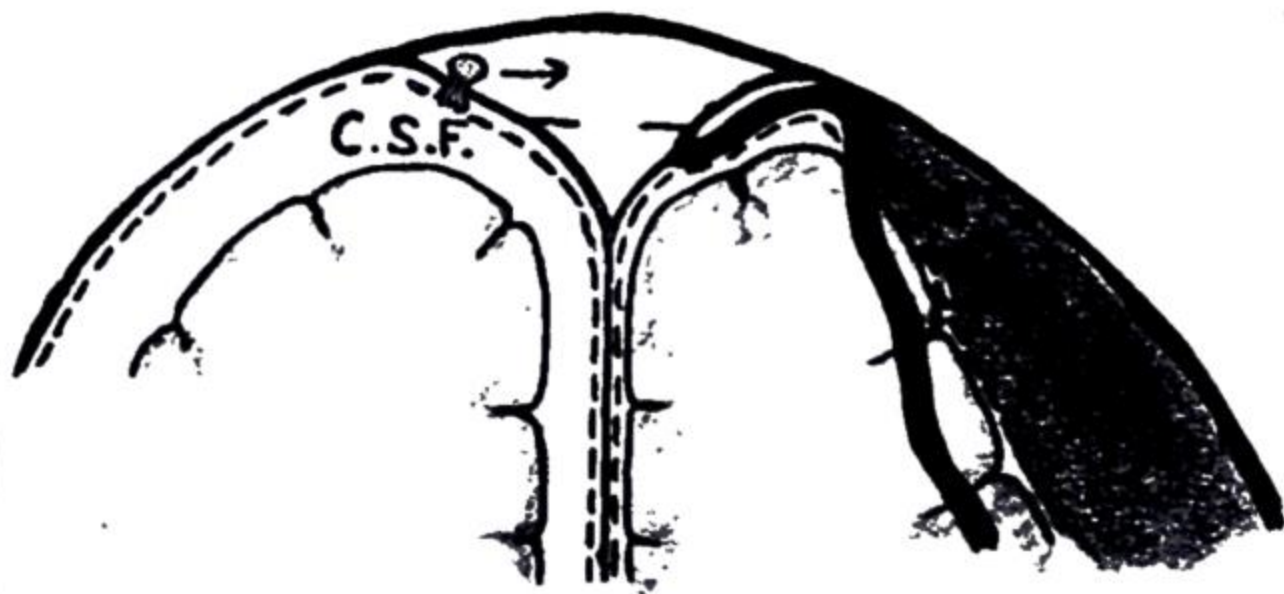


FIG. 1268.—Position of a subdural hæmatoma produced by tearing of the superior cerebral veins at the level of the arachnoid. The diagram also shows the partial or occasionally complete septum which divides the superior sinus. Cerebrospinal fluid drains into the upper compartment through the arachnoid granulations. The superior cerebral veins drain into the lower. (G. B. Northcroft.)

easier, and hence the condition becomes commoner with advancing age. The superior cerebral veins pass from the convexity of the hemispheres and pierce the arachnoid membrane before crossing the potential subdural space to join the inner aspect of the dura 1 inch (2.5 cm.) or more from the middle line; they then run inwards to drain into the lower compartment of the superior longitudinal sinus.

One end of the vein is fixed to the dura, the other to the mobile hemisphere. Sudden displacement may snap the vein at the level of the arachnoid, allowing blood to pour down into the potential subdural space between the arachnoid and dura. Frequently, corresponding veins on both sides are affected and the condition is bilateral in 50 per cent. of cases. The hæmatomata are often large, bilateral collections of 60 ml. a side or unilateral collections of 120 ml. being quite usual.

In the acute form the clots produce symptoms of cerebral compression within hours or days of the injury; in the chronic form not until months



after the injury. The normal pressure in the superior cerebral veins is extremely low; hence venous bleeding by itself could never compress the brain and overcome arterial pressure without one of the following additional factors. Vomiting after injury may force blood out at a high pressure and account for the onset of pressure occurring in a period of hours, otherwise the pressure increases as a result of the osmotic traction of the blood in the subdural space drawing fluid from the cerebrospinal fluid system through the semipermeable arachnoid, so that the cyst increases steadily in size and produces compression symptoms in days or months after the injury.

**Clinical Features.**—The symptoms may follow a preceding concussion, but owing to the slight nature of the force required to produce displacement, this complication may occur without preceding loss of consciousness and without the head being even struck. It can follow a sudden jolt, as when a driver is thrown against the steering-wheel of a car, or be produced by knocking the head against the lintel of a door or landing heavily on the feet when jumping from a height; it has followed dental extraction and electroconvulsive therapy.

*In the acute form* developing within hours, the onset of coma, hemiplegia, and dilated pupil simulates an extradural hæmorrhage without appro-

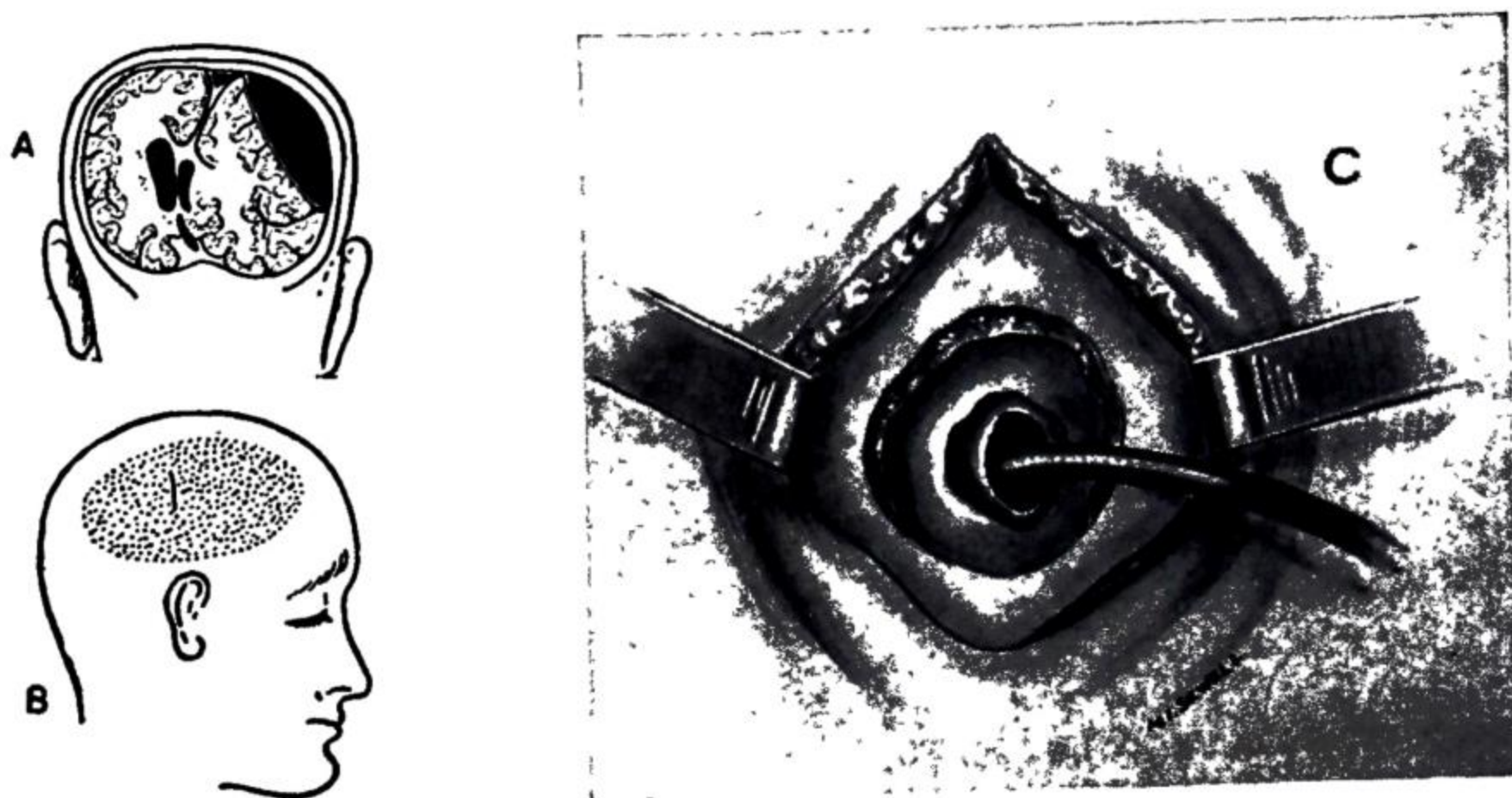


FIG. 1269.—(A) Site of clot. (B) Lateral diagram showing extent of clot and site of incision. (C) Burr-hole exploration. Emptying of cyst with catheter.

priate evidence of skull fracture. Otherwise the symptoms consist of: (1) Headache which is unduly severe or unduly prolonged, following a blow on the front or back of the head. (2) Cerebral anoxia, causing mental apathy, slowing of cerebration, slowness of response to questions merging into stupor. (3) When the stupor develops, it comes and goes as the brain volume varies, the patient being inaccessible at times and then rousing sufficiently to answer questions accurately, but very slowly and after a considerable pause. When this phase passes on to coma as the result of the formation of a mid-brain pressure cone, the operative mortality rises from nought to 30 per cent.; hence the importance of the significance of these early symptoms.



Physical signs vary. Acute compression may cause hemiplegia in young subjects. In older patients, where more room is available and if the cyst collects slowly, there may be no signs, or at most a unilateral or bilateral extensor plantar response from pressure on the motor cortex or brain-stem displacement. Pupillary changes occur last when the brain stem is affected and pressure-cone formation is imminent. Lumbar puncture shows a fluid at low pressure with protein increased to 120 mg., often stained yellow from the transudation of pigment, but no cells. Papilloedema is exceptional.

**Treatment.**—Bi-parietal burr holes are formed under local anæsthesia to expose the dura, which is often stained blue-green from the blood pigment. On incising the dura, black tarry blood is removed by suction through a soft rubber catheter (fig. 1269), which should be passed downwards and also backwards in the subdural space. If the blood is thick, bi-frontal burr holes are fashioned and the subdural space is washed through with saline. Solid clots must be removed by craniotomy. The results are excellent if the operation is performed before a mid-brain cone develops (see p. 977).

Post-operatively, the patient is nursed with the head low in order to encourage expansion of the brain. Repeat X-rays show absorption of air from the subdural space. Rarely, repeat of the puncture is required if the brain is not expanding or if symptoms persist, indicating the clot has only been partially evacuated.

#### FRACTURES OF THE SKULL

**Mechanism.**—Fractures of the vault and base of the skull are produced : (1) by compression of the sphere ; (2) by local indentation ; (3) by tangential injury. These mechanisms vary, not only in their local effect upon the skull bone, but also in the severity of the cerebral injury that accompanies the fracture, the mechanism and nature of which can be visualised when interpreting the skull X-rays.

**Fractures of the vault** produced by compression of the sphere are the commonest skull fractures, and result from distortion of the skull when it comes into contact with a hard flat surface. Usually closed linear fissures are produced which, although not important in themselves, are often associated with severe diffuse cerebral injury resulting from brain displacement occurring at the moment of impact. Contact with a flat surface renders the spherical skull more ovoid. The fracture line starts at the points of maximum convexity thus produced and spreads through thin areas of bone, being deflected at an obtuse angle from bony buttresses of the temporal and occipital crests towards the base of the skull ; hence many fractures of the base are produced by the extension into the base of fissures starting in the vault.

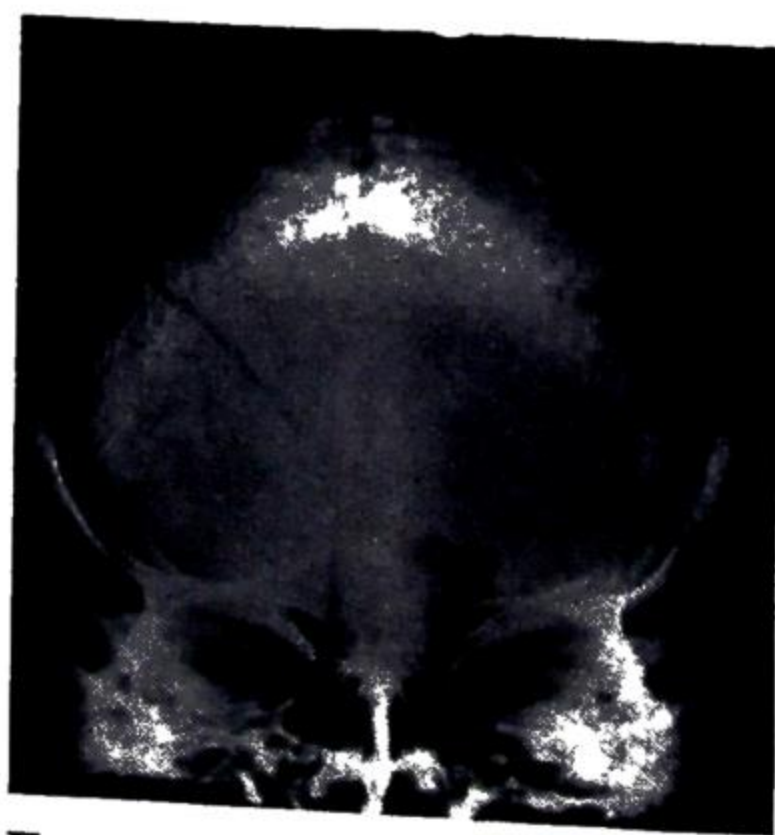


FIG. 1270.—Fracture of the vault extending to the base.

**Fractures of the vault produced by local indentation** give rise to closed or compound depressed fractures according to the surface area of the injuring agent.



Blows from large rounded objects produce closed pond depressed fractures; the scalp is bruised but remains intact. The skull ruptures at the points of maximum convexity; it is dented but it is not indriven, the underlying dura remaining intact. The brain surface is bruised under the intact dura, but is not penetrated. This bruising may cause local signs, such as paralysis or aphasia. Healing occurs by absorption of the tips of damaged convolutions forming a shallow ulcer on the brain surface, surrounded by a zone of reactive gliosis. The risk of epilepsy is in the neighbourhood of 4 per cent.

Blows from small round objects produce compound depressed fractures. The scalp is irregularly torn by the degree of indentation. The skull is actually indriven and

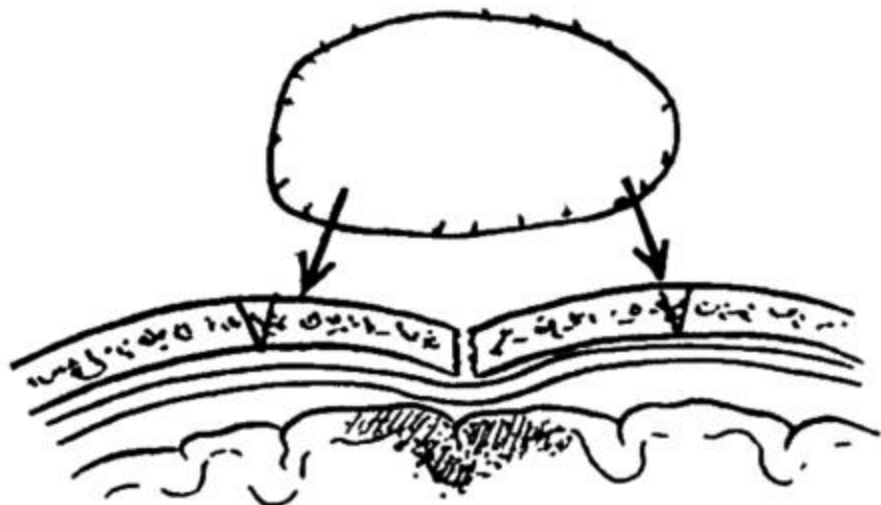


FIG. 1271.—Pond fracture produced by large round object.

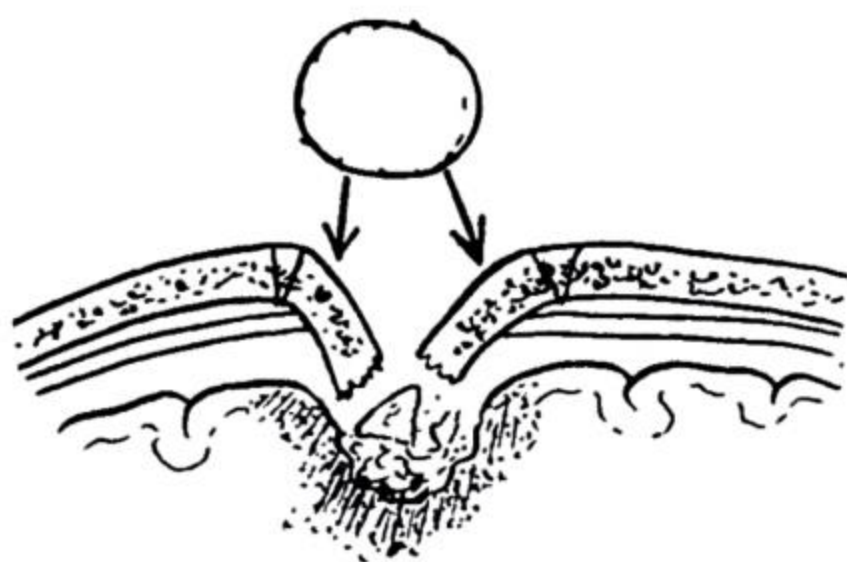


FIG. 1272.—Compound fracture produced by small round object.

lacerates the dura. The brain is lacerated. Fragments of bone may separate from the inner table and lodge in the brain. There is immediate risk of infection and a later risk of epilepsy resulting from the ingrowth of contracting fibrous scar through the open dura which increases the incidence of epilepsy to 25 per cent. in untreated cases.

**Fractures of the Vault by Tangential Injury.**—Tangentially directed violence may secure a grip on the skull and prise up large segments, which are lifted away from the dura which remains intact. When a window cleaner, falling to earth, catches his brow on the ledge of a window, the vault of the skull may be lifted like the lid of a coffee-pot, a horseshoe fracture surrounds the calvarium. Such injuries are compound and the skull X-ray is alarming, but there may be little or no associated cerebral injury, as the injuring force has not been directed on to the brain. In one case (fig. 1273) the swinging door of a railway wagon, striking above the right ear, prised up both frontal plates and the frontal sinuses which were hinged laterally on the left temporal muscle, but the patient was unconscious for half an hour only.

**Treatment of fissured fractures of the vault** is governed by the degree of associated injury to the brain. Bed rest for three weeks is required on an average, with a careful watch for evidence of cerebral compression.

**Closed Depressed Fractures of the Vault.**—Simple depressed fractures are rare, as the scalp is relatively non-elastic, and an injury sufficiently severe to fracture and depress the bone is almost certain to lacerate the tough over-



FIG. 1273. — Lateral X-ray showing tangential fracture separating both frontal plates.



lying scalp. A hæmatoma in the deeper layers of the scalp sometimes simulates closely a depressed fracture, as the blood clots round the periphery (fig. 1274). On palpation, the margin of the clot resembles the edge of normal bone surrounding a depressed fracture, but the edge of the clot can sometimes be indented by the thumb-nail. In the absence of intracranial complications no emergency treatment is required and an X-ray will distinguish the two conditions. The fracture, if present, is sometimes more extensive than is suggested by the radiograph.

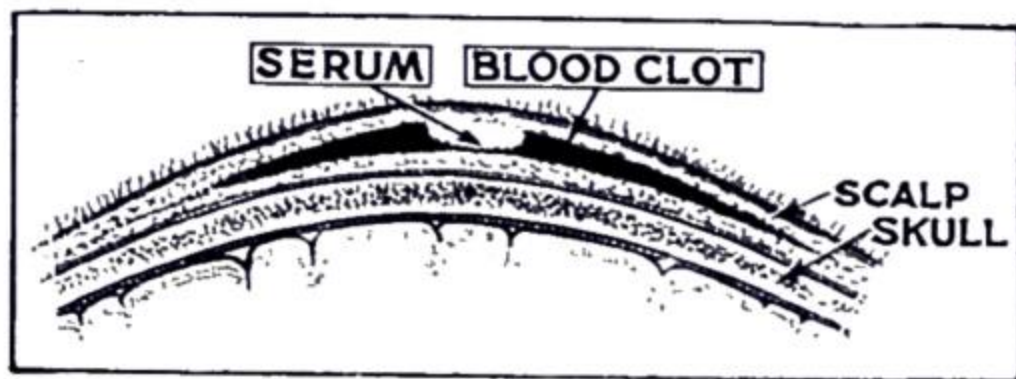


FIG. 1274.—Hæmatoma simulating a depressed fracture.

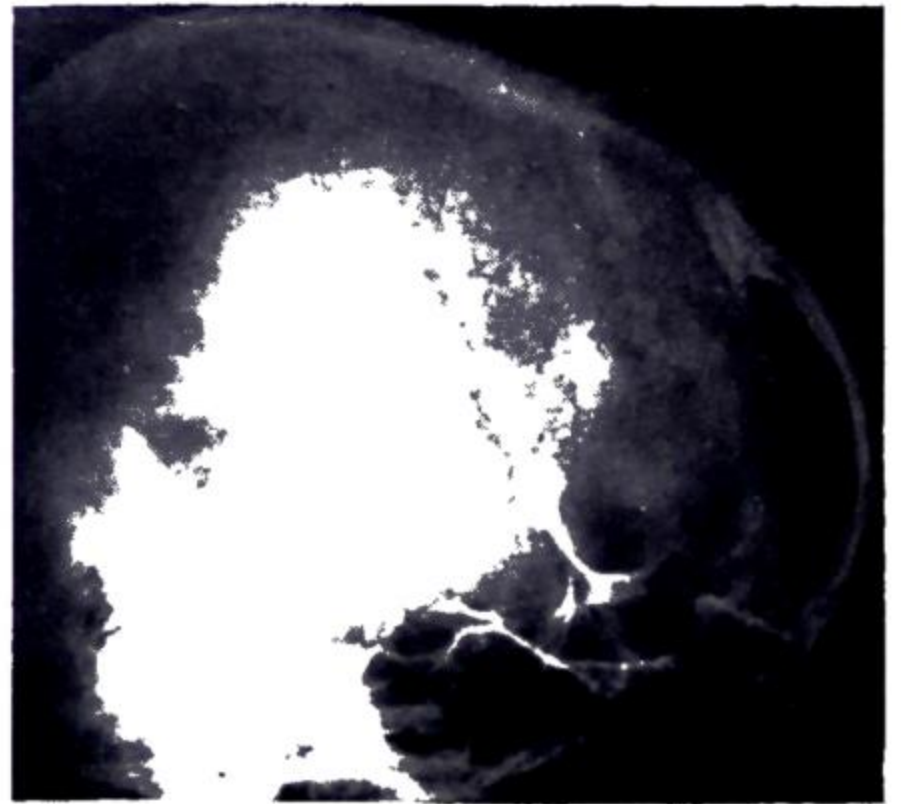


FIG. 1275.—Sharp bone spicules penetrating the dura.

The **treatment** of a closed depressed fracture depends on the extent of the depression and the site of the injury. Operation is not indicated if the fracture is small and no spicules which might pierce the dura mater are evident, provided that the affected site is not over an important cerebral area. Surgical interference is required if the fracture lies over the speech or motor areas, or if the X-ray suggests that spicules may have penetrated the dura mater, when a scar may form adhesions between the brain and membranes, with risk of subsequent epilepsy (p. 967).

**Operation.**—Merely to trephine and elevate the depressed bone is quite inadequate, as a proper examination of the brain and membranes is not possible. An osteoplastic flap, which includes the fracture, is raised (fig. 1275), and the depressed bone is either moulded into position or removed with suitable forceps. Attention is then directed to the dura, penetrating spicules are removed, and the membrane is then opened. Pulped brain is carefully removed by gentle suction at the site of penetration. Adhesions are divided. Hæmostasis is secured and the dura is carefully sutured, if necessary a fascial graft being inserted to prevent the ingrowth of fibrous tissue. The flap is then replaced and the wound closed.

Pond-shaped depressions occur in infants, as a result of prolonged pressure of the head against the promontory during birth, or of direct injury during the first few months of life. Spontaneous elevation usually occurs within a few months, but if signs of compression are evident, or if no spontaneous elevation follows after a few months, the depression must be elevated.

The simplest method of performing this is by means of a guarded gimlet, i.e. silk is wound around the gimlet to within  $\frac{1}{4}$  inch (6 mm.) of its point. A small incision is made over the centre of the depression, and the skull is perforated by the gimlet. An aneurysm needle is introduced through the aperture, and by this means traction is applied to the depressed bone. The elastic skull of the infant readily yields and springs back to its normal position.



**Compound fractures of the vault** vary greatly in severity, from severe crushes, with the escape of cerebral substance, to relatively insignificant compound fissured fractures. High-speed motor-cycle accidents and other road disasters produce the worst examples of severe frontal crushes, many of which are rapidly fatal and never come to treatment, or if treated leave severe residual disability, such as hemiplegia or mental deterioration from loss of cerebral substance. The incidence of these injuries has been considerably reduced by the general acceptance of crash helmets.

When the velocity of impact is low, large compound depressions can occur with less diffuse cerebral injury, particularly when produced by laterally directed blows—in which the midline septum of the falx will limit the associated brain displacement.

The fact that compound fractures are, at times, associated with little diffuse cerebral injury was, in the past, attributed to the belief that the fracture produced some degree of cerebral decompression. It is, in fact, the mechanism which accounts for the less serious injury. Rarely, if the skull is fixed at the moment of impact, as when the head is trapped against the edge of a kerb, the skull may be crushed, with injury to cranial nerves, without any loss of consciousness at all, because the brain is not suddenly displaced.

**Clinical Features.**—The clinical features are obvious, particularly when there is escape of brain substance. An irregular lacerated wound of the scalp is associated with a boggy subgaleal swelling produced by blood escaping from the fracture line, which is partly exposed in the depth of the wound. A compound fissured fracture has been mistaken for a normal suture line. A moment's reflection should be sufficient to decide whether the suspected lesion corresponds anatomically to a cranial suture, and furthermore a suture line is irregular and free from oozing blood. The majority of compound fissured fractures are visible at the bottom of the wound, but all scalp wounds should be explored adequately in order to exclude or discover a fracture. In compound depressed fractures the fracture lines extend far laterally beyond the limits of the surface wound (fig. 1276), and this must be allowed for in planning the requisite exploration.

**Treatment** is a matter of urgency, as infection rapidly becomes established.

*Operation* should be undertaken as soon as possible, unless the patient's condition is so precarious that delay is advisable, in which case antibiotics should be given in full doses.

*Pre-operative X-ray* is essential to determine the extent of the fracture.

*Adequate head shaving*; clearing the scalp beyond the margins of the fracture is essential.

Unconscious patients may be operated upon under local anæsthesia.

In frontal fractures heavy bleeding from the nose must be cleared by suction.

The field of operation is infiltrated with 1 : 100,000 of adrenalin in saline to diminish scalp bleeding. Small compound fissured fractures may be dealt with by extending the primary scalp wound after excision of its edges. Extensive depressions are best dealt with by forming a horseshoe scalp flap to expose the fracture site after previous



FIG. 1276.—Relative extent of the fractured area (shown by dotted line) in comparison with the surface wound.



excision and suture of the scalp wound (fig. 1277). A burr hole is formed beside the fracture to permit unlocking of the fractured particles (fig. 1278). Bone which has been completely detached or grossly contaminated by dirt is removed. The dura is inspected. If intact, it is not opened. If penetrated, indriven material and damaged

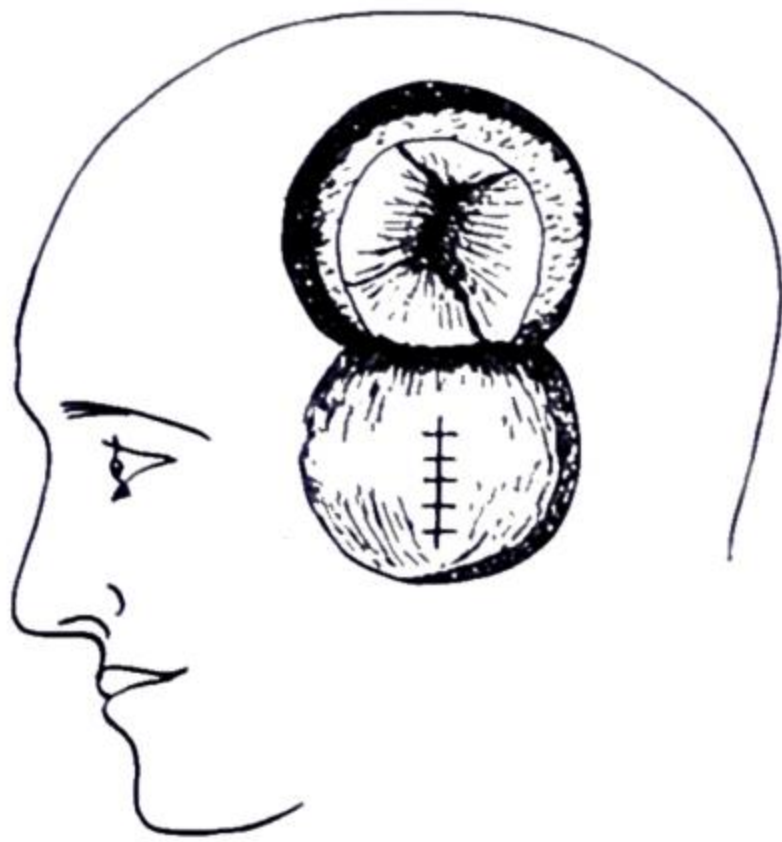


FIG. 1277.—Exposure of depressed compound fracture. The original scalp wound has been sutured and a horse-shoe scalp flap reflected to expose the full extent of the fracture. (G. B. Northcroft.)



FIG. 1278.—Formation of burr hole beside a fractured area to allow of unlocking the bone fragment.

brain tissue is removed by suction and the dura is then sutured. Clean portions of bone may now be moulded into place, the wound being then sutured and antibiotic treatment commenced. Careful judgment is required concerning the discarding of bone. If a tangential injury has lifted up large areas of the vault, the frontal plates, or roof of the orbit, far beyond any *exposed wound*, it is only necessary to remove contaminated areas in the wound. Removal of the entire detached area of bone would produce enormous unsightly deformities which could not be adequately restored.

**Compound fractures of the frontal sinus** are liable to become infected from the nose; hence the sinus must be obliterated after excision of depressed bone and

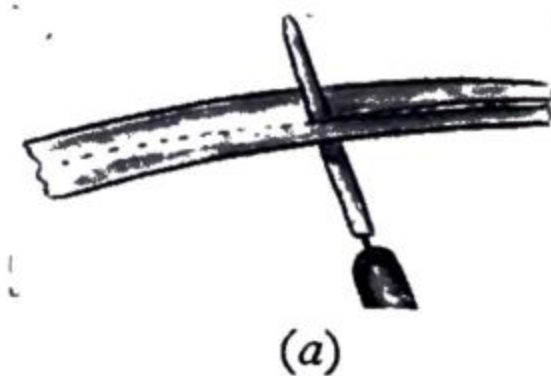
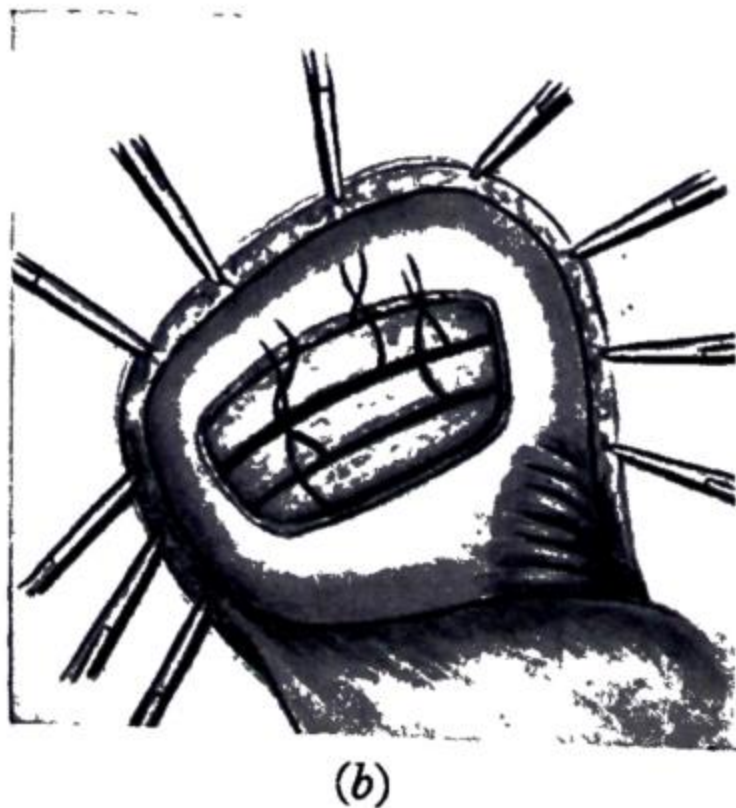


FIG. 1279.—Skull reconstruction by rib graft: (a) A segment of rib is split longitudinally with a finger saw to produce two parts. (b) Ribs are inserted into the defect which has been squared out, and secured in place with stitches which pass to the epicranium.

the mucous lining of the sinus. A pressure pad is applied over the scalp to cause the scalp to sink into the depression resulting from excision of the sinus and close the cavity by adherence to the dura. Three months later the sinus area is exposed by turning a scalp flap forward, the scalp is freed from the dura, and the deformity is restored by skull reconstruction.

**Skull Reconstruction.**—Areas of skull defect are restored at intervals of three to six months after injury, by the insertion of moulded tantalum plates or split-rib grafts (fig. 1279). Acrylic resin plastic plates may be accurately constructed from a plaster mould of the deformity and adjacent skull in order to reconstruct accurately gross defects of the brow visible in front of the hair line. Concealed horseshoe or transverse incisions within the hair line are used for these purposes.



**Head Wounds due to Missiles.**—The outcome depends on the explosive impact of the missile in the cranium, which is the commonest cause of fatality, and the relation of the wound track to the great vessels and the ventricles. Through-and-through tracks, from side to side or front to back, may be survived. Improvised operations must not be performed. Survivable injuries can be transported to a suitable hospital. Projection of the swollen brain through the dura at the site of entry or exit forms a hernia cerebri, which seals off the subarachnoid space during transport. A pressure dressing is applied over this.

**Operative treatment** consists of the excision of the surface wound and suction, cleansing, and removal of foreign material from the track. The dura is closed by suture or grafting at entry and exit points. Intrathecal penicillin treatment will then prevent serious infection unless an infected track crosses the ventricles or median fissures (see also p. 970).

**Penetrating wounds produced by sticks** are always to be regarded very seriously. Although scissors or pokers may enter the roof of the orbit when a child falls and thereafter be successfully withdrawn, a stick which goes in through the orbital roof or backwards behind the orbit into the temporal lobe cannot be withdrawn intact; portions which are left behind may, from previous contact with the ground, be infected with gas gangrene or tetanus, with resulting fatal infection.

**Fractures of the base of the skull** are usually produced by compression of the sphere and extension of fissures radiating from the vault. The complex fracture lines thus produced are accounted for by deflection of the fissure from the buttresses of the petrous bones, the basi sphenoid, and the sphenoid wings, which can only be crossed respectively at the weak points formed by the cavities of the middle ear, the sphenoidal air sinus, and the sphenoidal fissure. Elsewhere the fracture lines tend to wander into the foraminae for the exit of cranial nerves. The fractures become compound at the middle ear, accessory air sinuses, and the cribriform plates, but the evil reputation of fractures of the base is derived from the severe brain injury accompanying the fracture rather than from the risk of sepsis, which has been greatly reduced by modern methods of treatment.

**Fractures of the Base by Local Indentation.**—A ring fracture sometimes forms around the foramen magnum from the upward impact of the spinal column in severe fatal head-on collisions. Violence transmitted from the maxilla to the internal angular process may rotate the cribriform plate upwards on to its side, with laceration of the anterior fossa dura, a common cause of cerebrospinal rhinorrhœa in association with injuries of the middle third of the face. Rarely, the roof of the orbit may be penetrated by direct violence from sticks, umbrella ferrules, scissors, or small objects.

**Fractures of the Base produced by Tangential Injury.**—The mastoid process is sometimes driven off by an oblique blow from the edge of a kerb; this is a very painful but relatively harmless lesion.

**Clinical Features.**—The essential features are :

(1) The escape of cranial contents, i.e. blood, or cerebrospinal fluid, or very rarely, brain in substance.

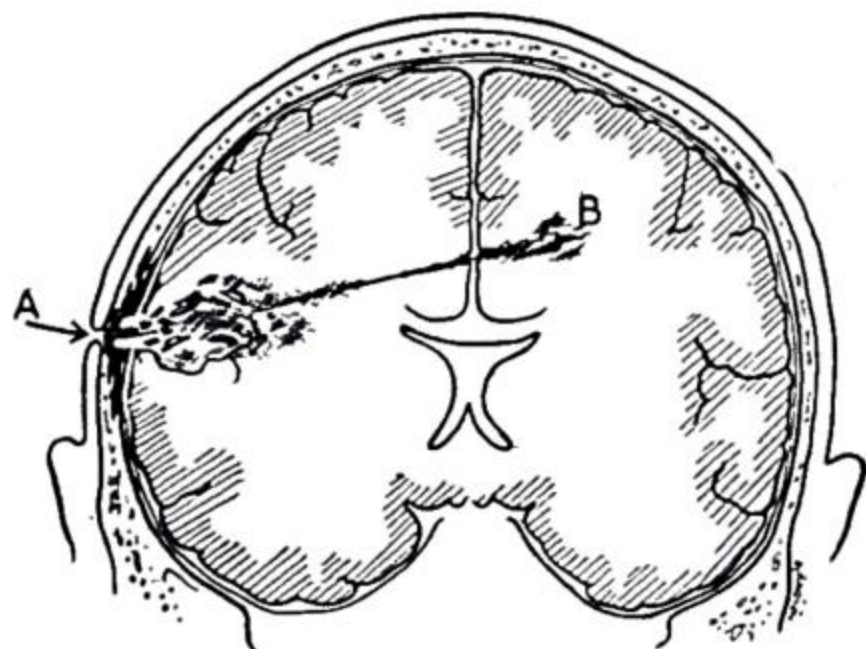


FIG. 1280. — Transverse penetrating wound, entry at (A) showing: (1) Protrusion of brain through the dura at entry site forming hernia cerebri. (2) Pulped brain and bone close to entry. (3) A metal fragment at (B) has crossed the open superior fissure.



(2) Injury to cranial nerves. All the cranial nerves are liable to be involved. The twelfth is only rarely affected, as the condyloid foramen is protected by a stout ridge of bone, and the line of fracture is usually diverted into the foramen magnum.

#### ANTERIOR FOSSA

(1) **Escape of Cranial Contents.**—Epistaxis occurs if the cribriform plate is involved. Should the fracture extend into the orbit, an effusion of blood follows. This is distinguished from a 'black eye' by the following features:

- (a) The skin round the orbit is not damaged.
- (b) The orbital effusion occurs some hours after the injury (fig. 1281).



FIG. 1281.—Fracture of the anterior fossa. Effusion of blood appeared twelve hours after injury. No bruising of skin.



FIG. 1282.—Intracranial ærocœle collecting in the frontal lobe from a fracture involving the posterior wall of the frontal sinus.

(c) The eye is sometimes pushed forwards, as the extravasation occurs into the tissues at the back of the orbit.

(d) This extravasation impedes the action of ocular muscles, and movements of the eyeball are limited.

(e) Should subconjunctival hæmorrhage follow, the patch is wedge-shaped with the apex in front, and the posterior limit cannot be seen.

Cerebrospinal fluid trickles through the cribriform plate, often in surprising quantities, a condition referred to as 'traumatic rhinorrhœa.'

**Traumatic rhinorrhœa** may persist for several weeks. Air may enter the cranial cavity when the patient blows his nose. In view of the ever-present risk of meningitis, operative closure is indicated. By means of an intradural approach, the rent in the dura is sealed with a patch of fascia lata and the wound is closed.

**Injury to Nerves.**—The olfactory nerve is frequently torn, but unless its fellow is also damaged, the partial anosmia is likely to pass unrecognised. The optic nerve usually escapes, but if it is contused, any loss of vision will be permanent. The third, fourth, first division of the fifth, and sixth nerves may be involved at the sphenoidal fissure. Third-nerve palsy produces a dilated pupil in a conscious patient.

#### MIDDLE FOSSA

**Escape of Cranial Contents.**—Epistaxis occurs if the fracture involves the nasal sinuses. The mucoperiosteum is closely adherent to the bone, and therefore fracture of the accessory air cells is always associated with laceration of the mucoperiosteum and is consequently compound.

Escape of cerebrospinal fluid and blood from the ear is common. Blood from torn tympanic membrane will clot, but when blood continues to drip for days, it is because it will not clot, owing to mixture with cerebrospinal fluid.

Serious arterial hæmorrhage from the ear may follow injury to the posterior branch of the middle meningeal artery (see p. 956).



**Injury to Nerves.**—The facial nerve is commonly injured at the time of the accident. Usually the nerve is torn and paralysis is permanent. Occasionally paralysis occurs at an interval of a few days after injury from compression by extraneural hæmorrhage. Recovery is to be anticipated if the facial muscles are supported and treated by electrical means. If paralysis develops some weeks after the injury, it is produced by pressure from fibrous tissue or callus and the paralysis will be permanent. The eighth nerve is sometimes injured, with resulting deafness. The sixth nerve is occasionally implicated, with the resulting internal strabismus.

#### POSTERIOR FOSSA

**Escape of Cranial Contents.**—Extravasation of blood in the suboccipital region produces a boggy swelling at the nape of the neck or discoloration posterior to the mastoid process.

**Injuries to Nerves.**—The ninth, tenth, and eleventh nerves are occasionally damaged at the jugular foramen, but the hypoglossal nerve usually escapes, as it is protected by a bony buttress.

**Treatment** is that of the associated brain injury with administration of antibiotics. The patient should be propped up in bed to diminish the escape of cerebrospinal fluid from the nose or ear. If the discharge persists undiminished for ten days, fascial repair of the dural gap is required. The skull should be X-rayed to see if an intracranial ærocœle has developed in association with cerebrospinal rhinorrhœa. Air collections may be observed either in the substance of the frontal lobe or in the subarachnoid space, occasionally filling the ventricle. Sepsis does not occur at first because the upper respiratory air cells are sterile, but later, septic granulation tissue forms outside the dura, and the moment the discharge of cerebrospinal fluid stops, meningitis arises from this source; hence an early repair is necessary.

#### LATE EFFECTS OF BRAIN INJURY

After a severe head injury, sequelæ such as headache, irritability, and lack of concentration are common and sometimes persist. One effect is increased susceptibility to alcohol. These changes are attributable to damage to nerve cells and axons. Severe injury may produce gross mental impairment, necessitating seclusion in a mental hospital, or even precipitate the onset of schizophrenia.

**Post-traumatic epilepsy** is of two types.

True post-traumatic epilepsy is produced by the formation of contracting fibrous scar tissue in the brain and between the brain and the membranes (p. 961). Scar formation takes time to develop and the fits occur within six months to twenty-one

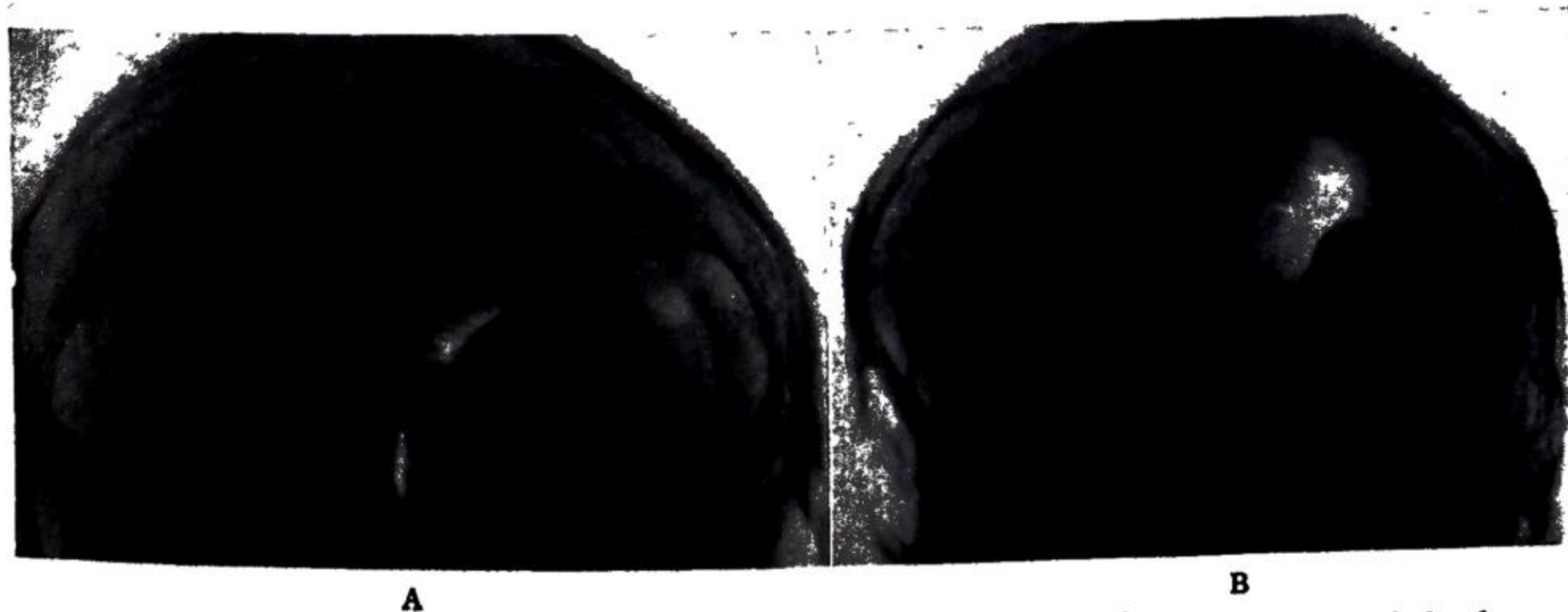


FIG. 1283.—(A) Normal air encephalogram. (B) Traction on and expansion of the lateral ventricles following injury. This lesion is too diffuse for excision.



years from the date of an injury which has been severe enough to lead to penetration of the dura mater or laceration of blood-vessels on the brain surface, thus allowing fibrous tissue to mingle with the normal gliosis of brain healing and produce a contracting scar. When fits occur within days or weeks of a minor injury, they are not produced by scar formation, but by the firing off of a latent idiopathic epilepsy which has commenced for the first time following injury. This may be distinguished by finding gross bilateral abnormalities on electro-encephalography. In true post-traumatic epilepsy, the electroencephalogram is either normal or shows a focal lesion.

Clinically, post-traumatic epilepsy may be Jacksonian in type. Attacks of uncontrollable twitching occur commonly in the hand or thumb, spreading progressively to other muscle groups and the arm and shoulder and face before consciousness is lost and the convulsion becomes generalised. Alternatively, focal lesions in the frontal lobes cause generalised convulsions exactly like idiopathic epilepsy. In other areas a typical aura precedes a generalised fit (see p. 978).

**Treatment** consists of investigation by air encephalography to see whether the scar is focal or too diffuse to be excised. If a focal scar is present, the ventricle is



FIG. 1284.—Operation sketch showing area of scar excised and insertion of nylon membrane.

drawn out to a fine point or spike at the site of contraction. Surgical treatment consists of the excision of the scar in the membranes of the brain down to the wall of the ventricle, and the repair of the dura by fascial grafting or insertion of nylon membrane to prevent more fibrous tissue growing in from the surface (fig. 1284).

#### INFLAMMATORY CONDITIONS

**Acute infective meningitis** may result from implantation of infection from the surface in infected wounds and compound fractures, from local extension from adjacent disease of the ear, or sinuses, or from the various types of intracranial abscess, or be blood borne from distant foci of infection, such as staphylococcal infection in acute osteomyelitis or pneumococcal infection following pneumonia. The condition is

ushered in by headache and vomiting. Severe constitutional symptoms follow, and if meninges over the convexity are affected, convulsions, delirium, and photophobia are in evidence. Should the base of the brain be chiefly involved, head retraction, papilloedema, and implication of cranial nerves are the main features. Lumbar puncture is performed in order to clinch the diagnosis and to identify the causative organism.

**Treatment** consists in dealing with any causative lesion, e.g. an infected middle ear. Lumbar puncture and intrathecal penicillin administered daily (10,000 units) are valuable. Larger doses or more frequent injections are apt to cause complications, such as fits or retention of urine. Chemotherapy and antibiotics are administered according to the causative organism. The cerebrospinal fluid is examined regularly for cells and organisms. Intrathecal and systemic treatment is continued for at least ten days after the infection has subsided to sterilise outlying loculi and prevent relapses.

#### INTRACRANIAL ABSCESS

**Intracranial abscess** is of three types. (1) Extradural. (2) Subdural. (3) Intracerebral.

The first two varieties require immediate treatment by drainage to prevent



infection of the subarachnoid space. Intracerebral abscess must be allowed to localise before treatment is commenced. Too hasty intervention will spread infection in the brain and lead to ventricular infection.

**Extradural abscess** is produced by osteomyelitis of the skull (see p. 946 for causes) and is usually secondary to spread from infection from the middle ear or frontal sinus. In the case of the middle ear, infection most commonly reaches the extradural space by spreading through the tegmen tympani. Following frontal sinusitis, a large collection may form behind the frontal bone, infection having passed through the posterior wall of the sinus. Spread in the diploic veins may carry the infection to bone areas an inch or more above the ear or frontal sinus with local sequestration.

*Clinical features* are those of osteomyelitis. Acute localised pain, acute localised tenderness, and swelling occur as in the long bones, but in the skull these are represented by *acute localised headache, tenderness on local percussion of the skull*, and localised pitting œdema of the scalp over the affected area described by Percival Pott and known as Pott's puffy tumour. There is a variable constitutional disturbance. These symptoms and signs alone demand urgent exploration. Only rarely, if the abscess is large, will there be evidence of pressure or focal neurological signs.

**Treatment** consists of drainage, the approach depending on the cause of the abscess. Many cases are dealt with by removal of the posterior wall of the frontal sinus or tegmen tympani during the course of an operation for frontal sinusitis or mastoiditis. Alternatively, a burr-hole opening is made at the site of the œdema. The dura is pressed slightly inwards to allow pus to escape. Twenty or 30 ml. may be removed by suction. Penicillin powder is inserted and the wound drained for twenty-four hours. Antibiotic treatment serves to sterilise the bone infection.

**Subdural Abscess.**—This condition, at one time 100 per cent. fatal, can now be treated with a 30 per cent. mortality. It is produced by septic thrombophlebitis of the superior longitudinal sinus, spreading usually from infections of the frontal sinus or accessory air cells. Infection extends from the superior sinus to the superior cerebral veins, and thus infects the subdural space. The abscess extends in this space over the cerebral hemispheres, often bilaterally, and must be treated before it spreads widely over the inner or under aspects of the hemispheres. Successful treatment therefore depends on the recognition of early symptoms.

**Clinical features** are distinguished by the marked evidence of *toxæmia* and the early development of *intracranial pressure, epilepsy, and paralysis within a matter of days*. Following a heavy 'cold' or 'influenza,' the patient runs a high pyæmic temperature, becoming rapidly sallow and dehydrated with wrinkled skin. Blockage of the superior compartment of the superior sinus into which cerebrospinal fluid is absorbed from the lateral lacunæ produces pressure, headache, and papilloedema. Blockage of the lower compartment receiving the superior cerebral veins produces cortical thrombosis, causing epilepsy and paralysis of sudden onset. The condition differs from cerebral abscess in the rapidity of development of all these features.

*Percival Pott, 1713-1788. Surgeon to St. Bartholomew's Hospital, London.*



**Treatment.**—If suspected, the condition must be treated by the formation of bilateral frontal burr holes just within the hair line. On opening the dura, thin pus is found in the subdural space and is allowed to escape. A fine catheter is now introduced to instil antibiotics into the space. Systemic treatment is given in full doses.

**Intracerebral Abscess.**—Success in the treatment of cerebral abscess is determined far more by the pathological type of the abscess than by the method of treatment adopted. Some abscesses rapidly spread to infect the ventricle; others localise readily, becoming walled off, and pass into the favourable subacute or chronic stages.

Intracerebral abscesses are produced by (1) implantation of infection; (2) by blood metastasis; and (3) by local extension of adjacent infection.

**Implantation abscesses** result from penetrating wounds and have, as a rule, a low mortality, except in the case of wounds from sticks (see p. 965). The infecting organisms are normally derived from the skin surface and are of low virulence. The entry track is closed at the dural level by protrusion of a hernia cerebri, which seals the subarachnoid space and provides a pathway for the extension of the infection to the surface away from the ventricles (fig. 1285).

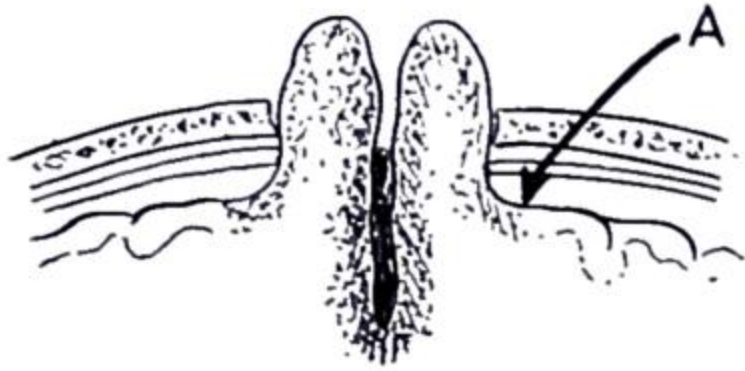


FIG. 1285. — Protrusion of a hernia cerebri through a penetration of the dura, closing the subarachnoid space at A.

an intracranial space-occupying lesion at the site of a wound years after injury. Peter de Marchettis, a monk in Padua, treated such cases successfully by the insertion of lampwick drains in 1665.

**Treatment.**—In the acute stage the track is explored from the surface, bone and foreign material are removed, and pus is evacuated by repeated aspiration or tube drainage. Antibiotic treatment is given freely. Chronic abscesses may be excised intact.

**Metastatic abscess** is a complication of lung abscess or bronchiectasis or pyæmic states and was at one time uniformly fatal. Infected clot from the lung passes to the left heart, thence via the carotid, usually into the middle cerebral circulation, which forms a direct continuation of the carotid syphon; hence the infection is implanted deep in the white matter of the parietal or temporal lobe close to the ventricle. The blood supply of the brain is poorest in white matter, but rich in the cortex; tissue reaction is therefore feeble, and the septic encephalitis spreads rapidly and produces fatal septic ventriculitis within a matter of days.

**Clinical Features.**—The patient with a causative disease is seized with sudden headache, collapse, and pyrexia, and rapidly develops well-marked localising signs. Hemiplegia, hemi-anæsthesia, or hemi-anopia indicate widespread destruction of the white matter.

**Treatment.**—Under modern conditions antibiotic treatment may cause the infection to localise. After a few days an exploratory burr hole and cerebral puncture are made to see if pus formation has started. If so, pus is aspirated and antibiotics are instilled. Further treatment is continued, as in the case of local extension abscesses. The average mortality is now approximately 30 per cent.

**Local extension abscesses** are produced by septic thrombosis spreading from foci of infection in the ear or frontal sinuses. Usually three out of five abscesses arising from the ear are situated in the corresponding temporal lobe; the remainder are in the cerebellum. Frontal lobe abscesses are usually on the same side as the infected frontal sinus.

Very rarely, aberrant abscesses may occur, for example, contralateral frontal



abscesses produced by infection crossing the superior sinus, or frontal or parietal abscesses from ear disease. The site of implantation may be (a) subpial, or (b) subcortical.

**Subpial Abscess.**—The infection is conveyed as far as the cortex only. A minute abscess forms, which is covered on its surface only by the pia mater. This invariably ruptures into the subarachnoid space, producing meningitis without focal signs. It is probable that most causes of meningitis complicating ear or sinus disease are produced in this way; hence the need for prolonged antibiotic and intrathecal therapy to sterilise the subpial abscess and prevent relapse.

**Subcortical Abscess.**—The infection is conveyed across the unobliterated subarachnoid space to lodge in the white matter beneath the cortex. Three stages may be recognised—acute, subacute, and chronic.

In the acute stage there is septic encephalitis without pus formation. This may extend to produce ventriculitis or localise with pus formation.

The subacute stage commences at three weeks by the formation of a glial wall, the thickness of which is determined by the local blood supply and is therefore thickest towards the cortex and thinnest towards the ventricle. A unilocular or multilocular cavity is produced, containing active organisms. The wall becomes thick within six weeks.

The wall becomes increasingly thick, infecting organisms die off, staphylococci living longest. The pus gradually becomes sterile and extremely thick, at which stage the abscess is inert.

**Clinical Features.**—*In the diagnosis of intracerebral abscess, general features are far more important than focal signs, which are few in number and of late onset.*

*In the acute stage, persistent pyrexia and headache are the most important features and should lead to the suspicion of an abscess when seen in association with ear or sinus disease. The temperature and pulse-rate are raised at the commencement, but as the abscess enlarges, so intracranial pressure rises also, with slowing of the pulse. Leucocytosis is present, but its significance must be discounted if some other active condition is also present. Headache, irritability, drowsiness, and vomiting are commonly in evidence. These symptoms demand investigation by lumbar puncture, which will show an increase in cells and a protein figure raised from the normal 40 mg. to approximately 80 mg. per cent.*

Acute fulminating syndromes are rarely seen under antibiotic treatment. Many cases are undoubtedly sterilised and the abscess aborted at the acute stage of septic encephalitis without pus formation, as the result of the administration of antibiotics in the treatment of the primary focus of infection from which an abscess has extended. Focal signs are often absent in the acute stage except where there is extensive cortical thrombosis.

*In the subacute stage the temperature and pulse often fall to a subnormal level and physical signs appear—these are few in number.*

*In frontal lobe abscess—a contralateral facial weakness only.*

*In temporal lobe abscess—a contralateral hemiparesis with absent abdominal reflexes and an extensor plantar response.*

*In cerebellar abscess—nystagmus, hypotonus, and inco-ordination on the side of the lesion.*

Lumbar puncture shows a reduction in number of cells but increase in the protein figure to 120 mg. per cent.

*In the chronic stage intermittent headaches and ill health persist. The patient becomes pale and cachectic. There may be no physical signs. The*



cerebrospinal fluid may return to normal, but the abscess continues to enlarge and gradually uses up available adaptation within the head and

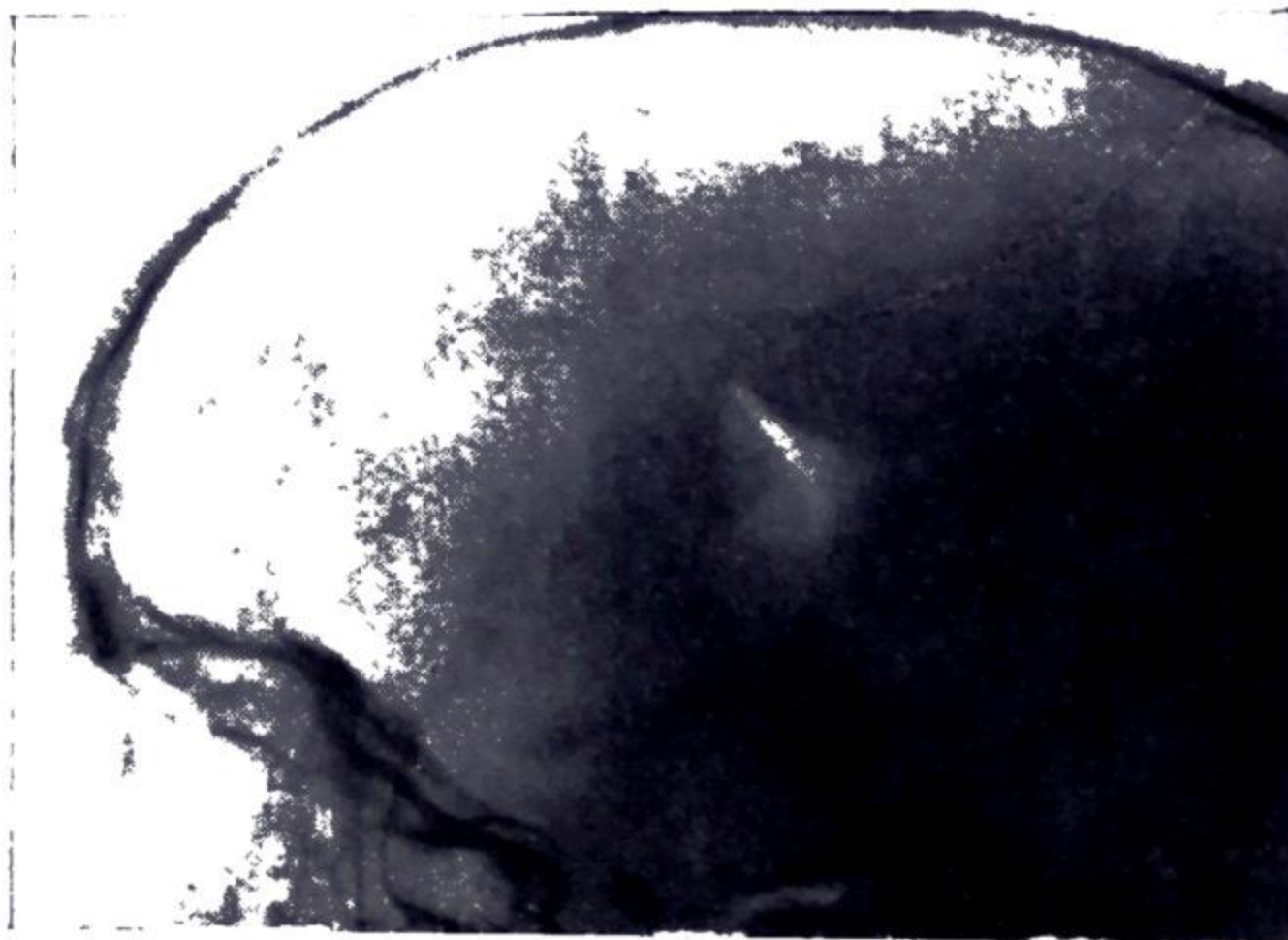


FIG. 1286.—Ventriculography. Showing crescentic deformity of the frontal horn produced by a 30-ml. abscess in a child whose only symptoms were headache, cachexia, and wasting following a compound frontal fracture. The cerebrospinal fluid was normal.

then suddenly produces urgent pressure symptoms when no more space is available. The patient may then develop severe headaches and exhibit evidence of a threatened mid-brain cone with a dilated pupil, within a period of days, several years after the initial infection.

Often the symptoms and physical signs of a chronic abscess develop immediately or within a day after operation has been performed on the

ear or frontal sinus for the relief of a chronic headache—in these cases operation reveals an abscess with thick walls and much pus. Clearly a subacute or chronic abscess was present at the time that the operation was performed, and was itself the cause of the head pain for which the operation had been conducted. The local disturbance of the operation causes a reaction in the abscess cavity, and stimulates the early post-operative onset of physical signs. It is important to realise that the presence of well-marked localising signs developing within a period of days usually indicates re-activation of a chronic abscess requiring immediate treatment.



FIG. 1287.—Townes' view showing thorotrast in a collapsed cerebellar abscess which is at the *apex* of the petrous.

In every case of suspected cerebral abscess it is important to examine all possible sources of infection. In many cases the probable cause is evident, but discharge from an ear may cease when intracranial complications develop, for hindrance to discharge by inspissated pus predisposes to the extension of infection.



**Treatment.**—Drainage, formerly the recognised method of treatment of a cerebral abscess, has, in the majority of cases, been replaced by repeated aspiration of the abscess cavity and occasional excision. For example, an abscess which complicates otitis media is no longer treated by opening the middle ear and draining the cavity by that route. Neurosurgeons now regard the primary focus as of secondary importance, and means are taken to encourage the infection to localise. Localisation and subsequent enucleation diminish the risks of cerebral œdema and meningitis (Northfield). Drainage is only indicated if the abscess is superficial, as in the case of one which follows a penetrated wound.

In the early stages of cerebral inflammation antibiotics and chemotherapy are employed, and the infection may thus be overcome. Ventriculography may be required

to determine whether an abscess is present or not after a course of antibiotics has been given. When an abscess has localised, or if signs are urgent, a diagnostic burr hole is made. Burr-hole openings are formed: (1) Immediately within the hair line, tapping forwards and inwards for a *frontal abscess*. (2) Immediately above the downturned ear, tapping straight inwards for a *temporosphenoidal abscess*. (2) Over the occipital plate, tapping forwards and inwards for a *cerebellar abscess*

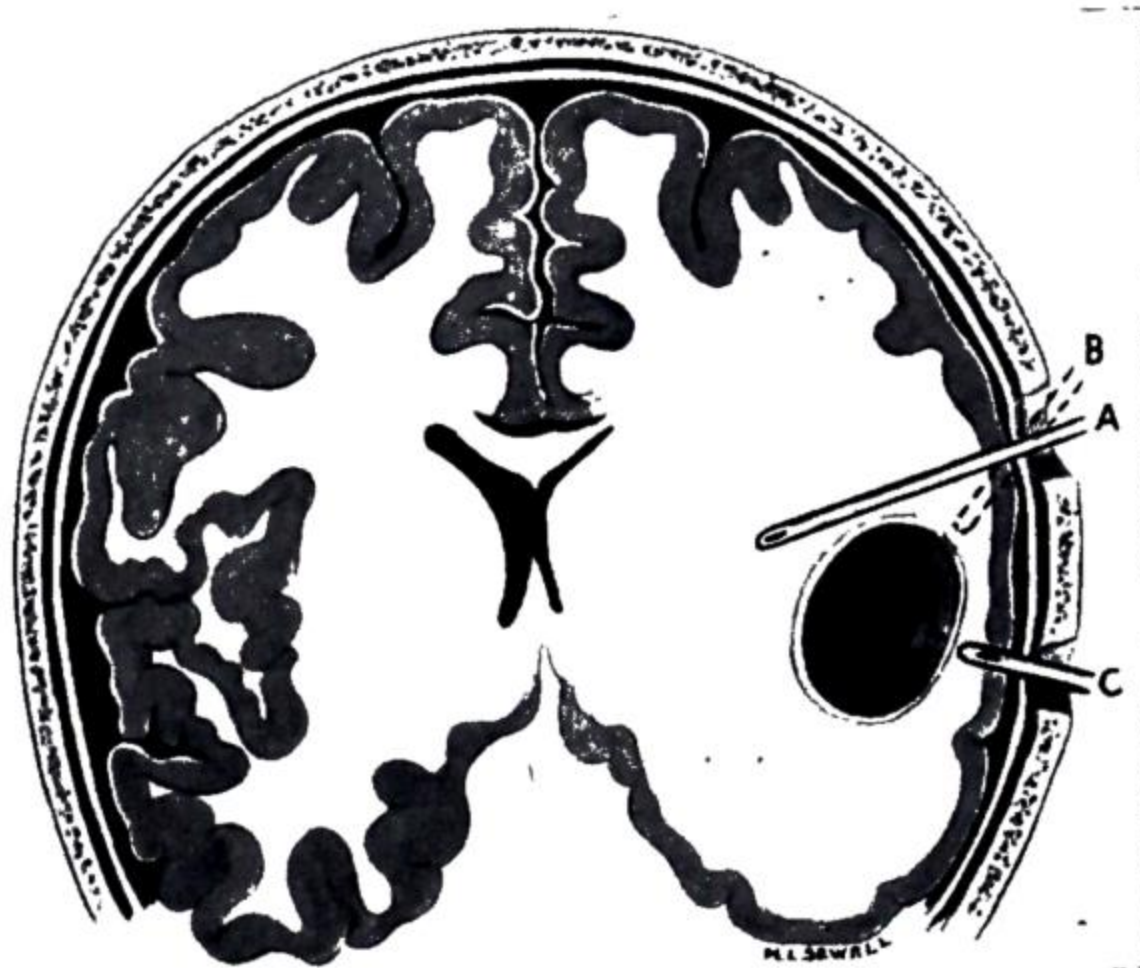


FIG. 1288.—Method of localisation of metastatic abscess by burr-hole exploration. Needle at A encounters resistance at B. Puncture is performed by a second burr hole over the site of the abscess C.

(fig. 1287). The dura is opened and a blunt ventricular needle is inserted and the resistance of an abscess will be felt. Then the canula is pushed through the wall into the cavity and pus will either well up or have to be aspirated slowly. Thirty ml. is a common volume to obtain. Two hundred thousand units of penicillin and 1 ml. of thorotrast is then inserted into the cavity. Pus is examined, and if necessary a further puncture is performed next day if other antibiotic treatment is required. For example, a single injection of streptomycin may completely sterilise the at one time fatal *Esch. coli* abscesses. The thorotrast is taken up into the wall of the abscess and demarcates its outline. Repeated X-rays are taken at intervals and progress is carefully observed. If evidence of a multilocular cavity is seen on X-ray, or if the cavity is increasing in size or signs are increasing, further aspirations are performed. After several taps, the cavity begins to diminish steadily in size and finally shrinks to the size of a pea, and nothing further is required (fig. 1289).

Excision of the abscess is needed only for rigid abscesses which will not



collapse or for cerebellar abscesses which respond less satisfactorily to tapping and in which urgent symptoms may develop. If a cerebellar abscess does not respond to two aspirations, excision is indicated at an early stage.

Other abscesses should be enucleated within the third month, as the wall is by then sufficiently tough to separate from surrounding brain tissue. Too

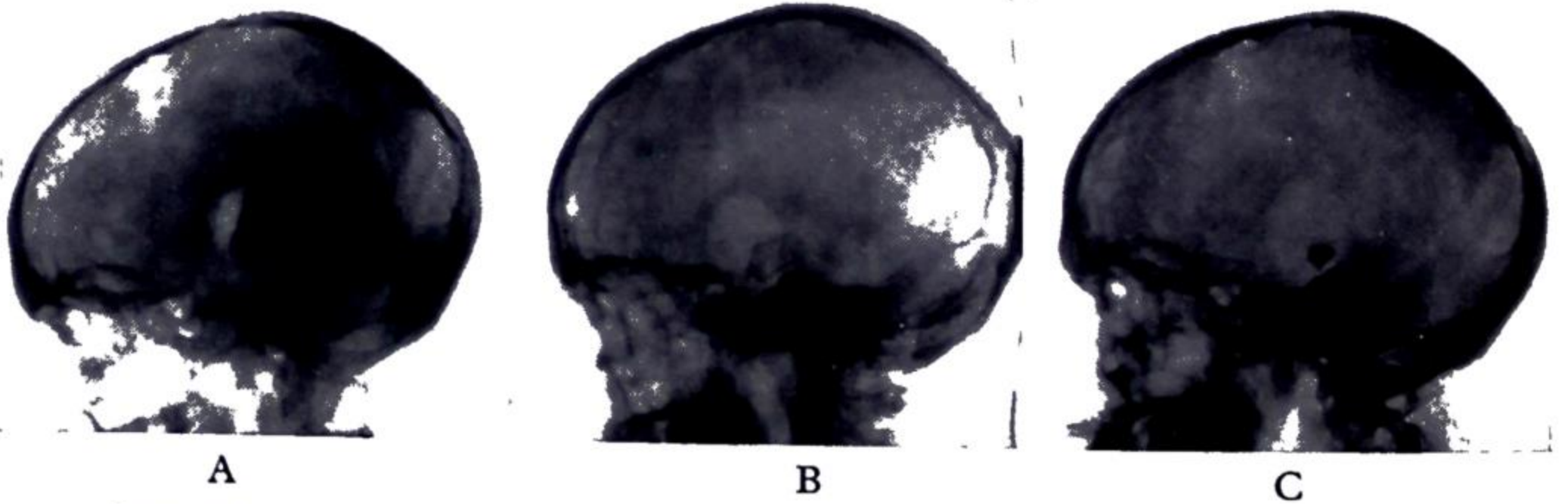


FIG. 1289.—Progressive reduction in size of an abscess by repeated tapping.

long a delay results in excessive scar around the cavity, also formation of loculi is encouraged. Enucleation of a cerebellar abscess demands special care, as cranial nerves may be adherent to its wall.

### INTRACRANIAL TUMOURS

Tumours arise in connection with the meninges, nerve sheath, or cerebral substance (gliomas). Tumours of the pituitary gland, vascular malformations, gummas, tuberculomas, blood-clots, and chronic abscess contribute to the total. Secondary carcinoma is far more common than primary intracranial tumour. Secondary deposits are most common from the lung, but may originate from any organ in the body and from the naso-pharynx. When the majority of these have been excluded, an average surgical series will be as follows :

Meningioma, 18 per cent.

Neurinoma, 8 per cent.

Glioma, 43 per cent.

Pituitary adenoma, 12 per cent.

Craniopharyngioma, 5 per cent.

Metastatic carcinoma, 6 per cent. (not previously excluded on clinical grounds).

Blood-vessel tumour, 2 per cent.

Plus granulomas and unclassified and rare tumours.

**Meningiomas, 18 per cent.**, vary in structure and vascularity and include psammomas (calcified meningiomas, usually spinal), fibroblastomas, endotheliomas, and angioblastic meningioma. They are usually globular, but occasionally form a flat carpet work, meningioma en plaque, which spreads widely in the meninges. Arising from the arachnoid, the tumour gains secondary attachment to the dura, the arteries and veins of which



enlarge to provide a tumour circulation. Dilated emissaries between the bone and dura carry the tumour's blood to the veins of the diploe and scalp, and along these veins tumour cells invade the bone, causing bone destruction and reactive hyperostosis. These bone changes increase the difficulties of operation.

Meningiomas occur in the following situations :

(1) **Parasagittal**—arising from the lateral lacunæ and pressing down on to the upper aspect of the frontal parietal and occipital lobes.

(2) **Fronto-basal**—occurring on the cribriform plate, outer, middle, and inner third of the sphenoid wing, and tuberculum sellæ, pressing on the olfactory ocular motor and optic nerves as well as the brain.

(3) **Posterior fossa**—in the region of the cerebello-pontine angle and jugular foramen.

They may rarely arise from the falx or from the choroid plexus within the ventricle, or may develop from the depth of a sulcus expanding subcortically as intracerebral 'hæmangioblastoma.'



FIG. 1291.—Characteristic globular meningioma.

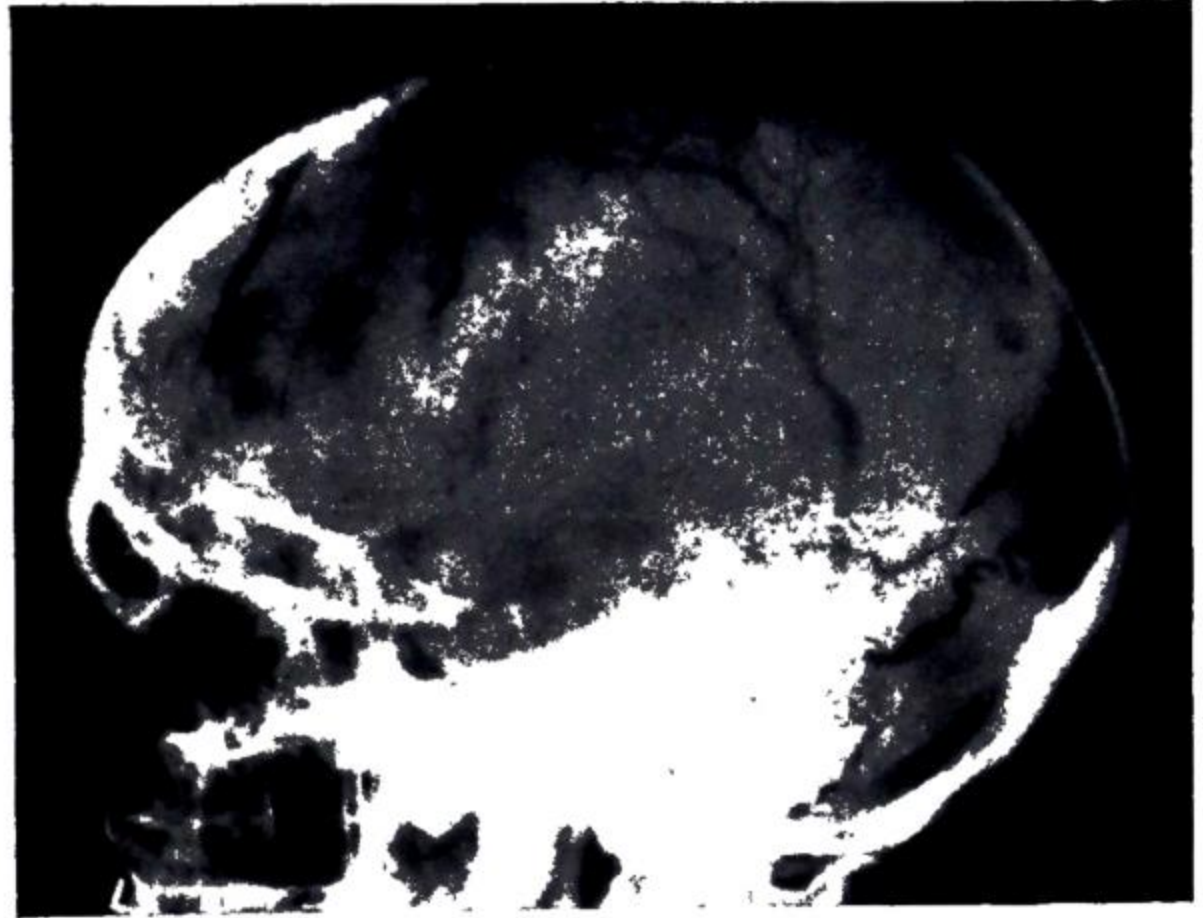


FIG. 1290.—Converging vascular markings overlying a meningioma.

**Neurinomas, 8 per cent.**, are usually found on the sheath of the auditory nerve (eighth nerve tumour), and may be multiple in association with von Recklinghausen's disease and sometimes occur in association with multiple cerebral or spinal meningioma.

**Gliomas, 43 per cent.**, have been classified by Bailey and Cushing according to the stage of development of the glial cells from which the tumour arises. The malignancy of the tumour varies in proportion to the degree of reversion to the primitive type of cell.

**Astrocytoma**, as the name suggests, is composed of star-shaped cells which resemble adult neuroglial tissue. It occurs in three forms: (1) The diffuse or infiltrating, which cannot be totally removed as its margins are unrecognisable and it often affects the brain stem. (2) The solid, which can be completely excised from suitable areas, if necessary by lobectomy. (3) The cystic, in which the nodule of tumour secretes fluid from its surface, forming a cystic cleft between itself and compressed normal brain. The tumour projects into the cyst cavity, and removal of this mural nodule produces a complete cure.

Astrocytomas occur in the frontal lobes of adults and in the cerebral hemispheres of young subjects.

**Oligodendro-glioma.**—An adult cell tumour consisting of cells with short stunted processes affects the deep portions of the hemispheres in adults. It is prone to undergo central cystic degeneration, and forms a ragged cyst the walls of which consist of tumour tissue. Treatment is usually palliative by evacuation of the cyst, and seldom results in a complete cure.

*Percival Bailey, Contemporary. Professor of Neurosurgery, Chicago.*  
*Harvey Cushing, 1869-1939. Professor of Surgery at Johns Hopkins and Harvard University.*



**Spongioblastoma polare** arises from primitive uni- or bi-polar spongioblasts and affects inaccessible regions, such as the optic chiasm, third ventricle, and hypothalamus in young subjects. It is irremovable, somewhat radio-sensitive, and rarely produces seedling metastases in the cerebrospinal fluid.

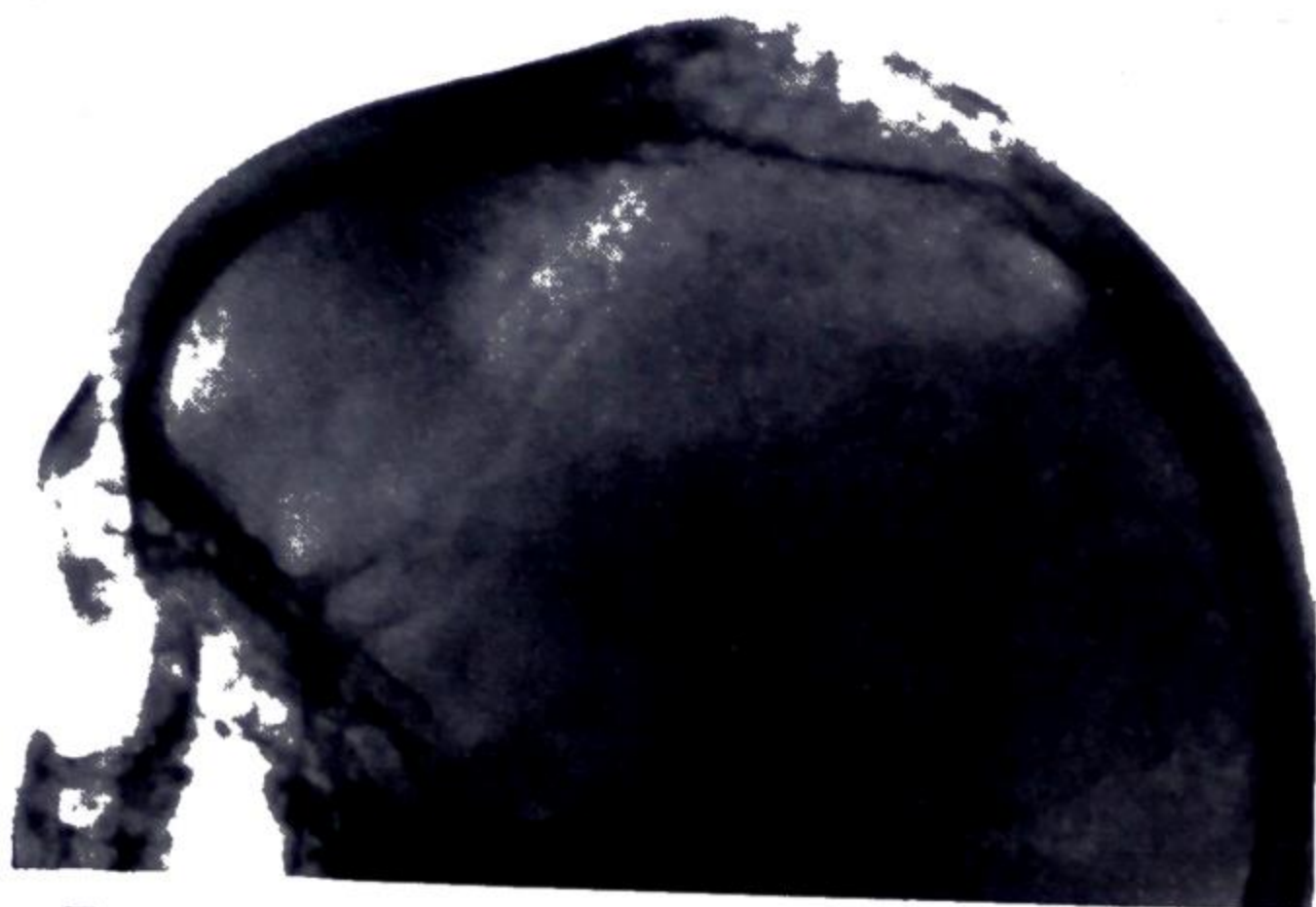


FIG. 1292.—A large meningioma hyperostosis extending from the right to left parietal bones. Successfully removed together with underlying tumour. This necessitated a nine-hour operation.

It arises as a result of malignant degeneration in a preceding astrocytoma. The structure is bizarre, containing every variety of glial cell together with giant cells; the tumour is radio-sensitive.

**Clinical features** depend upon the site of the tumour. All tumours have an initial period of silent growth which varies in length according to the position of the tumour and its speed of growth. If the tumour is not near any area which will produce symptoms or signs, it will take up space provided in the subarachnoid cisterns; it will flatten and displace the ventricle

#### DISEASE COURSE OF CEREBRAL TUMOUR

Stage 1	Stage 2	Stage 3	Stage 4
Initial period of silent growth.	Focal syndromes. Epilepsy.	Raised intracranial pressure.	Brain displacement. False localising signs. Cone formation.

and brain until it can gain no more room, and it will then produce symptoms of raised intracranial pressure, such as morning headache, projectile vomiting, and papilloedema. It may be several years or more before this occurs in the case of a meningioma. If the tumour is situated in an important area, it may, by its local effect, produce symptoms of *epilepsy* or *progressive neurological syndromes* before any evidence of intracranial pressure is produced. Hence *the absence of headache, vomiting, and papilloedema does not exclude a tumour.* **Epilepsy** arising for the first time in adult life should always be suspected as being due to a tumour until this possibility has been disproved (fig. 1293).

**Medulloblastoma** occurs usually in young children, affecting the vermis of the cerebellum and obstructing the fourth ventricle. It grows rapidly and produces seedling metastases throughout the meninges of the spine and cerebral hemisphere. Microscopically, it resembles a small rounded-celled sarcoma and is highly radio-sensitive.

**Glioblastoma Multiforme.**—The malignant glioma of adult life affects particularly the middle cerebral territory of males.

The structure is bizarre, containing every variety of glial cell together with giant cells; the tumour is radio-sensitive.



Idiopathic epilepsy does not occur before the age of six. Ninety per cent. of cases of idiopathic epilepsy have their first seizure before the age of thirty. After the age of thirty, epilepsy is usually symptomatic, and in patients between the ages of thirty and fifty tumour is a common cause.

**Progressive focal syndromes** should likewise be regarded as indicating a tumour until this possibility is disproved.

Degenerative conditions such as disseminated sclerosis are characterised by periods of remission and exacerbation. Vascular lesions occur instantaneously and are followed by some degree of improvement. If repeated on several occasions, as in multiple emboli, an appearance of steady progression is produced, but there is only one condition that will produce a steadily progressive syndrome, and that is a tumour.

**The stage of raised intracranial pressure** can develop in association with focal symptoms or be the sole evidence of tumour formation. Pressure symptoms occur late in the case of tumours in the frontal lobes which push the ventricles back. They occur earlier in tumours in the temporal and

parietal lobes which partially obstruct the outflow of fluid from the opposite ventricle. They occur earliest in midline and posterior fossa tumours which obstruct the flow of fluid from both ventricles, producing an internal hydrocephalus. Tumours of these types add to their own bulk the effect of the retained ventricular fluid. The effects of pressure include headache, vomiting and papilloedema, bradycardia, and retarded cerebation. The headache often wakes the patient in the early morning, and is aggravated by coughing and straining, which promote cerebral congestion. Vomiting occurs without warning, and is not preceded by nausea or related to food. Papilloedema may cause blindness.

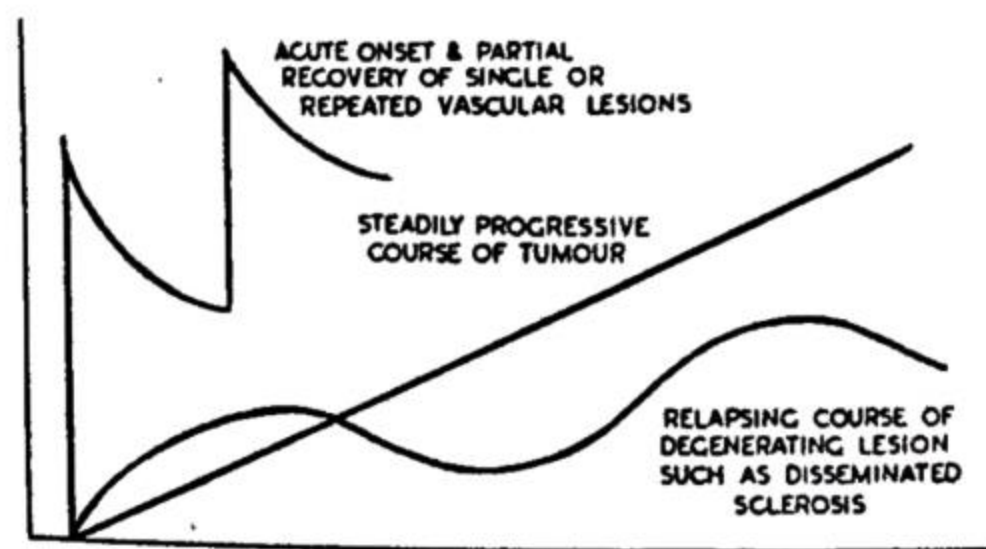


FIG. 1294.—Disease courses of vascular neoplastic and degenerative lesions.

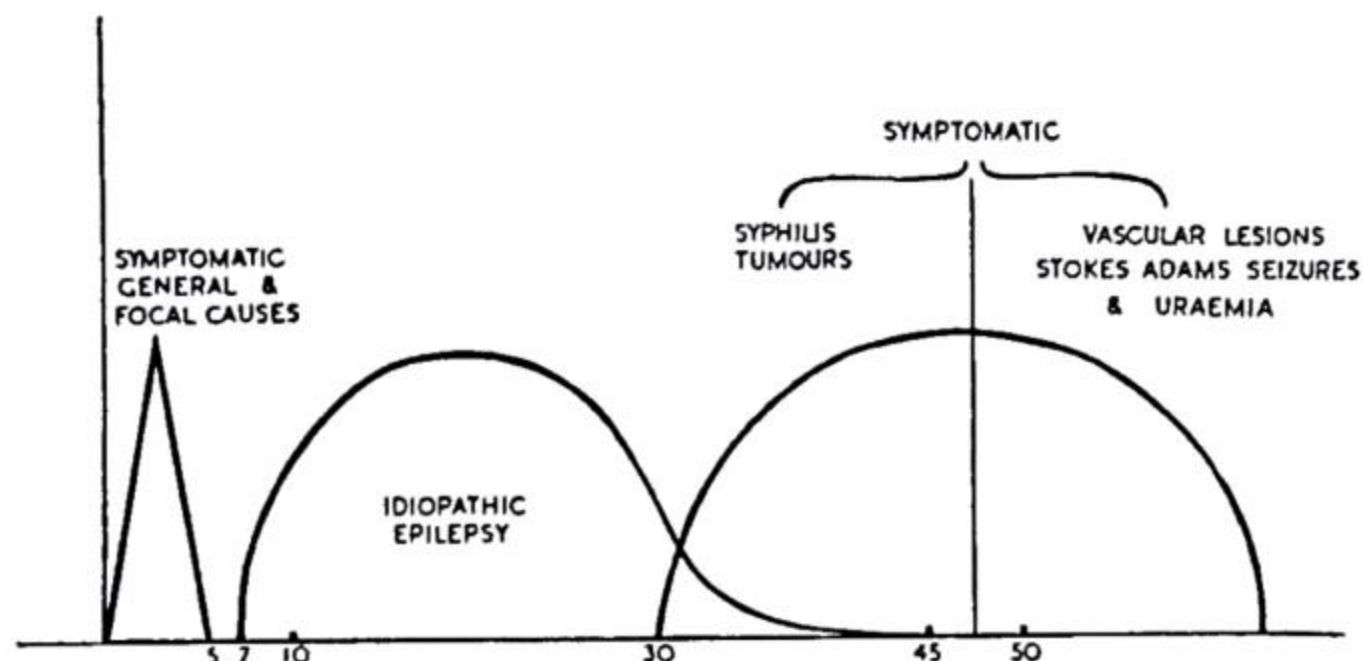


FIG. 1293.—The principal causes of epilepsy at different ages.

**The Stage of Cone Formation.**—Certain patients do not present until cone formation is imminent. When intracranial pressure becomes high, brain is extruded from one cranial compartment to another. The inner border of one hemisphere may go down under the falx plugging the superior longitudinal fissure and blocking the pathway for the cerebrospinal fluid absorption. The temporal lobe may be forced down into the tentorial



opening from above. The cerebellar vermis may be pushed up into this opening from below or the cerebellar tonsils may be forced down into the foramen magnum. Ominous signs of a threatened cone include violent paroxysmal headache, drowsiness, slow cerebation, slow pulse, and neck stiffness. Unilateral pupillary dilatation is an urgent sign. Lumbar puncture must be rigidly avoided at this stage.

**Focal syndromes** produced by tumours of the hemisphere may be seen in patients who exhibit no evidence of pressure or dangerous symptoms of imminent cone formation. As already stated, pressure symptoms occur chiefly with posteriorly situated tumours. Space does not permit of adequate analysis, but the main syndromes are as follows :

**Frontal lobe tumours** if deeply situated produce a progressive change in personality, with lack of insight, neglect of normal pastimes, occupations, and duties, and an alteration in emotional reaction particularly noticeable to relatives, consisting usually of a simplicity and unwarrantable cheerfulness (euphoria) or irritability. Epilepsy is generalised in type, and localising signs are limited to contralateral facial weakness.

**Parietal lobe tumours** produce Jacksonian epilepsy and progressive hemiparesis. Examination reveals marked loss of touch analysis, resulting in asteriognosis. Deeply situated left-sided tumours have marked intellectual impairment with loss of power of calculation (acalculia).

**Occipital Lobe Tumours.**—Epilepsy is generalised in type, preceded by an aura of flashing lights in the contralateral visual field. Signs, other than homonymous hemianopia, are few.

**Temporal lobe tumours** on the left side may produce progressive aphasia or visual or auditory hallucination. Lesions of the uncinate region produce uncinate hallucination of smell and taste and dreamy states of unreality. Otherwise temporal lobe epilepsy is usually of a generalised type. Tumours in the silent right temporal region present with symptoms of epilepsy only together with raised intracranial pressure. Localising signs include hemiparesis and superior quadrantic hemianopia.

**Parasagittal meningiomas** overlying the various lobes produce similar syndromes, but are distinguished by the skull X-ray changes associated with these tumours.

**Basal meningiomas** produce involvement of the olfactory and optic, oculomotor, and trigeminal nerves, in addition to pressure on the brain. Bone changes in the region of the orbit may cause proptosis or fullness in the temporal fossa.

**Midline tumours** always produce bilateral internal hydrocephalus with pressure symptoms.

**Tumours of the Third Ventricle.**—Colloid cysts at first cause a ball-valve obstruction producing intermittent blockage of the foramen of Monro. Severe unilateral headache is produced by lying on one side of the head and relieved by turning to the other side. Later, persistent bilateral hydrocephalus is accompanied by severe pressure symptoms or progressive cerebral atrophy and dementia. Gliomas of the floor of the ventricle cause hydrocephalus associated with endocrine disturbances, disturbances of sleep rhythm, and sexual precocity.

**Pineal tumours** by pressure on the quadrigeminal plate produce hydrocephalus with paralysis of the ocular motor nuclei with loss of upward, lateral, and downward movement of the eye.

**Subtentorial Tumours.**—Tumours of the posterior fossa produce hydrocephalus and cause raised intracranial pressure early in their syndromes. The effect of the hydrocephalus varies with the age of the patient.

**Cerebellar vermis tumours** are usually medulloblastomas and occur in young children before the sutures have united. The hydrocephalus causes progressive enlargement of the head, with resulting headache. At a later age, when the sutures have united, there are serious pressure symptoms and stiffness of the neck from



herniation of both cerebellar tonsils into the foramen magnum. Since the vermis controls the co-ordination of trunk and legs, localising signs are only seen if the child is taken out of bed ; it will then be seen to walk with the feet wide apart and have a tendency to pitch over forwards when standing with the feet together.

**Cerebellar hemisphere tumours** are often removable astrocytomas. They produce hydrocephalus and pressure symptoms in older subjects. Since the hemisphere controls the co-ordination of the corresponding side of the body, there is deviation to the affected side on walking and unilateral inco-ordination of the arm. Nystagmus may or may not be present.

**Acoustic neuromas** grow from the auditory nerve at the internal auditory meatus and produce enlargement of this structure, visible on X-ray. Arising from the eighth nerve the first symptom is unilateral deafness which is often first detected by the patient on the telephone. The tumour projects into the cerebellar pontine angle and presses upon the adjacent seventh, sixth, and fifth nerves, causing a syndrome of unilateral deafness, facial weakness, and sometimes squint. The corneal reflex is reduced from pressure on the fifth nerve. There may be trigeminal neuralgia from this cause or trigeminal anæsthesia. Later the tumour presses upon the cerebellum and brain stem, producing cerebellar signs and raised pressure, finally the tumour grows up into the tentorial opening from below, and here it not only blocks the up-flow of cerebrospinal fluid but assumes a position anterior to the brain stem coming into close relationship with the basilar artery and twisting the pons. See fig. 1295. Cerebrospinal fluid protein is always high, over 200 mg. per cent.

**The investigation of cerebral tumour** must attempt to define the site and nature of the tumour.

*History taking* must be designed to cover the function of the various cortical areas and cranial nerves. The history alone will sometimes indicate the site of the tumour and also give a hint as to its pathological type. If symptoms have been long-standing, they suggest a slowly growing and favourable tumour. A short history may, however, be due to the final breakdown of adaptation in a slowly growing tumour or indicate a rapid malignant growth.

The history may suggest a primary disease to which the cerebral condition is secondary. Since metastatic carcinoma, especially bronchial, is far commoner than primary cerebral tumour, particular attention must be paid to history of loss of weight, chronic cough, or hæmoptysis. Secondary brain abscess is suggested by a history of lung abscess or bronchiectasis, chronic otitic abscess by symptoms of cachexia and a discharging ear. Weight loss is always suspicious, as there is no wasting with primary cerebral tumour.

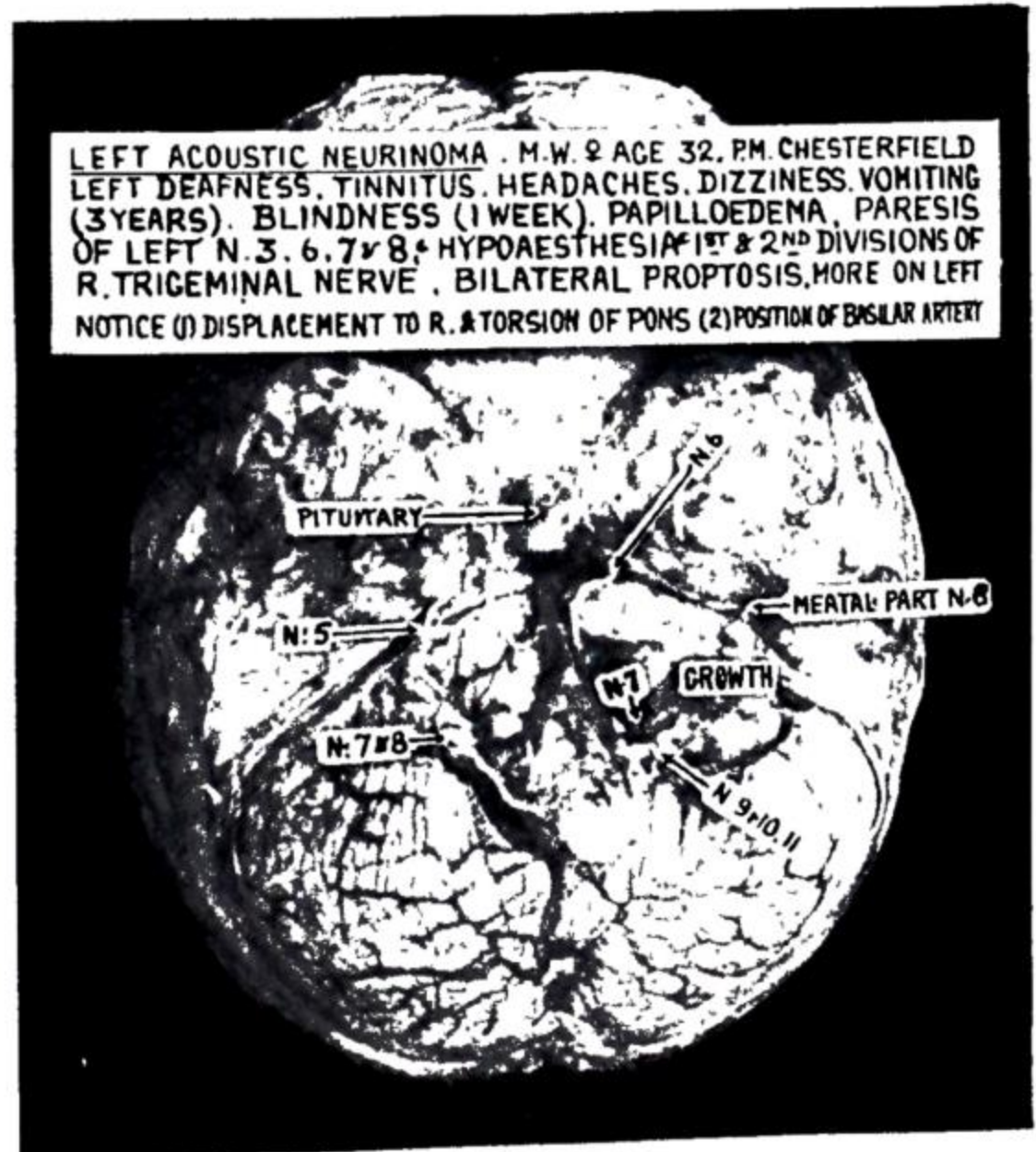


FIG. 1295.—Post-mortem findings in a case of auditory nerve tumour, showing displacement and distortion of the pons and basilar artery.



*Clinical examination* must include the general examination in search of primary disease. Examination of the optic discs may provide evidence of papilloedema or optic atrophy. Tumours are often present without papilloedema.

*Neurological examination* of cranial nerves and nerve tracts may localise where a tumour is, but never indicates what it is.

*Accessory investigations* are essential. X-ray of the skull, X-ray of the chest, and the erythrocyte sedimentation rate must be taken in every case.

A high E.S.R. is strongly suggestive of secondary tumour.

*An X-ray of the chest* may reveal an unsuspected bronchial carcinoma. Thirty per cent. of bronchial carcinomas present with cerebral symptoms before any chest symptoms have occurred.

*An X-ray of the Skull* may show that a Tumour is Present:

(1) By pressure changes including: (a) A beaten silver appearance of the vault from the pressure of tight convolutions

(sometimes normal in thin skulls). (b) Separation of sutures in young subjects. (c) *Most important*—erosion of the posterior clinoid pro-

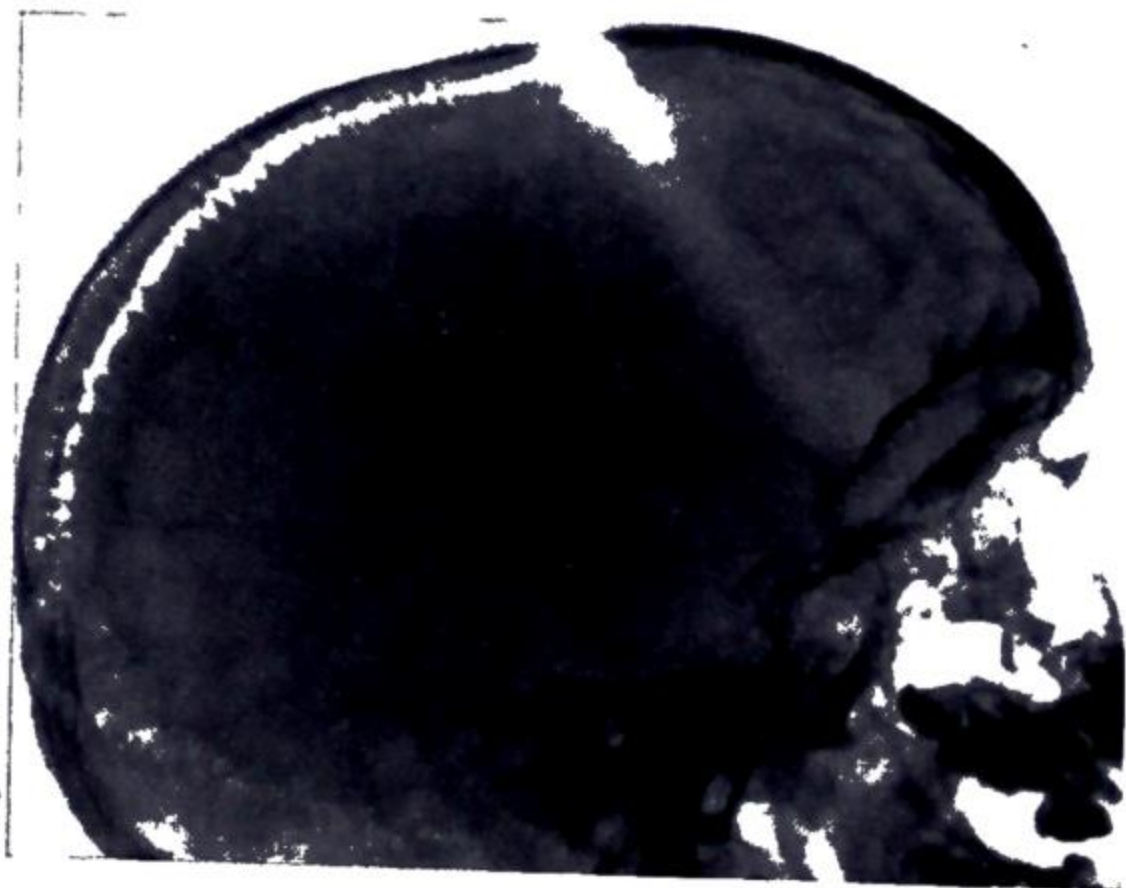


FIG. 1296.—Separation of sutures, beaten silver appearance, and erosion of posterior clinoids.



A

B

FIG. 1297.

Calcified astrocytoma in frontal lobe.

After removal by lobectomy.

cesses, a very valuable sign which indicates long-standing pressure and therefore a *possibly removable tumour*.

(2) By lateral displacement of a calcified pineal shadow indicating the side of the tumour.

(3) By characteristic intracranial calcification produced by astrocytomas,



angiomas, 50 per cent. of craniopharyngiomas, and some meningiomas and tuberculomas.

(4) By unilateral alteration in skull, vascular markings in meningiomas, including new converging diploic channels, and an increase in the size of the meningeal groove.

(5) By changes in the skull bones, including meningioma hyperostosis, local expansion at the site of a cyst, and evidence of bone destruction in secondary tumours.

**Electroencephalogram** yields valuable evidence. Characteristic wave-forms indicate the site or presence of focal or deep-seated tumours and distinguish between epileptic seizures produced by focal lesions and idiopathic epilepsy.

**Lumbar puncture** is seldom employed except in early cases where there is no clinical evidence of pressure, and it is necessary to exclude non-tumorous conditions. The pressure and content of the cerebrospinal fluid are recorded. An increase in pressure and protein suggests tumour. The W.R. is also examined. Lumbar puncture is avoided in the presence of raised pressure and is absolutely contraindicated in the presence of symptoms of threatened cone formation.

**Surgical investigation** by arteriography or air study is employed last of all, and is required to localise a silent tumour producing pressure but no physical signs, or indicate the extent of a known tumour, and to provide evidence of its type.

**Arteriography** was originated by Egas Moniz. Twelve ml. of 30 per cent. pyelosil is injected into the common carotid artery either by percutaneous puncture or

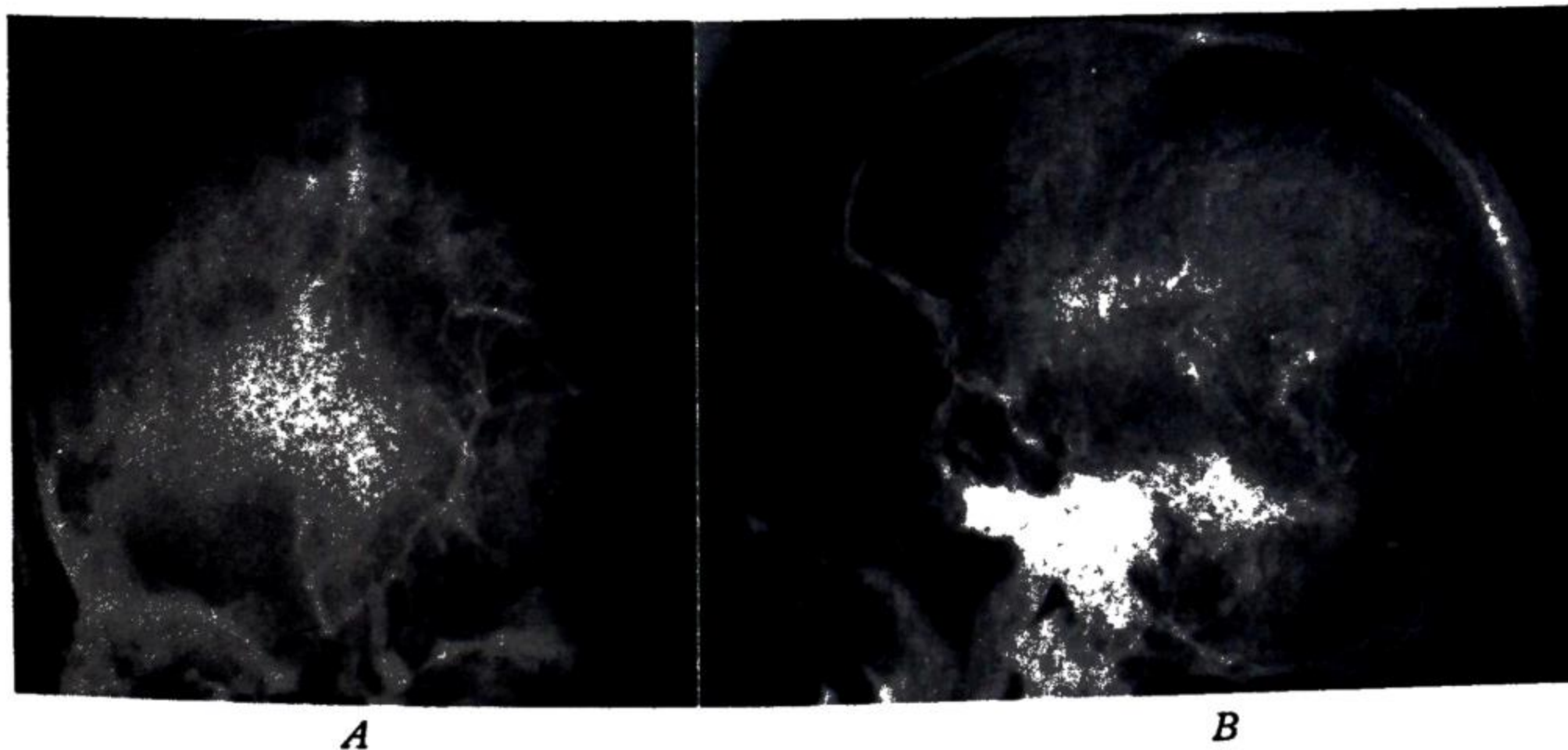


FIG. 1298.

(A) A.P. arteriogram showing inward displacement of the anterior and middle cerebral arteries and tumour circulation causing a blush in a meningioma at the outer third of the sphenoid ridge. (B) Lateral arteriogram showing primitive glioblastoma vessels in posterior temporal region.

by open operation. Three lateral films are taken at intervals of one second to show the arteries and then the veins, and this is followed by a further injection to obtain antero-posterior films. This investigation is safe even in high-pressure cases, as it does not disturb the intracranial pressures. The site of the tumour is shown by the displacement of cerebral vessels, e.g. upward or downward deviation of the middle cerebrals or displacement of the anterior and middle cerebrals in the antero-posterior view. Pathological tumour circulation is seen in meningiomas and glioblastoma multiforme only. Meningiomas produce a diffuse blush; glioblastomas produce a group of very primitive and imperfect vessels.

*Egas Moniz, 1874-1955. Neurosurgeon, Lisbon. Introduced cerebral arteriography and leucotomy.*



**Investigation by Air Study.**—*Ventriculography* was originated by Walter Dandy. Bilateral parietal burr holes are formed under local anæsthesia. A hollow ventricular canula is inserted to a depth of up to 5 cm. to puncture the vestibule of the ventricle. Available cerebrospinal fluid is removed and replaced with 10 per cent.

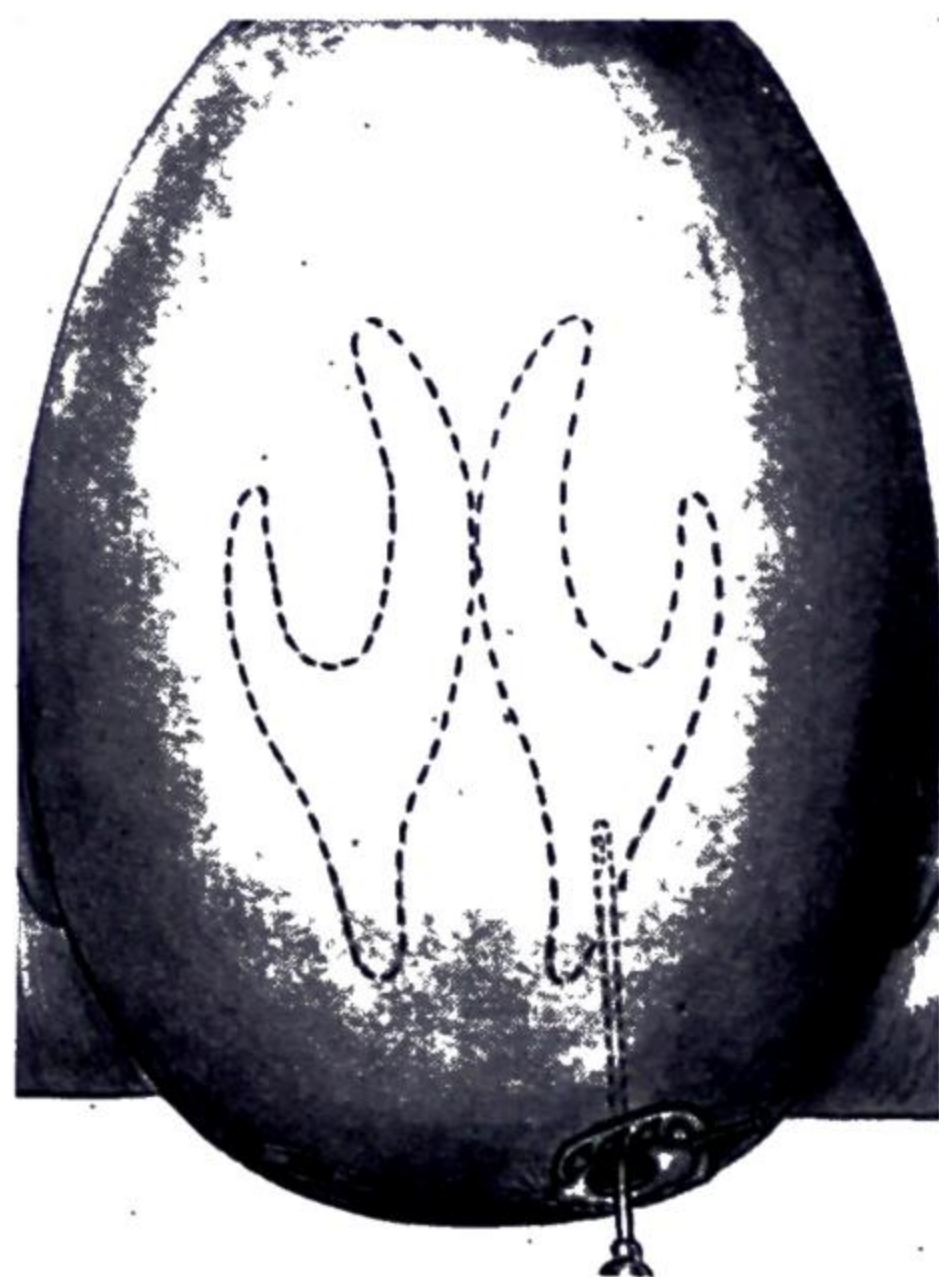


FIG. 1299.—Diagram of ventriculography.

*Cystography.*—If a cyst is defined in the course of ventriculography, the cavity is aspirated and air or thorotrast is injected in order to produce a picture of the cyst.

**Air Encephalography.**—Thirty ml. of cerebrospinal fluid is aspirated slowly and replaced by air at cisternal or lumbar puncture. This method is highly dangerous in cerebral tumours and should be reserved for investigation of low-pressure cases with symptoms of epilepsy.

**Investigation by Cerebral Puncture.**—If the above investigation suggests that the symptoms are produced by an unfavourable lesion in which craniotomy is contraindicated, such as secondary carcinoma or malignant glioma, or if a cyst is suspected, a burr hole is fashioned over the tumour site and the tumour is aspirated by ventricular canula.

A favourable cyst produced by astrocytoma or hæmangioblastoma contains golden-yellow clotting fluid.

A malignant cyst contains muddy non-clotting fluid like stale beer.

A malignant glioblastoma multiforme renders the brain soft, necrotic, and highly vascular, whereas meningiomas and astrocytomas are firmly resistant.

If stained smears show the presence of glioblastoma multiforme, the possibilities of operation must be carefully assessed. Any open decompression of the dura is

Walter E. Dandy, 1886–1946. Professor of Neurosurgery, Johns Hopkins University, U.S.A., introduced ventriculography in 1918.  
Norman Dott, Contemporary. Neurological Surgeon, Edinburgh Royal Infirmary.

less volume of air. The ventricle may be entirely obliterated by a tumour. The investigation is dangerous in high-pressure cases, as tapping a displaced and expanded ventricle on the side opposite to the tumour may allow brain to be pushed farther over, with cone formation as the temporal lobe sinks into the tentorial opening.

There is a mortality rate directly attributable to ventriculography. However, the danger of opening the skull in the wrong place in the presence of increased pressure is greater than that of ventriculography (Norman Dott). Films are taken in various planes and show displacement and distortion of the ventricle by the tumour. Views of the third ventricle and aqueduct may be obtained by suitable posture. Since air rises and fluid falls, the patient is positioned in such a way that that portion of the ventricular system which we wish to fill with air is brought to the highest level.

**Myodil ventriculogram in hydrocephalus** will also demonstrate the third and fourth ventricles and aqueduct after the injection of 3 ml. of myodil.

Both ventricles are already on one side of the head. This is not unusual.



FIG. 1300.—X-ray indicating dangers of ventriculography. Both ventricles are already on one side of the head. This is not unusual.



contraindicated, as the tumour contains primitive vessels and will swell up from the production of acute œdema and hæmorrhage into the tumour if the pressure of the dura is relaxed. This 'acute brain swelling' will cause additional symptoms of aphasia and hemiplegia. In non-essential areas it may be possible to secure an internal decompression by sucking out the centre of a tumour through a small dural

FIG. 1301. — Antero-posterior ventriculogram showing flattening separation and downward displacement of both ventricles produced by a large meningioma growing from the lower border of the falx, internal to the motor cortex. Completely excised by approach across the right frontal lobe.



opening and then giving deep X-rays. But in important areas of the brain, operation on glioblastoma multiforme is firmly contraindicated.

**Treatment.—Cerebral Tumour.**—Temporary dehydration may be employed as a pre-operative emergency measure if intracranial pressure is acute. Fifty to 100 ml. of 50 per cent. sucrose given slowly over twenty



A

FIG. 1302.

Cyst in occipital lobe defined by thorotrast.  
Tumour produces defect at A.



B

Operative sketch of removal of tumour.

minutes produces a reduction of pressure by absorption of œdema fluid from the brain and cerebrospinal fluid from the ventricle. The effect lasts up to six hours, and is beneficial if the ventricles are dilated by posterior fossa lesions.

**Operative treatment** must not be delayed when pressure is high, as sudden and unexpected collapse may occur. Improvement in neurosurgical technique permits a radical excision to be performed in a high percentage of cases.



Infiltrating malignant gliomas are hopeless, but a large proportion of circumscribed gliomas, such as astrocytomas, can be excised. Solid nodules are enucleated entire, or mural nodules are removed after opening the cyst in which they lie, infiltrating growths may be removed by lobectomy of the affected frontal, temporal, or occipital lobe. If the tumour cannot be removed, a decompression should be performed when the tumour is of slow growth, central necrotic areas being removed by suction. Open decompression of rapidly growing malignant gliomas results in a hernia cerebri with aphasia and hemiplegia and is to be avoided. Parasagittal meningiomas are removed intact. Basal meningiomas are reduced in bulk by cutting out the centre of the growth, following which the collapsed capsule is removed intact.

**Craniotomy.**—An osteoplastic flap is fashioned over the site of the tumour and must be sufficiently large to expose either the lobe to be excised or an adequate margin of normal brain around the tumour which is to be enucleated. In the case of meningiomas a length of the superior longitudinal sinus greater than the known length of the tumour must be displayed. Various scalp incisions are employed transverse or horseshoe, all of which are hidden as far as possible within the hair line. The field of operation is infiltrated with 1 : 100,000 of adrenalin in saline. The skin incision is outlined, the area of operation is sealed off by lint trephine cloth, which is gummed to the scalp with gum mastiche and cut through in the line of the proposed incision. The scalp is now incised. The assistant and surgeon exert digital pressure with the fingers on either side of the cut. Before pressure is released, artery forceps are applied to the epicranial aponeurosis upon either side; these are folded back so that the vessels in the scalp are bent on themselves, and each bunch of four or five forceps is secured with a rubber ring. By degrees the incision is enlarged and an extensive exposure can be obtained, almost bloodlessly, using a sufficient number of forceps. The scalp flap is now reflected and wrapped in a warm swab. Skin towels are applied to the wound edge. Burr-hole openings are then fashioned in a suitable pattern, being placed at the summit of each convexity in order to reduce pressure on the dura when the saw guides are passed from hole to hole. Gigli guides and saws are now passed between the burr holes, and the intervening areas of bone are sawn through, the cut being fashioned obliquely, so as to form a mortise edge in the bone in order to prevent the bone flap sinking in when it is replaced. The base of the flap is designed to hinge on the temporal muscle. The bone flap is now elevated and the base cracks through, the osteoplastic flap then being turned down on the hinge of temporal muscle and wrapped in a warm cloth. If a meningioma is being dealt with, the bone flap is extremely vascular, and on lifting the flap, hæmorrhage occurs from the torn emissary veins crossing between the bone and dura. The exposed dura mater is now inspected for an excess of vessels and torn emissary veins, indicating an underlying meningioma, or for surface evidence of underlying glioma, such as discoloration of the brain or widening of convolutions visible through the dura.

To delineate the extent of a subcortical tumour, ventricular needles are inserted at three or four points in order to detect the resistance of a tumour margin. When the position and nature of the growth have been decided, the dura is opened in a horseshoe flap, either with guarded scissors or a knife cutting on to a dural guide. Meningeal vessels of large size are secured with Cushing's silver clips.

**Excision of Meningiomas.—Parasagittal.**—The dural incision is completed all round the base of the tumour unless this invades the longitudinal sinus. The margin between the brain and tumour is defined, and vessels crossing this are secured with diathermy or silver clips; the tumour is then rotated upwards from its bed and cut off from beside the superior sinus.

**Basal Meningiomas.**—Occasionally it is necessary to amputate the frontal lobe of the brain to expose tumours on the middle or inner third of the sphenoid ridge, otherwise the lobe of the brain is retracted and the bulk of the tumour is reduced by cutting out its centre with punch forceps and diathermy, following which the capsule is gently drawn away from important branches of the circle of Willis which surround



it. Finally, the collapsed capsule is excised intact, together with the adjacent dura.

**Excision of Gliomas.**—(a) *By Enucleation.*—The tumour nodule is exposed either by opening a cyst or by ‘uncapping’ the area of overlying cortex. A medallion of cortex of adequate area is defined. Vessels entering this zone are secured with diathermy or silver clips, the defined area being then removed down to the level of the tumour margin. Vessels crossing from brain to tumour are gradually secured and the nodule is rotated from its bed (fig. 1304).

(b) *By Lobectomy.*—Veins passing from the frontal or occipital lobe to the superior sinus are coagulated on a blunt hook, secured with silver clips, and divided. Veins passing from the temporal lobe to the sphenoidal or petrosal sinuses are likewise secured. The plane of section is now defined, and vessels crossing this are secured with silver clips or diathermy. The incision is now deepened across the white matter to the opposite aspects of the lobe, where vessels are similarly dealt with and the lobe is excised.

If a tumour is irremovable, central necrotic areas are removed by suction in order

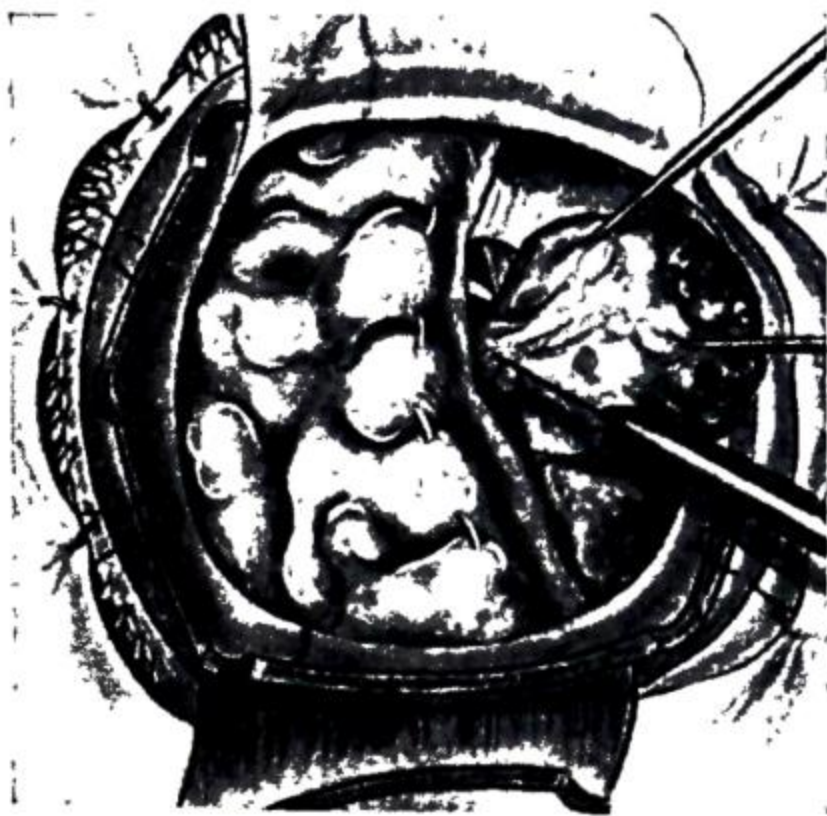


FIG. 1303.—Excision of collapsed capsule of a basal meningioma exposed by frontal lobectomy.



FIG. 1304.—Excision of astrocytoma from cyst in parietal lobe showing, (a) the dark mural nodule projecting into (b), the white-walled cyst whose walls consist of compressed cerebral tissue.

to reduce pressure. In all cases hæmostasis must be complete before the wound is closed. The dura is sutured completely, and if necessary with the introduction of a graft of nylon membrane. If bone has been invaded by meningioma hyperostosis, it is excised. Finally, the scalp is sutured in two layers. Blood transfusion is required during operation in vascular cases.

#### POSTERIOR FOSSA CRANIECTOMY

Intratracheal anæsthesia is essential. The head is fully flexed and supported with the patient lying, or in the sitting-up position, which reduces venous congestion. As a first step, a fine rubber catheter is inserted into the ventricle through a ventricular burr hole in order to provide for ventricular drainage to reduce acute intracranial pressure. A midline incision is now formed from above the external occipital protuberances to the level of the third cervical spine. The lateral skin flaps are raised from the occipital muscles, retractors are inserted and the ligamentum nuchæ is divided with diathermy to expose the arch of the first cervical vertebra. The occipital muscles are cut through  $\frac{1}{4}$  inch (6 mm.) below their attachment and dissected with diathermy from both occipital plates; this exposes the two occipital plates, the rim of the foramen magnum, and the arch of the atlas. The arch of the atlas is removed. Both occipital plates are drilled through and then removed with biting forceps. This exposes the posterior fossa dura as high as the transverse sinus, the foramen magnum, and upper cervical dura. The dura is palpated, and if the pressure is high, it is reduced by releasing fluid from the ventricles or tapping the cisterna magna. The dura is incised transversely, the occipital sinus being secured with Cushing's silver clips, and a vertical incision is now made downwards in the midline



to the upper cervical region to release the pressure cone at the foramen magnum. If both tonsils are forced down, the tumour will be found in the midline. If one tonsil is down, the tumour is in the corresponding hemisphere. Astrocytoma

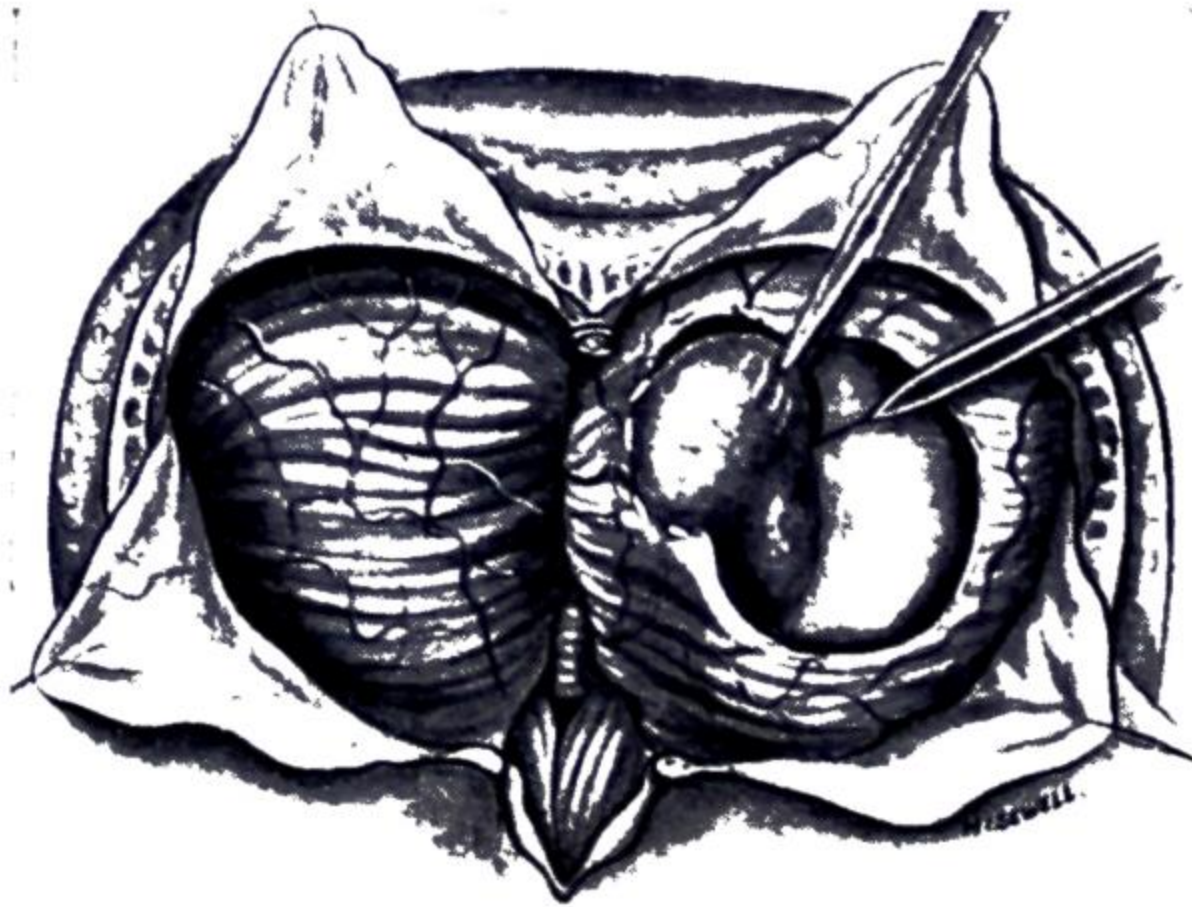


FIG. 1305.—Removal of astrocytoma nodule of cerebellum.

nodules are excised, but medulloblastomas are best left intact with an open decompression for deep X-ray treatment.

**Unilateral exposure** may be performed through a hook incision extending up from the third cervical spine to the external protuberance and then laterally and finally downwards to the mastoid tip. The ligamentum nuchæ is opened to expose the arch of the first cervical, and the occipital muscle is reflected downwards from the occipital plate, which is then removed. The cisterna magna is tapped to reduce pressure and the dura is opened.

*Eighth nerve tumours* are exposed by this route. The lower third of the cerebellar hemi-

sphere is cut away and the tumour exposed anterior to the cerebellum. The capsule is incised, its contents are evacuated, and the capsule is gently drawn away from the side of the brain stem and downwards through the tentorial opening before being cut away. A small portion is left over the facial nerve in order to prevent facial paralysis.

Large tumours are extremely dangerous. These grow a long way up into the tentorial opening, distorting and compressing the pons and basilar vessels supplying the brain stem. A fatal brain stem thrombosis may occur as a post-operative complication following extraction of the upper pole of the tumour.

## THE PITUITARY BODY

**Development and Structure.**—This small body, which plays a part in metabolism out of all proportion to its size (5 to 10 grains (300 to 600 mg.)), has been described as the leader of the endocrine orchestra (Pennybacker). It is composed of four portions :

*Pars anterior*, or anterior lobe, is developed from ectoderm in the roof of the stomadeum. It is composed of two varieties of cells, chromophobe and chromophil. The latter are either eosinophil or basophil, according to their staining reaction. The anterior lobe is well supplied with blood, and its secretion passes directly into the blood-stream.

*Pars Intermedia.*—This portion, with the pars nervosa, comprises the posterior lobe. The pars intermedia is derived from cells of Rathke's pouch, and is represented by a narrow layer of tissue containing clear cells; in the spaces between the cells colloid material is found which contains granules. These granules pass through the pars nervosa into the third ventricle. Their function is unknown.

*Pars nervosa*, which arises as an outgrowth from the embryonic brain, and during foetal life contains a cavity which communicates through the infundibulum with the third ventricle. It is only in mammalia that this portion becomes associated with the remainder of the pituitary body. The pars nervosa contains neuroglial and ependymal cells, and is less vascular than the remainder of the pituitary body.

*Pars Tuberalis.*—This also is formed from an off-shoot of the embryonic pharynx. It comprises a mass of cells which encircle the pituitary stalk, and spread thence over the adjacent tuber cinereum, which is an eminence of grey matter forming part of the floor of the third ventricle, and from the centre of which the pituitary stalk, or infundibulum, is attached. The pars tuberalis is composed of vesicles which contain colloid material.

Joseph B. Pennybacker, *Contemporary*. Neurosurgeon, Radcliffe Infirmary, Oxford.  
Martin Heinrich Rathke, 1793-1860. Professor of Zoology and Anatomy, Königsberg.



**Function.**—Many points regarding the functions of these various portions still require elucidation, but the main surgical importance of the gland is concerned with tumours.

#### TUMOURS OF THE PITUITARY BODY

comprise three varieties of adenoma : chromophobe, acidophil, and basophil, and congenital tumours derived from Rathke's pouch: craniopharyngiomas.

**Chromophobe adenomas** occur most commonly in female patients between the ages of twenty and fifty. The average tumour is solid and slow-growing and expands steadily to form a mass the size of a walnut in a period of several years. In certain cases spontaneous involution may occur with cessation of growth and cystic change (cf. adenoma of thyroid). Occasionally highly cellular rapidly growing tumours are found which grow with the characteristics of local malignancy invading laterally into the cavernous sinus or extending into the lobes of the brain. Three stages of development may be recognised :

- (a) The stage of intrasellar development.
- (b) The stage of extrasellar extension.
- (c) The stage of massive intracranial extension.

(a) *Intrasellar Development.*—Inside the confines of the sella turcica the expanding chromophobe cells, which possess no active secretion of their own, compress the acidophil and basophil cells of the pars anterior and inhibit their secretion which are concerned with growth and sex functions. Since the tumour arises at an age when growth is complete, the effect is felt by the thyrotropic and gonadotropic hormones. The patient becomes fat and sluggish with a lowered metabolic rate, as in myxœdema, and amenorrhœa is invariable. Pressure on the diaphragma sellæ causes severe headache. X-ray of the skull reveals pressure changes of the sella (fig. 1306). The floor is depressed towards the sphenoidal air sinus, lateral pressure on the petroclinoid ligaments leads to separation



FIG. 1306.—Typical X-ray appearances of enlarged sella in chromophobe adenoma.

of the anterior clinoid processes, and the posterior clinoids become thin.

(b) *The Stage of Extrasellar Extension.*—The tumour breaks through the diaphragm at a weak point between the anterior clinoid processes and extends up in front of the pituitary stalk to press on the under aspect of the optic chiasm. Headache becomes less severe from relief of intrasellar pressure, amenorrhœa persists, and gradually bitemporal hemianopia is produced by stretching of the decussating fibres in the optic chiasm over the posterior border of the tumour. Paralysis of these fibres, which comes from the inner



half of each retina, leads to loss of vision towards each temporal side. Stretching of the optic nerves anterior to the chiasm produces primary optic atrophy with pale white optic discs. The diagnosis is usually made at this stage.

(c) *The stage of massive intracranial extension* is rare. If the optic chiasm is in an abnormal position, either pre- or post-fixed, the tumour may slip by the chiasm without causing serious visual disturbance and enter the frontal lobe, or highly cellular rapidly growing tumours may spread laterally into the temporal lobe or upwards and backwards behind the chiasm into the third ventricle. These extensions will act as a space-occupying tumour and produce symptoms of raised pressure or epilepsy. Extension into the temporal lobe produces an additional homonymous hemianopia from involvement of the optic radiation.

*Differential Diagnosis.*—The syndrome may be simulated by meningiomas of the dorsum sellæ and aneurysm of the anterior communicating artery. Arteriography is required in doubtful cases.



FIG. 1307.—Intradural exposure of pituitary tumour, showing (a) optic nerve and, (b) pituitary tumour.

**Treatment.**—Chromophobe tumours are not radio-sensitive. Many alleged successes following deep X-ray have been attributed to spontaneous cystic involution or an abnormality of the chiasm which allows the tumour to go on growing without serious visual loss developing. Years later the growth is found to have formed a massive intracranial extension.

Operation performed before the stage of massive extension has a mortality of 2 to 4 per cent.; after extension 30 per cent.—hence early operation is advisable.

The tumour is exposed by frontal osteoplastic craniotomy, after opening the dura and elevating the frontal lobe. The extradural approach dividing the dura at the sphenoid wing gives less adequate exposure. The tumour looks like a dark plum or solid tumour is removed by punch forceps. The capsule of the tumour is then drawn down from behind the chiasm and excised. This step is essential to prevent post-operative hæmorrhage into a nodule lying beneath the third ventricle which stimulates the temperature centres and causes death from hyperthermia. Relief of pressure on the basophil cells restores sex function, and pregnancy can take place after operation. Post-operative deep X-ray is required to prevent recurrence in highly cellular growths.

**Acidophil Adenoma.**—These tumours are small in size, usually no larger than a damson. They rarely cause pressure on the optic chiasm except in cases of fugitive acromegaly, in which the tumour reverts almost to a chromophobe type. Normally the symptoms are due to excessive production of growth hormone by the acidophil cells and inhibition of the basophil sex secretion.

In children the tumour causes gigantism, while patients whose epiphyses have united develop acromegaly (a term which implies enlargement of the extremities).

Acromegaly is characterised by thickening of the subcutaneous tissues of the scalp, lips, and tongue, the face, hands and feet, and overgrowth of cer-



tain bones (Chapter xlvii) of the frontal sinuses, jaw, and distal phalanges. There is also overgrowth of hair and sebaceous glands. Asthenia causes slackening of ligaments with the development of marked kyphosis, which causes the enlarged hands to hang low beside the knees. This, combined with the atavistic appearance produced by the beetling brow, prognathous jaw, and overgrowth of hair on the chest, produces the 'ape man' of the circus. Fatty degeneration of the heart and herniæ are additional disturbances.



FIG. 1308.—Acromegaly.

**Treatment** is by deep X-ray, to which the tumour is sensitive. Operation is only rarely required, which is fortunate, since the patients are poor operative risks on account of the heart and chest condition, and approach is difficult, owing to enlargement of the frontal sinuses, which may necessitate a lateral or trans-sphenoidal operation.

#### BASOPHIL ADENOMAS AND CUSHING'S SYNDROME

Basophil adenomas are small in size and in stained sections are only a few millimetres across; the effects are produced by disturbance of endocrine secretion.

Cushing described a syndrome associated with basophil adenomata, although a similar condition is sometimes due to adrenal dysfunction (adreno-genital syndrome, p. 261). Females are most commonly affected. Fat accumulates on the trunk, neck, and face, which becomes moon-shaped, but the limbs remain normal. Purple striæ appear on the skin in considerable numbers. This becomes hirsute, arterial hypertension and glycosuria develop early, and in many cases a psychotic state of schizophrenia develops. Treatment is by adrenalectomy.

**Craniopharyngioma** (*syn.* Rathke Pouch Tumour).—Remnants of Rathke pouch may persist at four sites:

- (1) In the sphenoid bone; (2) in the sella turcica; (3) in the pars nervosa; (4) in the floor of the third ventricle, from all of which tumours may develop. Although congenital in origin, a proportion of cases do not produce symptoms until late in adult life.



FIG. 1309.—A large craniopharyngioma.

The term craniopharyngioma describes these tumours best. In structure, the growths form large masses in which cystic cavities lined with ciliated epithelium and containing cholesterol crystals are separated by areas of connective tissue. More than 50 per cent. of these growths are calcified and may form coral-like masses filling the interpeduncular space and extending backwards to the pons. Since they are adherent to the basal arteries and adjacent nerves,

they are irremovable. Occasionally single cysts are found in or above the sella, but the term suprasellar cyst describes only this one variety and is deceptively encouraging, as it suggests an invariably removable lesion. In fact, these tumours are by no means always suprasellar, nor are they necessarily cystic.



**Clinical Features.**—The symptoms depend upon the site of the tumour and the age of the patient.

(1) Intracellular craniopharyngioma cysts produce symptoms like the inert chromophobe tumour, but in young subjects they inhibit growth by compression of the acidophil cells as well as inhibiting sexual maturation. The result is a fat, impotent dwarf, who may subsequently develop bitemporal hemianopia from upward pressure on the chiasm. Intracellular calcification is often visible in X-ray.

(2) Suprasellar craniopharyngiomas in young subjects, by downward pressure on the sella, also produce a Fröhlich syndrome, but in this case involvement of the optic tract behind the chiasm causes homonymous hemianopia.

Pressure on adjacent centres of the hypothalamus, which control sleep and water metabolism, produce pathological somnolence and diabetes insipidus, so that the subject is liable to fall asleep during the day and drink and pass abnormal quantities of fluid. Similar symptoms may occur at a later age in adults.

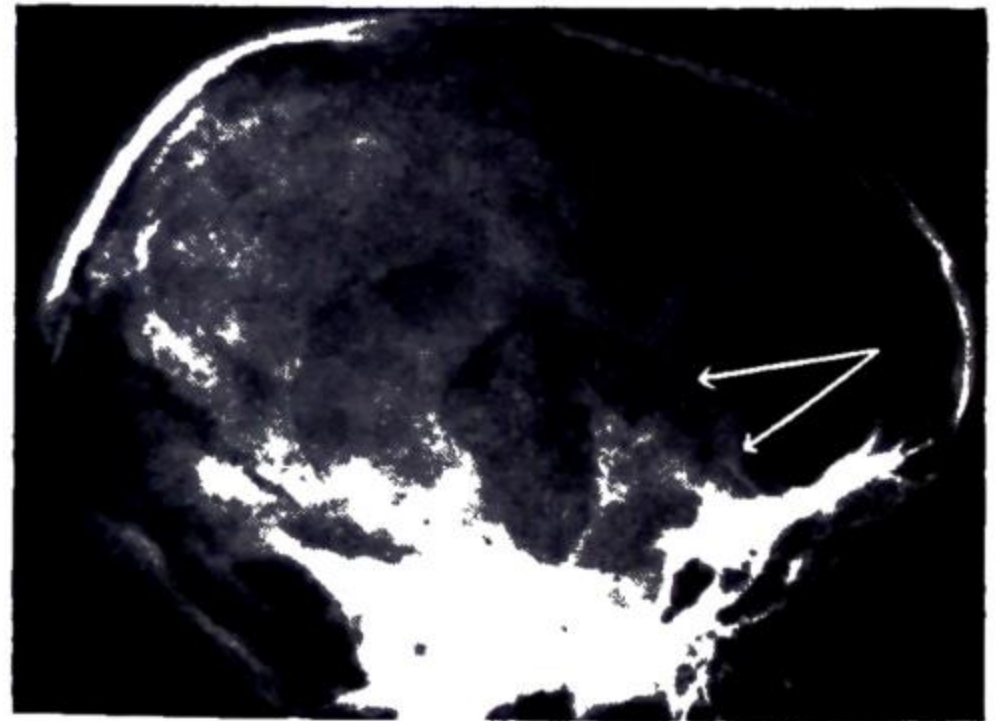


FIG. 1310.—Arrows indicate suprasella calcification in craniopharyngioma.

**Intraventricular tumours** may produce blockage of the third ventricle with symptoms of acute intracranial pressure, headache, vomiting, and papilloedema, without localising signs, or an organic confusional state and dementia from cerebral atrophy following long-standing pressure.

**Treatment.**—Cystic tumours in and above the sella may be evacuated by frontal craniotomy. When large masses block the third ventricle, the cerebrospinal fluid may be short-circuited to the cisterna magna by leading a catheter from the ventricle through a burr opening in the skull, thence under the skin and occipital muscles to drain into the cisterna magna, which has been exposed above the foramen magnum (Torkildsen's operation)—ventriculo-cisternostomy.

#### HYDROCEPHALUS

may be congenital or acquired.

**Congenital hydrocephalus** is often associated with other abnormalities, such as spina bifida and meningocœle. It is produced by obstruction to, or defective absorption of, the cerebrospinal fluid. Failure of development of the arachnoid villi through which absorption takes place is the commonest cause. This produces *communicating hydrocephalus* as the distended ventricles communicate freely with the subarachnoid space. *Obstruction of the cerebrospinal pathways* is produced by blockage of the outflow from the fourth ventricle associated with an Arnold-Chiari malformation of the hind brain in which the roof of the fourth ventricle lies below the level of the foramen magnum. At a higher level congenital stenosis of the aqueduct of Sylvius produces a similar effect.

**Clinical Features.**—The enlargement of the head may be pre-natal and obstruct labour. After birth, rapid enlargement usually occurs. The brow

Alfred Fröhlich, *Contemporary*, formerly Professor of Pharmacology, University of Vienna, described his syndrome in 1901.  
 Arne Torkildsen, *Contemporary*. Neurosurgeon, Rikshospital, Oslo, Norway.  
 Julius Arnold, 1835-1915. Professor of Pathological Anatomy, Heidelberg University.  
 Hans Chiari, 1851-1916. Professor of Pathological Anatomy, Strasbourg University.  
 François de la Boë (or Jacobus Sylvius, according to the Latinised form of his name), 1614-1672. Professor of Medicine, Leyden.



overhangs the roof of the orbits. The fontanelle is wide and the scalp veins are distended (fig. 1312). Although the ventricles become enormous and the cortex is reduced to a mere shell, there are no motor symptoms. Certain cases stabilise spontaneously, and intelligence is then preserved despite the enormous size of the head, but secondary endocrine effects result from pressure of the distended third ventricle in the pituitary fossa. Congenital stenosis of the aqueduct may not produce serious symptoms until the age of six or later, and then causes evidence of raised intracranial pressure associated with secondary endocrine disturbances.

**Treatment** is still experimental. The site of obstruction is localised by tracing the circulation of dye or radio-active sodium introduced into the ventricles. Attempts to overcome defective absorption include methods of diminishing secretion: (a) by excision or coagulation of the choroid plexuses, or (b) by bilateral carotid ligature; or providing alternative routes of absorption: (a) by ventriculo-jugular anastomosis, in which an acrylic tube is passed from the ventricle to the jugular vein; or (b) by anastomosis of the spinal theca to the ureter, or (c) ventriculo-peritoneal anastomosis in which a long acrylic tube is led subcutaneously from the ventricle and placed inside the lumen of a second long tube which is draining into the peritoneum. The overlap provided by a length of the small tube inside the large tube allows for the growth in length of the body. Obstructive hydrocephalus is treated (a) by suboccipital decompression for the Arnold-Chiari malformation, or (b) by opening the distended third ventricle from the front at third ventriculostomy.

Third ventriculostomy is the best operation for congenital stenosis of the aqueduct.

**Acquired Hydrocephalus.**—Obstructive hydrocephalus is produced by pathological obstruction within the cerebrospinal fluid pathways. The outflow from one ventricle may be blocked by the obstruction of the foramen of Monro by adhesions following ventriculitis or by tumour.

Bilateral internal hydrocephalus accompanies mid-line tumours, e.g. colloid cysts of the third ventricle, craniopharyngiomas, pineal and cerebellar tumours, and arachnoid cysts over the roof of the fourth ventricle.

**Communicating hydrocephalus** is usually post-inflammatory in origin and complicates acute or chronic meningitis and sarcoidosis. Blockage of the basal cisterns, cisterna interpeduncularis and cisterna chiasmatis, by inflammatory exudate or arachnoiditis throws a dam across the main channel for the ascent of cerebrospinal fluid to the absorption areas, and hence leads to stasis in, and distension of, the lateral ventricles.

**Treatment of obstructive hydrocephalus** is directed to the cause, e.g. tumour. In non-tumorous cases the site of obstruction is localised by air or myodil ventriculo-



FIG. 1311.—Ventriculogram showing enormous size of ventricles in congenital hydrocephalus.



FIG. 1312.—A marked degree of hydrocephalus showing the overhanging orbital margin and distending veins.



graphy. Blockage of the foramen of Monro is cleared by an approach across the frontal lobe. Obstruction of the aqueduct is treated by third ventriculostomy. Blockage of the roof of the fourth ventricle is dealt with by suboccipital craniectomy and removal of cysts and adhesions lying in the cisterna magna.

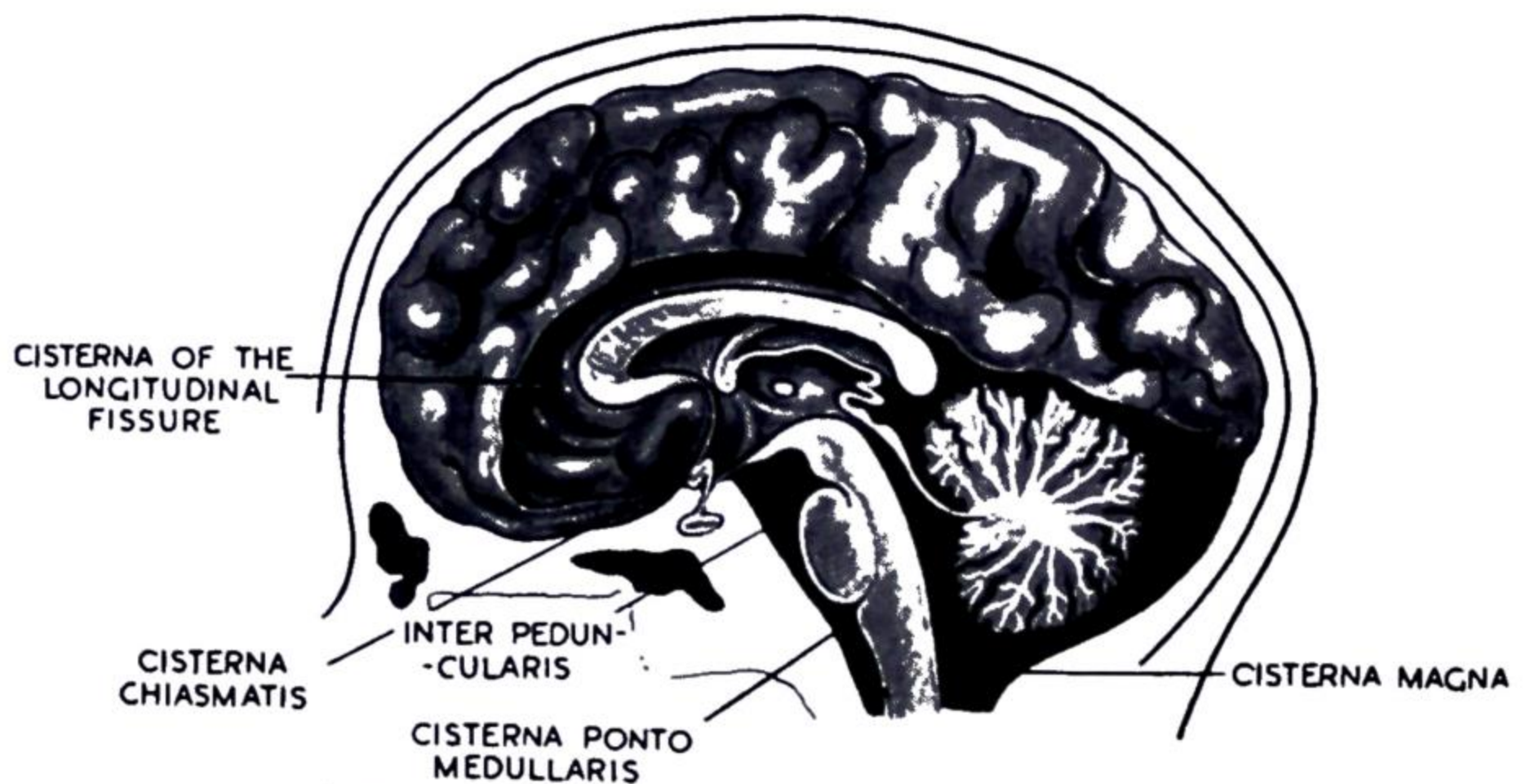


FIG. 1313.—The principal arachnoid cisterns.

**Post-inflammatory communicating hydrocephalus** often occurs in association with blockage at the roof of the fourth ventricle. An attempt must be made to clear the basal symptoms by absorbing exudate. In tuberculous meningitis—by energetic treatment with PPD and streptomycin. In sarcoidosis—by ACTH. Surgical treatment is limited to the formation of bifrontal burr holes, through which the ventricle can be tapped to relieve acute pressure symptoms or to introduce antibiotics.

#### INTRACRANIAL ANEURYSM

The development of the surgery of intracranial aneurysm was founded upon the original work of Sir Geoffrey Jefferson. Intracranial aneurysms may be considered in two main groups (Jefferson):

- (1) *Subclinoid*.—Acquired aneurysms on the carotid syphon of the internal carotid artery within the cavernous sinus.
- (2) *Supraclinoid*.—Congenital aneurysms of the circle of Willis.

**Subclinoid aneurysms** are produced by weakening of the muscle coat of the internal carotid by uneven distension of its walls at the anterior and posterior curves of the carotid syphon. The condition is most common in women, owing to the finer structure of their arteries. (Jefferson has remarked that this is the only known pathological evidence of the existence of a weaker sex.)

Fusiform aneurysms are produced on the anterior and posterior bends, and hence anterior and posterior syndromes may be recognised which vary only in regard to the physical signs produced by pressure of the aneurysm sac on adjacent structures.

**Symptomatology**.—A female patient is suddenly seized with severe unilateral headache, resulting from stretching of nerve fibres in the wall of the distending carotid artery. This ceases only when the wall of the artery comes against the wall of the cavernous sinus and receives support from this structure. The headache ceases, but soon additional symptoms appear from pressure on the nerves in the lateral wall of the cavernous sinus. These produce a combination of squint and trigeminal pain.

**Anterior Aneurysms**.—The commonest type press on the third and fourth nerves and first division of the fifth, causing supraorbital pain associated with ptosis, a dilated pupil, and divergent squint, owing to paralysis of the third nerve and unopposed action of the sixth.

**Posterior aneurysms** press on the sixth nerve and the whole of the trigeminus, causing pain in the entire face with a convergent squint from sixth-nerve paralysis and unopposed action of the third, the eye remaining open.

**Treatment** is highly successful except in long-standing cases where the sac has

Sir Geoffrey Jefferson, *Contemporary*. Professor of Neurosurgery, University of Manchester.  
 Thomas Willis, 1621–1675. Professor of Natural Philosophy, Oxford. Afterwards practised as physician in St. Martin's Lane, London.



become full with hard organised clot and cannot collapse. Ligature of the internal carotid might cause hemiplegia if the circle of Willis were sclerotic or if the anterior communicating artery were absent. Ligature of the common carotid, however, is employed with safety and with good effect. This reduces pressure in the sac and relieves the nerve symptoms without risk of hemiplegia, since there is a second-cross circulation above the level of the ligature. Blood passes across through the branches of the external carotid to reach the side of the ligature, then passes downwards to the carotid bifurcation above the ligature and then flows upwards with the internal carotid with reduced force but in sufficient volume to prevent cerebral anæmia.

**Arterio-venous fistula in the cavernous sinus** may occur *spontaneously* from rupture of a subclinoid aneurysm or from the effects of *trauma*

on the arterial walls in association with fracture of the middle fossa. Acute back pressure in the veins draining into the cavernous sinus produces pulsating exophthalmos, distension of the orbital and supraorbital veins, and bone erosion and enlargement of the orbit. A few cases heal spontaneously by aseptic thrombosis in the cavernous sinus occurring in the early stages. Usually, however, the condition will progress if untreated, and produce a terrible deformity, with extrusion of the eyeball.

**Treatment.**—Ligation of the internal carotid in the neck may be sufficient, but if the condition progresses as the result of cross circulation through the circle of Willis, the internal carotid must be occluded intracranially by the application of a silver clip inserted across the vessel above the level of the cavernous sinus.

**Supra-clinoid Aneurysms.**—Congenital aneurysms on the circle of Willis may produce pressure on adjacent nerves. Rupture produces symptoms of subarachnoid or intracranial hæmorrhage with or without associated pressure symptoms. They may rarely produce multiple emboli causing a progressive syndrome of paralysis.

**Pressure Symptoms.**—Aneurysms on the posterior branches of the circle, posterior cerebral and posterior communicating, produce symptoms of third-nerve palsy. Posterior cerebral aneurysms also cause hemianopia or pressure on the crus (Weber syndrome). Aneurysms on the anterior branches, such as the internal carotid bifurcation, anterior cerebral, and anterior communicating produce pressure on the optic tracts, optic nerves, and chiasm respectively, producing hemianopia, monocular visual loss, or bitemporal hemianopia and optic atrophy.

Middle cerebral aneurysms produce symptoms of hemiparesis from involvement of the striate branches, often by emboli. These symptoms may occur alone or in association with subarachnoid or intracerebral hæmorrhage.

**Subarachnoid hæmorrhage** produces sudden headache with severe pain in the neck and between the shoulders, followed by loss of consciousness of brief duration and later by acute pain from root irritation and marked neck stiffness.

**Intracerebral hæmorrhage** is to be suspected when sudden loss of consciousness persists for more than twenty-four hours and is associated with marked neck stiffness.

**Treatment.**—The objective of surgical treatment is to prevent repeated hæmorrhage. Following the first subarachnoid hæmorrhage, the patient is rested, if possible for ten days in order to allow the aneurysm to clot. If, however, repeated hæmorrhage occurs in the early stages, an arteriography must be performed early and the common carotid on the affected side must be ligated in an effort to stop recurrent bleeding. If prolonged unconsciousness indicates intracerebral bleeding the clot is evacuated by a puncture through a burr hole or by craniotomy, in which case the aneurysm may be clipped off after the clot has been turned out. If there is no immediate urgency, after a ten days' rest, the aneurysm is localised by bilateral arteriography during which the presence or absence of cross circulation in the anterior communicating artery is determined by compression tests. If no aneurysm is seen on carotid angiography, a vertebral angiogram is performed. The best results are found in those cases in which no aneurysm is demonstrated; here a small aneurysm has probably undergone a spontaneous cure by clotting. Arteriography is performed at the tenth day—as statistics show that repeated hæmorrhage becomes more frequent after that interval.

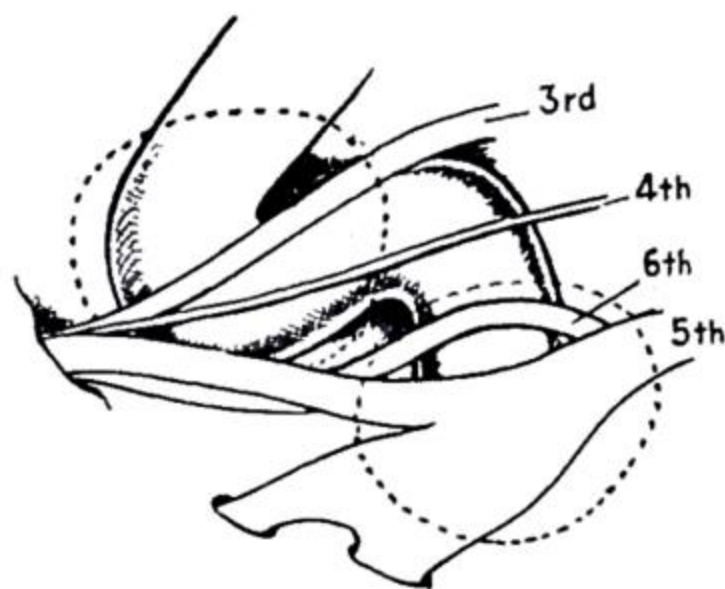


FIG. 1314.—The relationship of aneurysmal sacs to structures in wall of the cavernous sinus.



If an aneurysm is demonstrated by routine arteriography at the tenth day, direct operation on the aneurysm is only justified if the aneurysm is in a position where operation will not *cause* hemiplegia or mental symptoms.

Aneurysms of the anterior group are accessible to direct surgical approach. Anterior cerebral and anterior communicating are approached like pituitary tumours. Middle cerebral and posterior communicating are reached across the Sylvian fissure. The neck of a globular sac may be closed by applying a silver clip across the neck.

Recently, J. R. Gibbs has opened large sacs and reduced the lumen with a purse-string suture prior to occlusion of the neck. Fusiform aneurysms on the anterior cerebral and anterior communicating artery are treated by clipping off the nutrient anterior cerebral artery proximal to the aneurysm.

A direct attack on an anterior communicating aneurysm is extremely hazardous, as this may cause spasm and thrombosis in the antero-median group of perforating vessels which supply the hypothalamus, with resulting infarction of that area and the production of a state of akinetic mutism in which the patient remains alive but deprived of speech or volition.

Direct attack on fusiform middle cerebral aneurysms carries a risk of hemiplegia, and these aneurysms are best treated by wrapping with muscle or acrylic plastic in order to strengthen the wall and diminish the risk of recurrent bleeding.

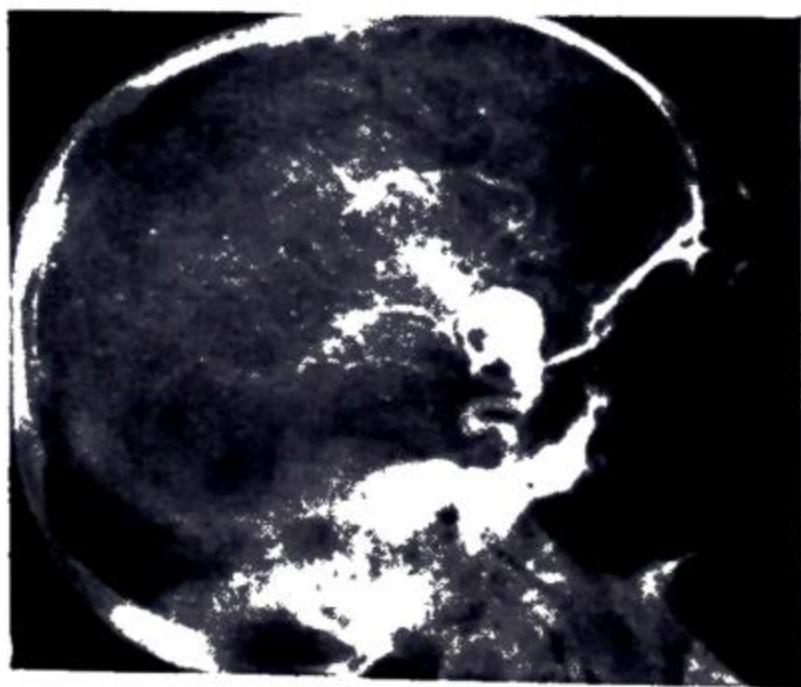


FIG. 1315.—Large aneurysm of anterior cerebral artery, producing monocular blindness.

**Intracranial angiomas** are congenital malformations and not true tumours. Although an excess of blood passes through the large arterio-venous malformations, absence of a true capillary system causes defective nutrition of the affected area, with death of tissue, gliosis, and calcification. This may produce symptoms of epilepsy and paralysis, often in adult life. Alternatively, the angioma may rupture spontaneously or follow a minor trauma producing symptoms of apoplexy in young subjects. Common carotid ligation always reduces the rate of blood flow through the tumour bed, which can be completely filled by gross circulation. Small surface angiomas may be successfully excised or caused to collapse by occlusion of the nutrient vessels.

**Surgical treatment of mental disorders** originated following the discovery by Moniz in 1936 that injection of alcohol into the frontal lobes of seriously disturbed psychotic patients had, in certain cases, produced a remarkable relief of their symptoms. The earlier operation of leucotomy consisted of subcortical division of all the central core of white matter in the frontal lobe through a laterally placed aperture at a point 3.5 cm. behind the outer margin of the orbit and 5 cm. above the zygoma. This gross operation lacked any precise objective, and although it succeeded in relieving emotional symptoms of tension, aggression, and agitation, it produced serious intellectual blunting as well, because it divided important association pathways in the lobe as well as fibres concerned in emotional feeling and emotional reaction. It has gradually been realised that the operation produces its good effect by division of emotional pathways passing up from the thalamus to the orbital convexity and cingulate areas of the frontal lobe. These fibres lie in the lower and inner part of the frontal lobe. Recent advances have concentrated on dividing these fibres alone but leaving the rest of the frontal lobe intact, either by leucotomy confined to the lower half of the lobe, or by undercutting or excision of the orbital convexity or cingulate areas of the cortex by open operation.

Lower-segment leucotomy is the best operation in seriously disturbed aggressive psychotic cases, such as schizophrenia and agitated melancholia, but in high potential cases of manic depressive psychosis and obsessional neurosis, and even in severe cases of neurotic tension, undercutting of the orbital cortex of the frontal lobe produces a remarkably high percentage of success with little or no intellectual deficiency, even in patients in whom previous treatment by electro-convulsive therapy has failed. This is because the orbital aspect of the lobe receives the majority of the emotional fibres from the hypothalamus. Division of the lower fibres by leucotomy also divides afferent pathways concerned with the perception of pain, and is helpful in the relief of suffering in the terminal stages of cancer.



CHAPTER XXXIX  
CRANIAL NERVES  
GEOFFREY KNIGHT

**THE Olfactory Nerve** is liable to be injured by fractures passing through the cribriform plate, resulting in partial loss of smell (hyposmia), or anosmia of the corresponding side. Olfactory filaments are apt to be damaged as a result of occipital injuries (*contre-coup*, p. 949).

The **Optic Nerve** may be damaged by fractures involving the optic foramen, or by compression by blood or inflammatory exudates in the orbit. Involvement by tumours or aneurisms is not uncommon. Blindness of the corresponding eye results, but contraction of the pupil occurs if the opposite retina is stimulated. The optic nerve is an outgrowth of the brain, and consequently gliomatous tumours occasionally arise in its substance.

The **Third Nerve** is sometimes involved by tumours, trauma, or aneurism, either in the skull, sphenoidal fissure, or the orbit. The following features are noticed.

(a) Ptosis of the upper eyelid, owing to paralysis of the levator palpebræ superioris.

(b) Proptosis, owing to paralysis of the majority of the ocular muscles, which normally exercise traction on the eyeball.

(c) Mydriasis, as the sympathetic fibres are unopposed, and cause unhampered dilatation of the pupil.

(d) Loss of accommodation, owing to paralysis of the ciliary muscle.

(e) Diplopia and external strabismus, with a slight downward inclination of the eyeball due to unopposed action of the external rectus and superior oblique muscles. Owing to their proximity, other nerves passing to the orbit are often affected. Pressure on the nerve above the tentorium occurs in the early stages of midbrain pressure cone formation.

The **Fourth Nerve** supplies the superior oblique muscle, and is rarely involved alone. Diplopia and deficient movement of the eye in a downward and outward direction may be noticed.

The **Fifth Nerve** or its branches are sometimes injured, and sensory disturbances follow (p. 1169).

Trigeminal neuralgia or *tic douloureux* occurs most commonly in females. The cause is unknown but may be related to infection of the nerve by the virus of herpes simplex. Pain usually commences in the third or second division and extends in time to adjacent divisions, the ophthalmic division usually escaping. The pain is characteristically intermittent and extremely severe, but of brief duration, often described as being like red-hot needles searing the flesh. Spasms of pain are precipitated by external stimuli such



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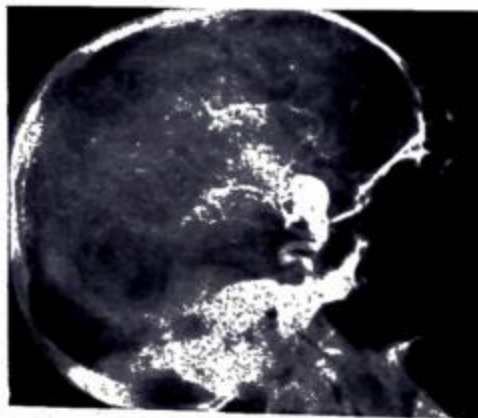


FIG. 1315.—Large aneurysm of anterior cerebral artery, producing monocular blindness.

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