CHAPTER XII

THE NECK

HAMILTON BAILEY

THE BRANCHIAL APPARATUS AND ITS ABNORMALITIES

IN a fœtus approximately thirty-five days old, four grooves can be seen on the side of the neck. These are the branchial clefts, which resemble the gills of a fish; the intervening bars are the branchial arches. Each arch contains a central cartilage. The clefts in human embryos are, more correctly speaking, grooves—grooves on the outside (fig. 242) and on the inside (pharynx). The first cleft persists as the external auditory meatus, the second, third, and fourth clefts normally disappear. The whole, or a portion of one of these vestigial structures, may persist and give rise to one of the following anomalies:

FIG. 242. — Fœtus, showing branchial grooves and arches.

Branchial Cyst.—A cyst arising from the second branchial cleft is the most common of these vestigial remnants, and it is highly important to recognise it; so frequently is it mistaken for a tuberculous abscess. Usually the cyst makes its first appearance between the twentieth and twenty-fifth years, but its advent may be postponed until the patient is over fifty. Its position is constant, viz. in the upper part of the neck beneath the upper third of the sternomastoid, protruding beneath its anterior border (fig. 243). The cyst is nearly always lined by squamous epithelium, and its contents bear a striking resemblance to tuberculous pus. If, however, a few drops of branchial fluid are examined in a fresh state under the microscope with a one-sixth power lens, usually an abundance of cholesterol crystals (fig. 244) can be seen. In this way a branchial cyst can be differentiated from a tuberculous collar stud abscess (see p. 199). It should be noted that from time to time these cysts are wont to become inflamed, which heightens their similarity to an abscess. In spite of this, the confirmatory test just described is always positive unless the contents of the cyst has been aspirated recently.

FIG. 243. — Typical branchial cyst.

FIG. 244.— Branchial fluid. Note the abundance of cholesterol crystals (rectangular, with a notch at one corner).

There is a rare variety of branchial cyst that is found lying closely related to the pharynx. It is lined by columnar epithelium, and filled with mucus. Occasionally small symptomless cysts of this type are present. From time to time they are discovered at necropsy.

Treatment.—Excision of a branchial cyst through an incision following one of the creases of the neck gives uniformly satisfactory results. After the anterior wall of the cyst has been exposed, the contents are partially aspirated. This procedure aids in the dissection of the deeper portions of the cyst, which may extend as far as the pharyngeal wall. The hypoglossal nerve is in proximity and must be recognised and protected.

Branchiogenic carcinoma undoubtedly occurs, but such a diagnosis is unjustifiable until every possible source of a primary growth in the mouth, pharynx, and external auditory meatus has been scrutinised with a negative result (p. 208). In early cases the neoplasm growing from the epithelial wall of the cyst is entirely encapsulated, and can be removed *in toto* with the cyst by dissection.

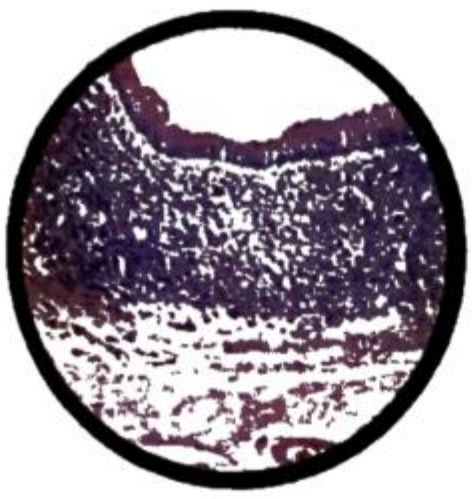

FIG. 245.—Section of a branchial fistula showing the lining of the wall.

Branchial fistula may be unilateral or bilateral and it is highly probable that the fistula represents a persistent second branchial cleft, the occluding membrane of which has broken down. The external orifice of the fistula is nearly always to be found in the lower third of the neck near the anterior border of the sternomastoid. Branchial fistulæ, which are clothed with muscle and lined by columnar ciliated epithelium (fig. 245), discharge mucus, and are often the seat of recurrent attacks of inflammation (fig. 246). In cases where the lining epithelium has been exposed to chronic infection for a long time, its characteristics are lost. When complete, the internal orifice of the fistula is commonly situated in the anterior aspect of the posterior pillar of the fauces, just behind the tonsil (C. P. Wilson). As a rule the track is incomplete and ends blindly in the region of the lateral pharyngeal wall. A branchial fistula is frequently a congenital condition, but it can be acquired. If a branchial cyst in an inflamed state is incised, the resulting sinus, which usually is situated

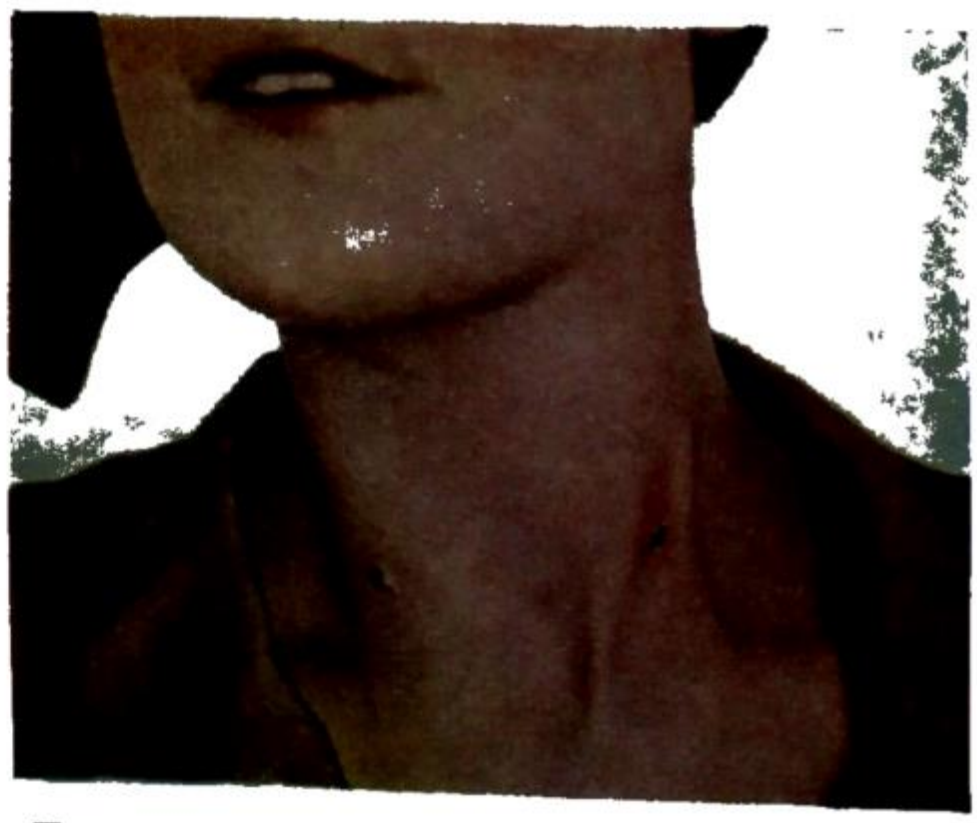

FIG. 246.—Bilateral branchial fistulæ; left side inflamed.

FIG. 247.—Complete branchial fistula. External opening in the lower third of the neck; internal opening in the tonsillar region. Injected with uropac.

Charles Paul Wilson, Contemporary. Senior Surgeon, Ear, Nose and Throat Department, Middlesex Hospital, London.

in the upper or middle thirds of the neck, continues to discharge, sometimes continuously and sometimes intermittently. The extent of the fistula can be determined by radiography following the injection of a radio-opaque medium (fig. 247).

Treatment.—When causing troublesome symptoms, branchial fistulæ should be removed completely by dissection.

In the case of a fistula without an internal opening, dissection can be facilitated in the following way: two or three days before the operation a purse-string suture is inserted subcutaneously around the external orifice. After radio-opaque medium has been injected, the suture is tied. Radiographs are taken. Pent-up secretion and the medium distend the tract, which subsequently can be followed more easily in the depths of the wound.

FIG. 248.—The step-ladder method of removing a branchial fistula.

The operation should be conducted through a transverse incision, and the dissection of the fistula proceeds in an upward direction as far as the limits of the wound permit. A second transverse incision is then made at a higher level, and the mobilised portion of the fistula is brought out of it. The dissection of the fistula is then recommenced (fig. 248). The fistula is followed to its termination, usually it passes through the fork of the common carotid artery and extends to the lateral pharyngeal wall.

FIG. 249.—Cervical auricle.

Branchial Cartilage.—A small, elongated piece of cartilage, connected to the deep surface of a cutaneous dimple in the position of an external orifice of a branchial fistula, is encountered occasionally. Usually the patient finds it accidentally, and often thinks that it is a foreign body. Histologically it is composed of typical cartilage cells.

Cervical Auricle.—So named because of its morphological significance, this cutaneous projection is found almost invariably in the position of the external orifice of a branchial fistula (fig. 249). Cervical auricles were recognised in the days of the Roman Empire, and are represented in some of the statuary of that period.

Pharyngeal Pouch (see p. 275) } are possibly derived from the
Laryngeal Pouch (see p. 291) } branchial apparatus.

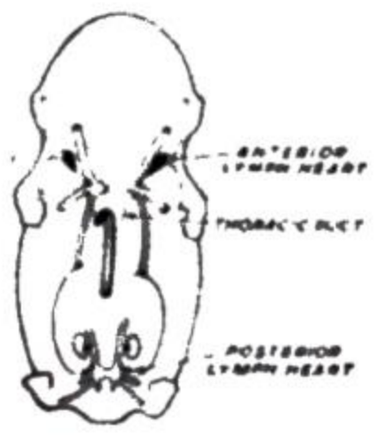

FIG. 250.—The lymph hearts of an embryo pig. (*After Sabin.*)

CYSTIC HYGROMA

Ætiology.—About the sixth week of embryonic life the primitive lymph sacs develop in mesoblast, the principal pair being situated in the neck between the jugular and subclavian veins; these correspond to the lymph hearts of lower animals (fig. 250). Sequestration of lymphatic tissue consequent upon failure of an important tributary of the primitive lymphatic system to link up with other lymphatic vessels or with the venous system accounts for the appearance of these swellings.

Of all the swellings of the neck, cystic hygroma rivals sternomastoid tumour as the earliest to appear: usually it manifests itself during early infancy, occasionally it is present at birth, and exceptionally it is so large as to

obstruct labour. Typically, the swelling occupies the lower third of the neck, and as it enlarges it passes upwards towards the ear (fig. 251).

FIG. 251. — Cystic hygroma. The swelling is brilliantly translucent. (*The late Professor Sir John Fraser, Edinburgh.*)

Due to intercommunication of its many compartments, the swelling is softly cystic and is partially compressible, but the characteristic that distinguishes it from all other cervical swellings is that it is brilliantly translucent. It often extends downwards behind the clavicle to lie upon the dome of the pleura. The axilla is another, though less frequent, site for a cystic hygroma. Exceptionally, it occurs in the groin or in the mediastinum. When situated wholly within the thorax, it cannot be differentiated from other benign neoplasms.

On pathological examination the swelling is found to consist of an aggregation of cysts like a mass of soap bubbles; the larger cysts are near the surface, while the smaller ones lie deeply (fig. 252) and tend to infiltrate muscle planes. Each cyst is lined by a single layer of endothelium having the appearance of mosaic and is filled with clear lymph.

FIG. 252. — A cystic hygroma consists of an aggregation of cysts filled with lymph. The larger cysts are nearer the surface. The spaces are lined by a single layer of endothelial cells.

Clinical Course.—The behaviour of cystic hygromata during infancy is so uncertain that it is impossible at that age to prognosticate as to what will happen. Sometimes growth is extremely rapid and occasionally respiratory difficulty ensues, a contingency that demands immediate aspiration of much of the contents of the cyst. At other times, as a result of nasopharyngeal infection, the swelling becomes the seat of inflammation. Provided the child, with the help of antibiotic therapy, can overcome the infection, occasionally spontaneous regression of the cyst follows this complication.

Treatment:

Excision.—Undoubtedly complete dissection of the entire cyst at an early age is the treatment of election. The operation should be performed early, because as time goes on the cyst becomes more adherent and therefore its complete dissection becomes more difficult. Admittedly tedious, because it is necessary to follow to their terminations numerous finger-like projections, the walls of which are of tissue-paper-like thinness, when performed early the operation is not particularly difficult, provided anæsthesia is excellent. On no account must the cyst wall be picked up with dissecting forceps, because it will tear, and partial collapse of the cyst will result. If the cyst is removed incompletely, the more immediate danger will be that there is so much leakage of lymph that unless fluid balance can be maintained the child will become dehydrated. In all cases the wound must be drained for forty-eight hours.

Insertion of a Buried Seton.—A wisp of fine floss nylon is attached to a wire, which permits both to be drawn through a maxillary antrum cannula. The instrument, with its trocar in place, is passed subcutaneously from the non-affected side of the neck, through the cystic hydroma, and out through the skin of the opposite side, the slant of the cannula being such that the tract is higher on the side of the lesion. The floss nylon is passed through the cannula by means of the wire, and the cannula is withdrawn. The ends of the seton are trimmed and tucked beneath the skin. The punctures are sealed. The objective is to provide continuous internal drainage into the opposite side of the neck, where there is no lymphatic obstruction (C. Bowesman).

Several other methods of treating cystic hygromata have been advocated, but none is effective, and directly or indirectly they have contributed to the mortality, which is not inconsiderable.

Solitary lymph cyst is a condition akin to the foregoing, but differs in that it is nearly always first seen in adult life. As its name implies, it is a single cyst filled with lymph, and it is usually found in the supraclavicular triangle (fig. 253).

FIG. 253.—Solitary lymph cyst of the neck.

Treatment by excision is eminently satisfactory.

STERNOMASTOID TUMOUR

This hard, fusiform swelling of the lower third of the sternocleidomastoid (fig. 254) makes its appearance one or two weeks after birth. It remains stationary in size until the third month, and then disappears gradually. Untreated, in a large percentage of cases it is the precursor of congenital torticollis. After the sixth month the affected muscle can be felt as a tight cord. It is not until about the age of four years, when the child's neck commences to increase in length comparatively quickly and as a consequence the head is drawn towards the shoulder on the affected side, that the deformity becomes unmistakable. Scoliosis and elevation of the scapula occur on the side of the lesion. Still untreated, irremediable facial asymmetry ensues; the face and the cranium on the affected side fail to lengthen *pari passu* with the normal side (fig. 255). A new macula lutea[1] is said to develop at a slightly higher level on the affected side. When a patient with torticollis is

FIG. 254.—Sternomastoid 'tumour.'

FIG. 255.—Asymmetry of the skull of an adult who had suffered from torticollis.

[1] Macula lutea—the point of clearest vision at the centre of the retina.

Charles Bowesman, Contemporary. Surgeon, Kumasi Hospital, Kumasi, Ghana.

seen for the first time and a history of a lump in early infancy is lacking, a radiograph must be taken to exclude a hemi-vertebra lacking on the affected side.

Pathology.—Histologically the mass in the sternomastoid muscle consists of white fibrous tissue (fig. 256). Middleton showed experimentally that such a condition can arise from thrombosis of veins draining the lower part of this muscle. Briefly, the condition can be regarded as a Volkmann's ischæmia of the sternocleidomastoid.

FIG. 256.—A sternomastoid 'tumour' excised from an infant aged six weeks, showing replacement of the muscle by fibrous tissue.
(D. S. Middleton.) (British Journal of Surgery.)

Theories of Causation.—For many decades controversy has centred around the cause of sternomastoid tumour. At the present time the theory that the condition is due to an ischæmia resulting from malposition *in utero* has the greatest number of adherents. The minority believe that the swelling is an example of the rarest tumour to which the body is heir—a pure fibroma.

Treatment.—(*a*) *Manipulation*, even when commenced soon after the disappearance of the swelling, often proves disappointing. To carry it out properly two persons are required, one to hold the shoulders and the other to extend the neck towards the non-affected side. To achieve the desired result, these manœuvres must be performed twice a day for years. Except in a few households, to make the necessary arrangements *every* day is impracticable.

(*b*) *Von Lackum's operation* is undertaken while the 'tumour' is still present, or soon afterwards. Through a transverse incision the swelling and muscle in the neighbourhood that is even doubtfully normal is excised, care being taken to preserve the integrity of the eleventh nerve, although its branch to the sternomastoid may have to be sacrificed. No attempt is made to close the gap, but the subcutaneous tissues are approximated accurately before closing the wound. No special after-treatment is required. Excellent results accrue; the muscle is said to regenerate.

(*c*) The correction of established torticollis is discussed in Chapter 51.

FIG. 257.—Webbing of the neck.
(Mr. Geoffrey Flavell, London.)

WEBBING OF THE NECK

This rare condition is usually associated with Turner's syndrome, which comprises webbing of the neck (fig. 257), an increased carrying angle of the elbow joints, and sexual infantilism. No satisfactory embryological explanation of the abnormality has been put forward. It may well be an example of atavism, for it occurs naturally in the chimpanzee.

CERVICAL RIB AND THE SCALENE SYNDROME

By mass radiography it has been ascertained that a cervical rib occurs in 0·46 per cent. of persons. In a little more than half of these the cervical

Brigadier Donald Stewart Middleton, 1899–1942. Assistant Surgeon, Royal Infirmary, Edinburgh. (Died on Active Service.)
Richard von Volkmann, 1830–1889. Professor of Surgery, Halle.
Herman LeRoy von Lackum, 1892–1928. Surgeon, Orthopædic Dispensary and Hospital, New York.
Henry Hubert Turner, Contemporary. Associate Professor of Medicine, Oklahoma University, U.S.A.

rib is unilateral, and somewhat more frequent on the right side. It is paradoxical that a cervical rib or ribs found in the course of routine X-ray examination hardly ever gives rise to symptoms, whereas more often than not when a radiograph of the cervical region is requested on account of symptoms suggesting a cervical rib, no such rib is demonstrable.

FIG. 258.—Cervical ribs that recurred after (subperiosteal) removal. Male aged forty-three years.

Usually extra ribs spring from the seventh cervical vertebra (fig. 258). Five main varieties of cervical rib exist :

(*a*) A complete rib, often containing a false joint in its length, articulates anteriorly with the manubrium or the first rib.

(*b*) The free end of rib expands into a large bony mass.

(*c*) A rib ending in a tapering point, which is connected by a fibrous band to the scalene tubercle of the first rib.

(*d*) A fibrous band closely applied to, or incorporated in, the scalenus medius alone is present. This not infrequent variety, of course, cannot be demonstrated radiologically.

(*e*) When there is 'postfixation' of the brachial plexus, by which is meant that the brachial plexus receives a contribution from the second thoracic nerve, a normal first rib can cause nerve-pressure symptoms in the same way as a cervical rib. However, there are no reports of a series of anatomical dissections in support of this hypothesis.

At their exit from the neck the brachial plexus and the subclavian artery pass through a narrow triangle (fig. 259). In this triangle the first dorsal nerve, together with the main aggregation of sympathetic fibres supplying the arteries of the upper limb, are in a vulnerable position ; they may be looked upon as in a potential vice (fig. 260), the ventral jaw of which is the scalenus anterior, while the particular structure forming the dorsal jaw varies :

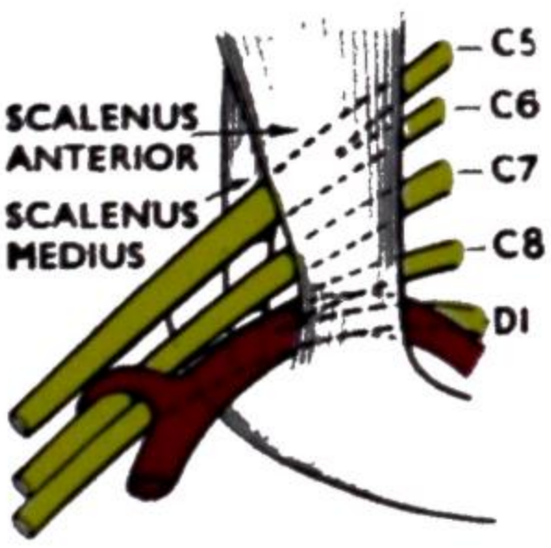

FIG. 259.—The anatomy of the parts concerned.
(*After Lambert Rogers.*)

1. Normally it is the scalenus medius.

2. Sometimes an inconstant little muscle—the scalenus minimus that at its insertion into the first rib lies between the subclavian artery and the nerve trunks.

3. An ossified or unossified (band of fibrous tissue) cervical rib.

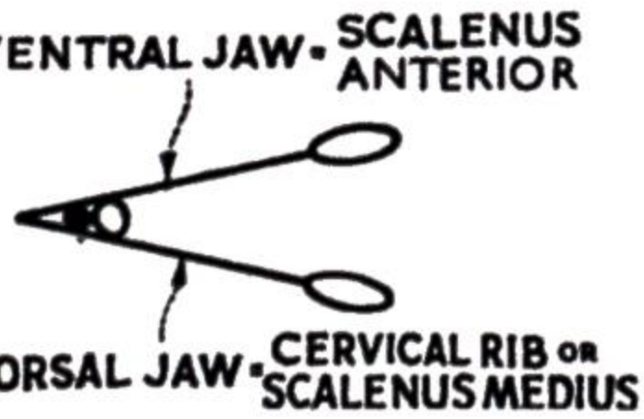

FIG. 260.—The constitution of jaws of the metaphorical scalene vice = vice No. 1.

To add to the threat of compression, on occasions the suprascapular artery arises from the third part of the subclavian artery, and it passes between the upper and middle trunks of the brachial plexus (see fig. 259), and compresses the latter and the lowest trunk against the subclavian artery (Lambert Rogers).

Clinical Features.—The patient usually presents during adolescence, when sagging of the musculature of the shoulder girdle sometimes occurs in those who are growing rapidly. There are many exceptions—change to an unaccustomed occupation, e.g. a widow who takes to washing (Sir Henry Head), or truly occupational, e.g. the postman with his bag. Symptoms are four times more common on the right side, owing to greater use of the right arm. Some temporary relief is effected by bracing the shoulders.

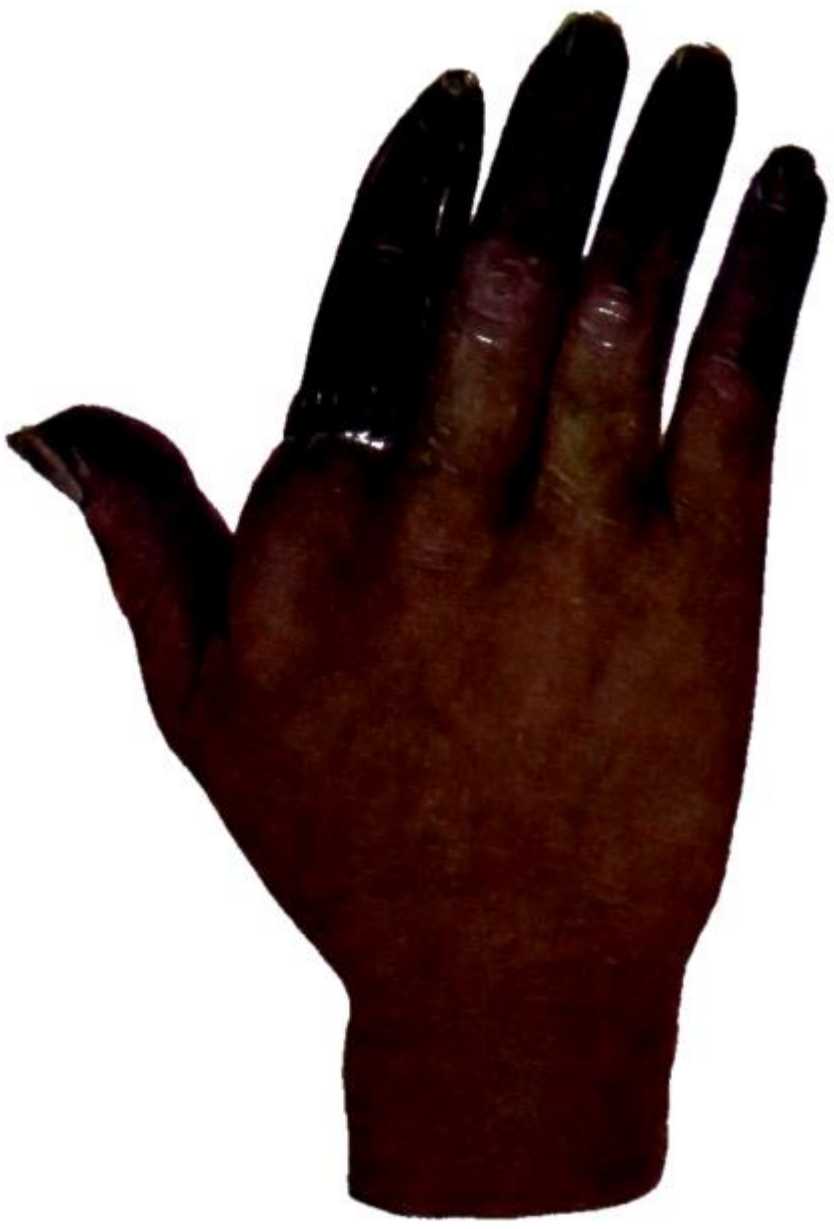

FIG. 261.—Cervical rib with vasomotor symptoms, culminating in gangrene of the index finger. (*Telford and Stopford.*) (*British Journal of Surgery.*)

The symptoms may be divided into three categories. Usually one alone is in evidence:

1. **Local symptoms** are present only in some instances of a well-formed cervical rib, particularly when it is of the second variety illustrated above. The chief local symptom is tenderness in the supraclavicular fossa. Sometimes a palpable, and occasionally visible, swelling is present.

2. **Vasomotor symptoms** are not common. They are due to squeezing of the aggregation of sympathetic fibres that lie beneath the first dorsal nerve. They are divided into two types.

(*a*) *Vascular symptoms* are those of increasing circulatory impairment in the affected limb, which eventually may progress to gangrene (fig. 261). The volume of the pulse is diminished, but it increases on raising the arm. When gangrene develops, it is the index finger that is affected, often exclusively. Compression of the artery cannot be the cause, because ligation of the subclavian artery, even in an elderly person, is not followed by gangrene. Therefore it must be concluded that the vascular symptoms are due to pressure-irritation of sympathetic nerve fibres passing to supply the brachial artery and the arteries of the forearm (E. Telford). These sympathetic nerve fibres form an isolated bundle beneath the first dorsal nerve.

Differential Diagnosis.—In the vascular variety a differential diagnosis must be made from Raynaud's disease, chilblains, and subclavian aneurism.

(*b*) *Hyperhidrosis* (*excessive sweating*) *of the hand* is occasionally the main complaint.

3. **Nerve-pressure symptoms,** due to squeezing of the first dorsal nerve in the scalene vice, can be subdivided into two varieties:

Lambert Charles Rogers, Contemporary. Professor of Surgery, University of Wales, Cardiff.
Sir Henry Head, 1861–1940. Physician to the Neurological Dept., The London Hospital.
Evelyn Davison Telford, Contemporary. Emeritus Professor of Surgery, University of Manchester.
Maurice Raynaud, 1834–1881. Physician, Hôpital Lariboisière, Paris.

(*a*) *A hypothenar syndrome*, characterised by tingling, numbness, and sometimes pain over the ulnar border of the forearm and later by wasting of the muscles of the hypothenar eminence. Early symptoms are relieved temporarily by elevation of the arm.

(*b*) *A Thenar Eminence Syndrome.*—The muscles of the thenar eminence are first affected, and wasting is often limited to the abductor and opponens pollicis, a distribution which is in contrast to progressive muscular atrophy. In long-standing cases a claw hand can result.

Differential Diagnosis.—When motor nerve-pressure symptoms are present a differential diagnosis must be made from progressive muscular atrophy, syringomyelia, peripheral nerve injury, and brachial neuritis in all its various forms. Above all, newer pathological concepts must be taken into consideration. First, many of the nerve-pressure symptoms formerly attributed to a cervical rib can be, and are, produced by pressure on the cervical roots in the region of the intervertebral foramena by lateral protrusion of intervertebral discs. Secondly, acroparæsthesia and wasting of the thenar eminence is often due to pressure on the median nerve at the wrist, in which case it can be cured easily by division of the flexor retinaculum (see Chapter 50). Thirdly, the hypothenar syndrome can also arise from compression of the ulnar nerve behind the elbow (Ll. Griffiths).

Treatment.—In mild cases the use of a sling and exercises aimed at strengthening the muscles of the shoulder girdle may alleviate the symptoms, at least temporarily. Even in cases where a cervical rib can be demonstrated, Adson has shown that in about 70 per cent. of cases the symptoms are relieved by dividing the scalenus anterior (scalenotomy) (fig. 262). Other surgeons make a practice of removing the cervical rib or the corresponding band in addition, and in this way reduce the number of unsatisfactory results. If a cervical rib is excised, it is essential to remove it with its periosteum or it will probably regenerate (see fig. 258).

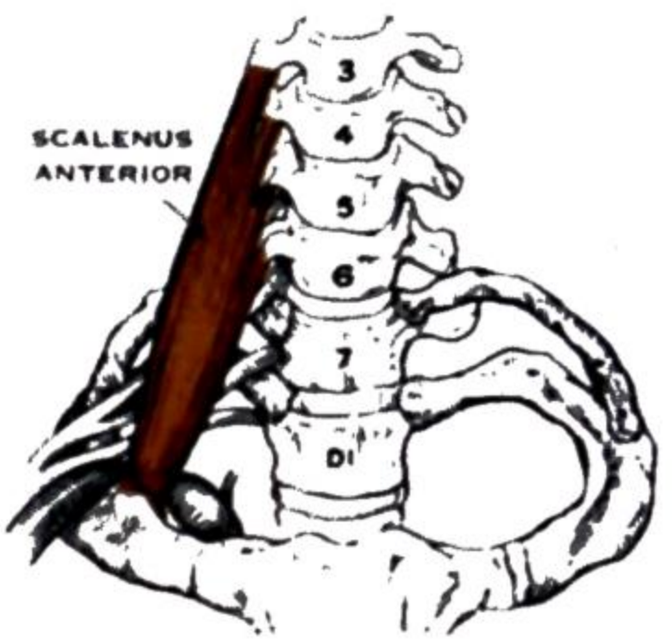

FIG. 262.—Showing the rationale of scalenotomy.

ALLIED SYNDROMES

The Costo-clavicular Syndrome.—Vascular symptoms predominate. The subclavian artery and the lowest trunk of the brachial plexus become compressed between the clavicle and the first rib (fig. 263). According to A. G. M. Weddell, congenital narrowing of the interval between the clavicle and the first rib is the cause. The subclavian artery itself can be compressed in this vice (Sir Francis Walshe).

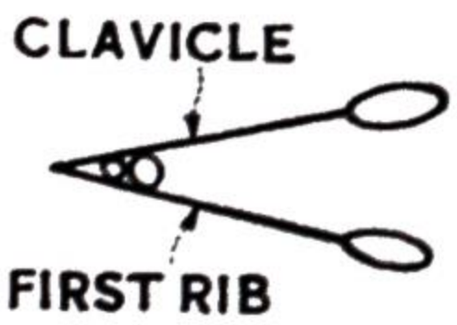

FIG. 263.—The costo-clavicular vice = vice No. 2.

The patient is instructed to stand at military attention. The volume of the pulse is noted. He is then instructed to abduct the arm to a right angle, and finally to raise it above the head. If the costo-clavicular syndrome is the cause of the symptoms, the pulse will weaken perceptibly in the last position.

Treatment.—Should exercises designed to strengthen the

David Lloyd Griffiths, Contemporary. Senior Orthopædic Surgeon, Royal Infirmary, Manchester.
Alfred Washington Adson, Contemporary. Senior Neurological Surgeon, Mayo Clinic, Rochester, U.S.A.
Alexander Graham McDonnell Weddell, Contemporary. Reader in Human Anatomy, University of Oxford.
Sir Francis Martin Rouse Walshe, Contemporary. Consulting Physician, University College Hospital, London.

levator scapulæ and trapezius muscles fail, scalenotomy, by enlarging the costo-clavicular space, affords some relief, but it is insufficient. That portion of the first rib in which the subclavian artery lies must be nibbled away, and the cut edges of the bone smeared with Horsley's bone wax.

Compression of the Axillary Artery by the Median Nerve.—E. D. Telford seems to have proved conclusively that the axillary artery can be squeezed between the two heads of the median nerve = vice No. 3.

Compression of the Axillary Vessels by the Pectoralis Minor.—Series of cases have been reported where division of the pectoralis minor has succeeded where other measures have failed. It is alleged that spasm or contracture of this muscle can compress the axillary vessels and the lowest cord of the brachial plexus = vice No. 4.

INJURIES

Cut Throat.—In more than half the cases of cut throat that reach surgical aid the wound does not involve any vital structure—only the skin, platysma, and perhaps the sternomastoid or other muscles are severed. Even the external jugular vein does not necessarily come under the category of a vital structure in this respect. The treatment of these superficial injuries follows elementary surgical principles.

Serious Cases.—Self-inflicted wounds of the neck are usually perpetrated with the head extended, the wound being more or less transverse. In this extended position the great vessels of the neck are protected by the sternomastoids and the larynx. So it comes about that the great vessels of the neck are comparatively rarely injured, while the air passages bear the brunt.

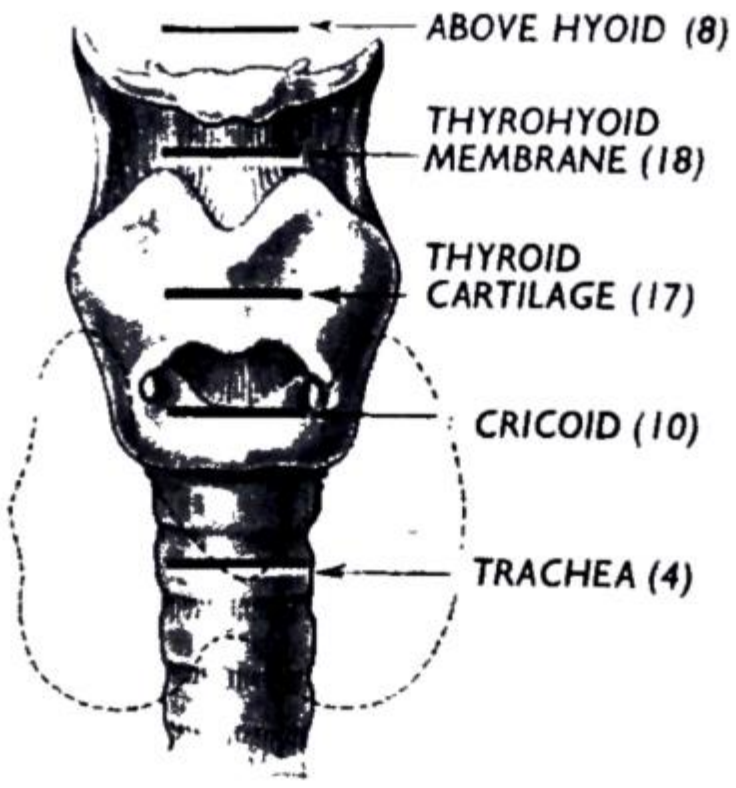

FIG. 264.—Position of the wound into the air passages of fifty-seven cases of suicidal cut throat with a deep wound.

Treatment.—Attention is directed, firstly, to arresting hæmorrhage; secondly, to dealing with the wounded air passage; and, thirdly, to the repair of other structures.

Various moderate-sized arteries and veins will require ligation. Hæmorrhage from an inaccessible branch of the external carotid is best dealt with by ligating that trunk near its origin. It has been stated already that injury to the main vessels is comparatively rare, and when it occurs death usually supervenes before surgical aid is forthcoming.

The principal sites of wounds of the air passages are indicated in fig. 264.

Wounds above the Hyoid Bone.—After cleansing the area the wound is explored with a finger. Quite often it will be found that the cavity of the mouth has been entered. The epiglottis is often partially divided near its base. This should be repaired with catgut sutures. The mucosa of the pharynx is trimmed and united. Unless the case is a very early one, it is best to pack the wound lightly with petroleum-jelly gauze and apply a viscopaste bandage. Secondary closure can be undertaken later.

Wounds of the Thyrohyoid Membrane.—Again the epiglottis is often damaged. The severed thyrohyoid membrane can usually be sutured. If there is respiratory distress, it is advisable to perform tracheostomy.

Division of the Thyroid Cartilage.—The thyroid cartilage can be repaired with sutures, provided these are not tied tightly, for a stitch through cartilage tends to cut out. Tracheostomy is usually indicated.

Sir Victor Horsley, 1857–1916. Neurological Surgeon, University College Hospital, London.

Wounds about the Cricoid Cartilage.—Tracheostomy should be performed. The larynx is repaired with interrupted sutures, and after débridement the wound is closed with drainage.

Division of the Trachea.—Wounds of the trachea are comparatively rare. In order to obtain adequate exposure it is usually necessary to divide the thyroid isthmus between hæmostats. In most instances it is advisable to perform tracheostomy below the wound, and then to proceed to repair the latter with sutures.

Injury to Nerves.—It is remarkable how rarely important nerves are injured in self-inflicted wounds. In stab wounds any nerve may be involved. In one of our patients, a sailor, the most inaccessible nerve in the neck, the cervical sympathetic, was divided in this way, the assailant's weapon being a small penknife.

COMPLICATIONS OF CUT THROAT

1. **Loss of Blood.**—If the hæmorrhage has been severe, dextran, plasma, or blood transfusion is indicated.
2. **Air Embolus.**—In cases encountered in medico-legal practice the cause of death is frequently venous air embolism (Keith Simpson).
3. **Infection of the wound** is not very frequent, but these wounds should always be drained as they have been inflicted with a potentially infected instrument. Cellulitis sometimes supervenes, and this may spread to the mediastinum.
4. **Pneumonia.**—In spite of antibiotic therapy pneumonia is a relatively common complication, especially in those cases where the air passages have been opened.
5. **Aerial Fistula.**—A persistent communication between the air passages and the exterior is likely to occur when there has been actual loss of substance of the larynx or trachea. In suitable cases a plastic operation may be undertaken.
6. **Stenosis of the Larynx or Trachea.**—Due to cicatrisation; rarely it necessitates permanent tracheostomy.
7. **Œsophageal Fistula.**—Œsophageal or pharyngeal fistula is a very rare occurrence, and it tends to heal spontaneously.
8. **Surgical emphysema** is another rare complication, and it usually occurs when tracheostomy tube has been omitted in the treatment of the case.
9. **Aphonia or dysphonia** may follow injury to the vocal cords or division of a recurrent laryngeal nerve.

WOUNDS OF THE CERVICAL PORTION OF THE THORACIC DUCT

Wounds of the thoracic duct are rare, and usually occur during dissection of lymph nodes in the left supraclavicular fossa. When the accident is not recognised at the time, chyle pours from the wound—as much as 2 or 3 pints in twenty-four hours—and, as a result, the patient wastes rapidly.

Treatment.—Should the accident be recognised during an operation, the proximal end of the duct must be ligated with fine silk. Ligation of the duct is not harmful, for there are a number of anastomotic channels between the lymphatic and the venous systems in the neighbourhood. Usually the first intimation of a severed thoracic duct is a copious chylous discharge from the wound on the day following the operation. That the fluid *is* chyle is substantiated if it has a specific gravity of over 1.012 and if fat can be extracted from it with ether. Firm pressure by a pad and bandage should be applied, but this simple expedient is seldom successful. More often the wound must be reopened. If the patient is given cream to drink an hour before the operation, more especially if the cream is coloured with confectioners' green dye (D-C 6), there is seldom any difficulty in locating a cut thoracic duct, which is about the size of a straw and an immediate external relation of the last 1½ inches (3·75 cm.) of the left internal jugular vein (fig. 265). If the duct is found, it should be ligated, but in any case the wound should be packed firmly and allowed to heal by granulation. Thanks to subsidiary anastomotic channels, these measures are regularly satisfactory.

FIG. 265.—The termination of the thoracic duct.

Cedric Keith Simpson, Contemporary. University Reader in Forensic Medicine, Supervisor of Medico-Legal Post-mortems, Guy's Hospital, London

INFLAMMATORY CONDITIONS

Acute cellulitis may be superficial or deep to the deep cervical fascia. The former is common, and methods of treatment follow that of cellulitis elsewhere. The latter is comparatively rare, but when it occurs above the level of the hyoid bone it is especially dangerous, because sudden asphyxia from œdema of the glottis is an ever-present possibility.

On the other hand, deep cellulitis in the lower third of the neck is free from this danger. Consequently, it can be treated by antibiotic therapy with every confidence, and should an abscess develop, it is opened.

FIG. 266.—Ludwig's angina. The brawny swelling beneath the mandible and the œdema of the floor of the mouth are characteristic.

There are three closed fascial spaces in the upper third of the neck, all of which require early decompression if symptoms and signs persist after a few hours' trial of antibiotic treatment. The three suprahyoid infections of the neck are Ludwig's angina, infection of the masticator space, and infection of the pharyngomaxillary space.

Ludwig's Angina.—Ludwig described a clinical entity characterised by a brawny swelling of the submaxillary region combined with inflammatory œdema of the mouth. It is the *combined* cervical and intrabuccal signs that constitute the characteristic feature of the lesion (fig. 266). The cause of the condition is a virulent (usually streptococcal) infection of the cellular tissues about the submaxillary salivary gland.

Clinical Course.—Unless the infection is controlled, certain cases rapidly assume a grave aspect. The swollen tongue is pushed towards the palate and forwards through the open mouth, while the cellulitis extends down the neck in that most dangerous plane—deep to the deep fascia.

Ludwig's angina is an infection of a closed fascial space, and untreated the inflammatory exudate often passes via the tunnel occupied by the stylohyoid to the submucosa of the glottis, in which event the patient is in imminent danger of death from œdema of the glottis.

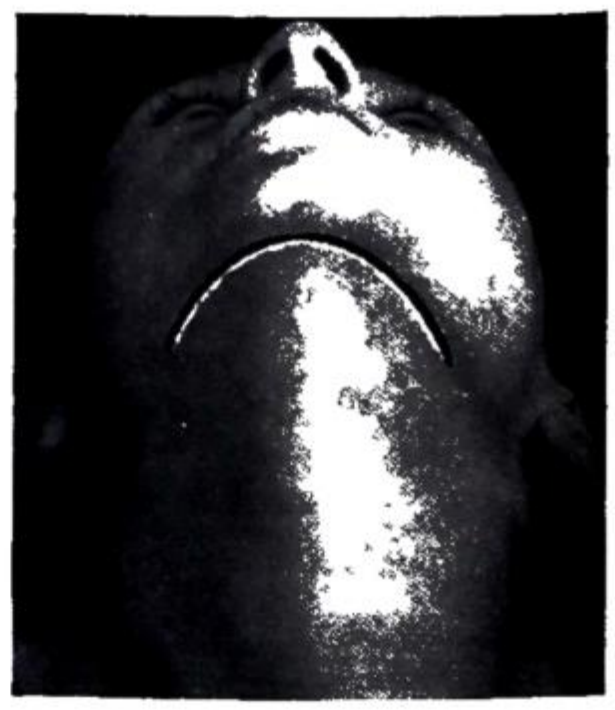

FIG. 267.—Incision for decompressing thoroughly the space beneath the mylohyoid muscle.

Treatment.—When the condition is diagnosed early, the results of antibiotic therapy are sometimes dramatic. In cases where the swelling, both cervical and intrabuccal, does not subside rapidly with such treatment, a curved incision beneath the jaw, as is shown in fig. 267, is made. The incision is deepened, and after displacing the superficial lobe of the submaxillary salivary gland, the mylohyoid muscles are divided. This decompresses the closed fascial space

Wilhelm von Ludwig, 1790–1865. ***Professor of Surgery and Midwifery, Tübingen ; also Court Physician.***

referred to. The wound is left open. The operation can be conducted (with the greatest safety) under local anæsthesia.

Infection of the Pharyngo-maxillary Space (*Parapharyngeal Abscess*).—The pharyngo-maxillary space is a potential cone-shaped space, base uppermost. The base is formed by the base of the skull; the apex abuts the great cornu of the hyoid bone; the medial wall consists of the superior constrictor muscle; the lateral wall, from above, downwards, is composed of the fascia covering the internal pterygoid muscle, the mandible about its angle, and the submaxillary salivary gland, below which the apex of the space becomes relatively superficial. Usually infection of this space originates in the tonsil, and in a number of instances it has occurred after tonsillectomy, especially when the operation has been performed under local anæsthesia.

Clinical Features.—Every posterior, peritonsillar abscess is a potential pharyngo-maxillary space infection, the general reaction of which is greater than that accompanying peritonsillar abscess. There is often *slight* trismus, and swelling over the lower part of the parotid gland: this is never present in quinsy. Tenderness, and later swelling below the angle of the mandible, appears when the apex of the space is involved. As the carotid sheath runs though the space, on numerous occasions the dreaded complications of thrombophlebitis of the internal jugular vein and/or erosion of an artery, usually the internal carotid, have occurred when the space has been left undrained for a number of days. Sometimes the abscess bursts spontaneously between the cartilaginous plates of the external auditory canal, but obviously such an eventuality is a fortunate escape from death, for which the patient's medical advisers can take no credit.

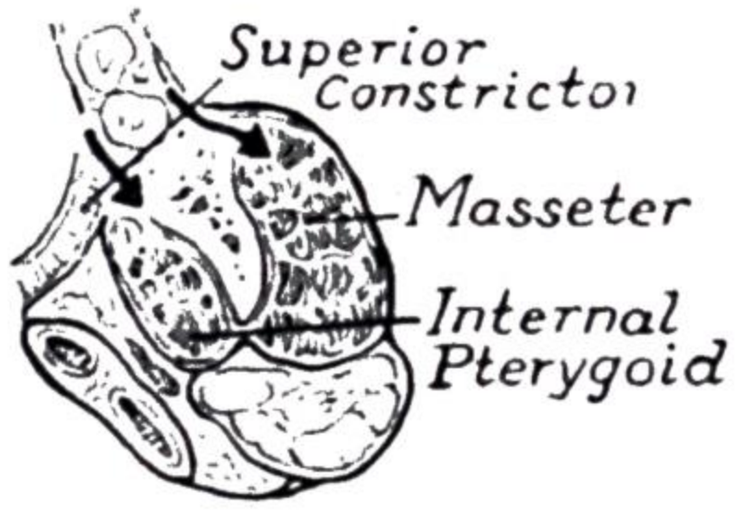

FIG. 268.—The masticator space. Arrows indicate the course of pus from an alveolar abscess of a molar tooth to this space.

Treatment.—As soon as the diagnosis is strongly suspected an incision should be made below and behind the angle of the mandible, on a line towards the hyoid bone. A finger is passed upwards, medial to the mandible, and the distended space is entered by rupturing its wall. The space is drained with a large soft wick drain.

Infection of the Masticator Space.—The masticator space is a closed fascial space containing the ascending ramus of the mandible and the muscles of mastication (fig. 268). Subperiosteal infection of the mandible and dento-alveolar abscess, especially from the third molar tooth, sometimes extend to involve this space.

Clinical Features.—Early *pronounced* trismus is a leading sign of infection of this space. The predominance of internal or external induration depends upon which aspect of the mandible is involved.

Treatment.—If antibiotic therapy is not quickly effective, an incision should be made over the angle of the jaw. If pus is not forthcoming, a closed hæmostat should be passed around the posterior border of the mandible—a step that is often rewarded by a gush of stinking pus. Corrugated rubber drainage completes the operation.

FIG. 269.—The woody phlegmon of Réclus.

CHRONIC CELLULITIS

The Woody Phlegmon of Réclus is uncommon. One side of the neck becomes swollen and extremely indurated; the supple integument of the neck becomes like a hide. There may be pitting on pressure, and some erythematous blush in the overlying skin. Woody phlegmon (fig. 269), which is probably due to an infection by an attenuated staphylococcus, runs a chronic course, is almost painless, and produces few or no constitutional symptoms. The condition must be distinguished from actinomycosis and advanced malignant disease.

Treatment.—Penicillin therapy should effect a cure; if it fails to do so, fomenta-

Paul Réclus, 1847–1914. Surgeon to the hospitals of Paris.

tions followed by suitable incisions are indicated. Once a flow of pus has been established, the neck regains its suppleness, and the condition clears up.

CERVICAL LYMPHADENITIS

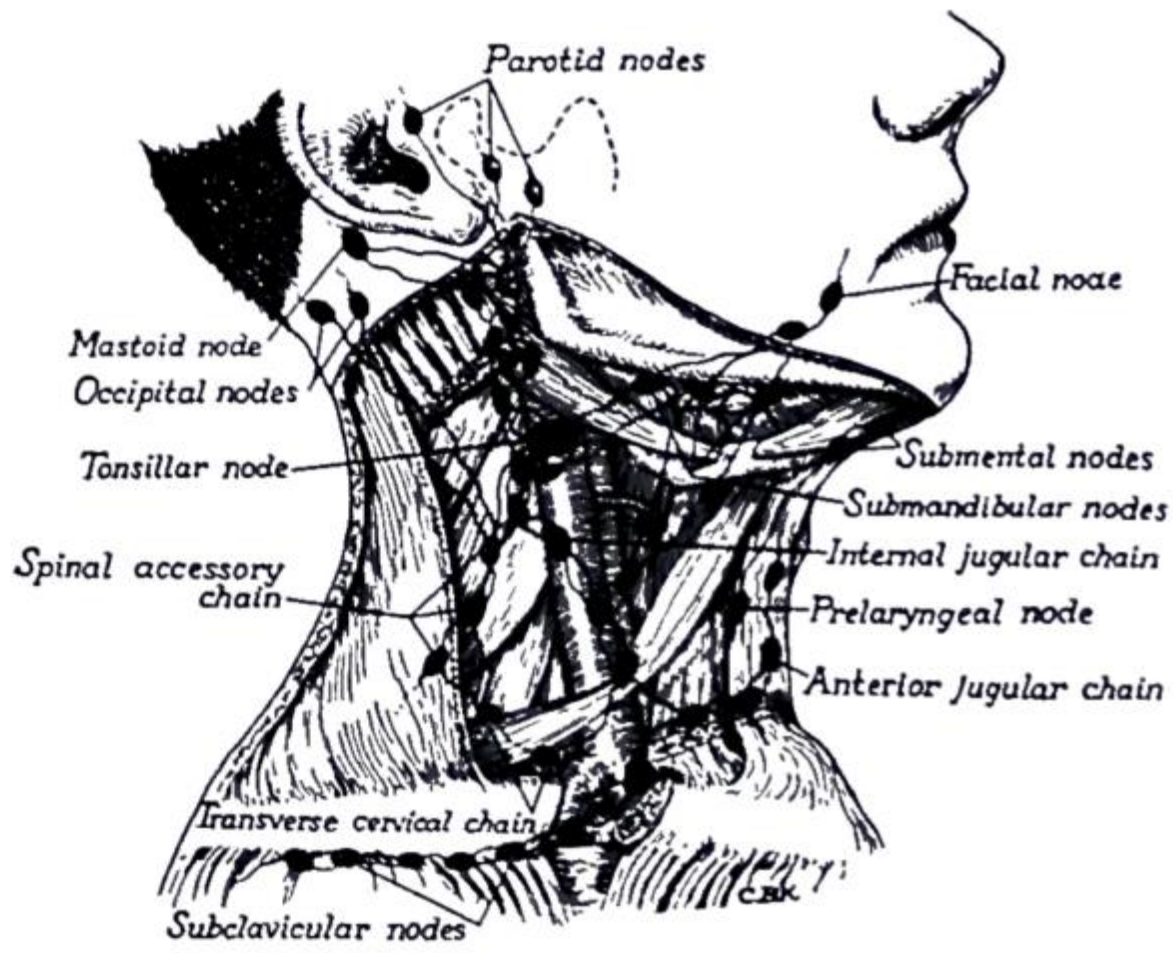

FIG. 270.—The lymphatics of the facio-cervical region. (*After Murry M. Copeland.*)

There are approximately 800 lymph nodes in the body; no fewer than 300 of them lie in the neck (fig. 270). Inflammation of the lymph nodes of the neck is exceedingly common. Infection occurs from the oral and nasal cavities, the ear, the scalp, and face. The source of infection must be sought for systematically.

Acute Lymphadenitis.—The affected nodes are enlarged and tender, and there is a varying degree of pyrexia. The treatment, in the first instance, is directed to the general condition and to the focus of infection, the neck itself being simply protected by a bandage over wool. If, in spite of antibiotic therapy, pain continues or certain nodes appear to be getting larger, fomentations are applied locally. Abscess formation calls for adequate drainage.

FIG. 271. — Subacute non-tuberculous cervical lymphadenitis.

Chronic Lymphadenitis.—In the early stages it is extremely difficult to distinguish tuberculous adenitis from subacute (fig. 271) and chronic non-tuberculous adenitis, but clinical experience shows that chronically inflamed nodes which do not resolve in the space of three or four weeks are nearly always tuberculous. Tuberculin skin tests (see Chapter 37) are helpful in confirming a diagnosis.

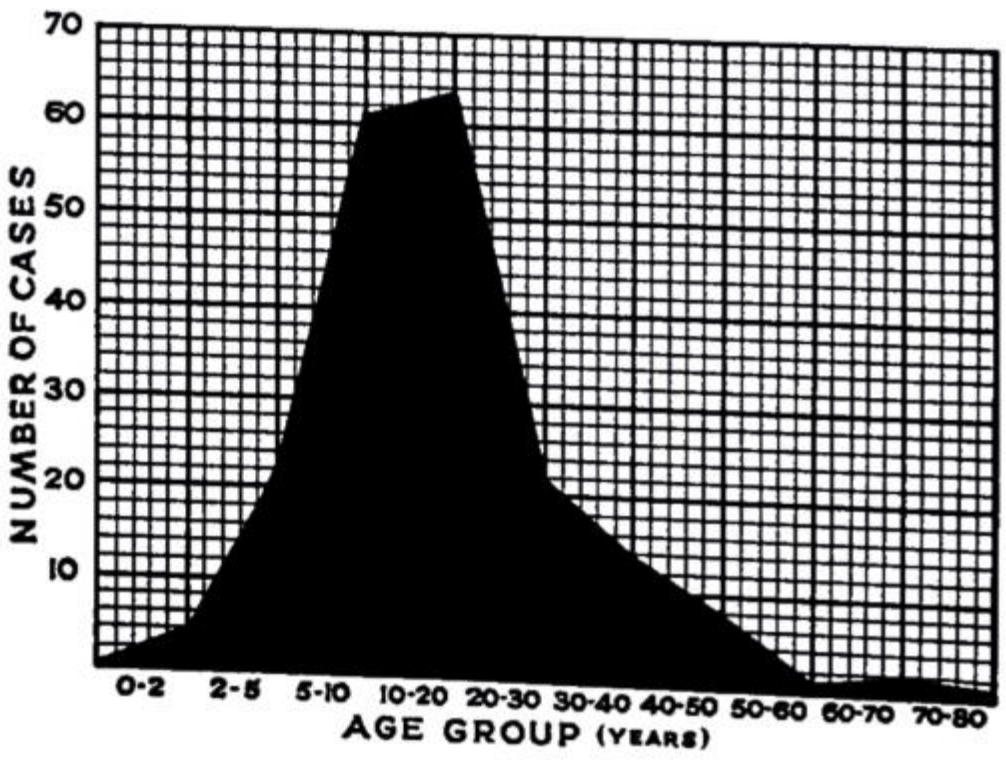

FIG. 272.—Age incidence of 200 consecutive patients suffering from tuberculous cervical adenitis.

Tuberculous cervical adenitis is very common in the British Isles. The majority of patients affected are children [1] or young adults (fig. 272), but the condition can occur for the first time at any age. Usually one group of cervical nodes is at first infected (fig. 273). It will be noticed that the ones infected most frequently are those of the upper jugular chain.

[1] Marfan's law states that those who suffer from tuberculous cervical adenitis that heals before adolescence seldom develop pulmonary tuberculosis.

Antonin Bernard-Jean Marfan, 1858–1942. Professor of Pædiatrics, Paris.

More rarely there is widespread cervical lymphadenitis, and it is in these cases particularly that periadenitis or matting of the lymph nodes is in evidence.

Source of Infection.—In the majority of instances tubercle bacilli gain entrance through the tonsil of the corresponding side. Sometimes tubercle bacilli can be demonstrated in carious teeth, and this is a portal that should be suspected when the submaxillary or submental groups of lymph nodes are principally affected. The frequency (22 per cent.) with which the nodes of the posterior triangle are infected is more difficult to explain. It is unlikely that tubercle bacilli often gain entrance through the scalp, which is rightly looked upon as the main portal of these nodes for other infections. Seeing that some of the lymphatic vessels from the adenoid area pass directly to the lymph nodes of the posterior triangle, it is probable that air-borne infection reaches the nodes of the posterior triangle through this often-diseased filter.

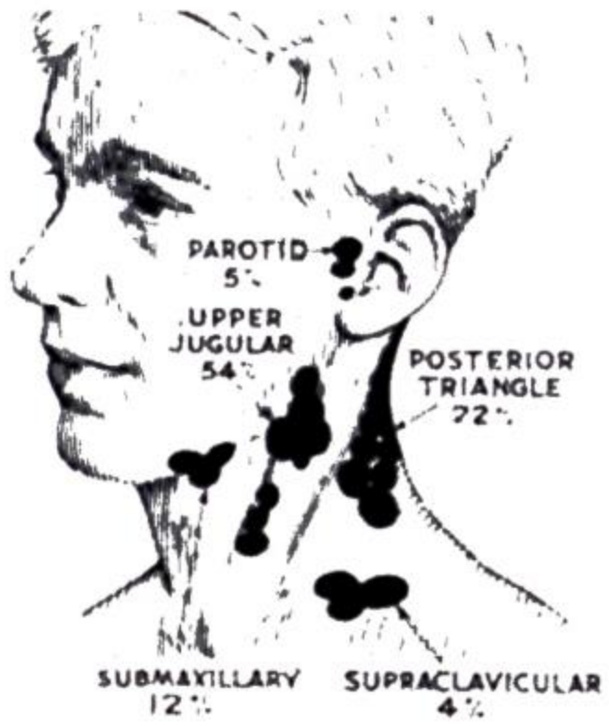

FIG. 273.—Groups of cervical lymph nodes infected by tuberculosis, founded on 372 consecutive cases. The 3 per cent. not labelled are divided between the mid-jugular group (shown) and the submental group (not shown).

Contrary to what is believed generally, it is the human,[1] and not the bovine, bacillus that is responsible for tuberculous cervical adenitis in about 70 per cent. of cases. In fully 80 per cent. of cases the tuberculous process is limited virtually to the clinically affected group of nodes; nevertheless, especially in widespread adenitis and in that occurring in the supraclavicular fossæ, a primary focus in the lungs must be suspected.

In the event of the patient developing a natural resistance to the infection or (more often) as a result of appropriate general treatment, resolution or calcification may occur. In other circumstances the caseating material (fig. 274) liquefies, breaks through the capsules of the nodes, and a 'cold abscess' forms. The pus is at first confined by the *deep* cervical fascia. In a few weeks this dense sheet becomes eroded at one point, and the pus flows through the small opening into that more commodious space beneath the *superficial* fascia. The process has now reached the well-known stage of collar-stud abscess (fig. 275). The superficial abscess enlarges steadily, and unless skilful treatment is adopted the skin will soon become reddened over the centre of the fluctuating swell-

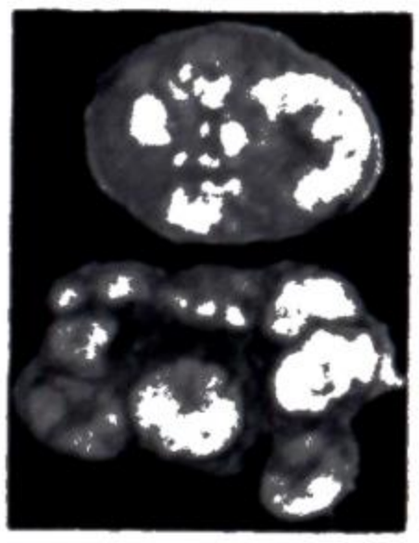

FIG. 274.—Caseating tuberculous lymph nodes.

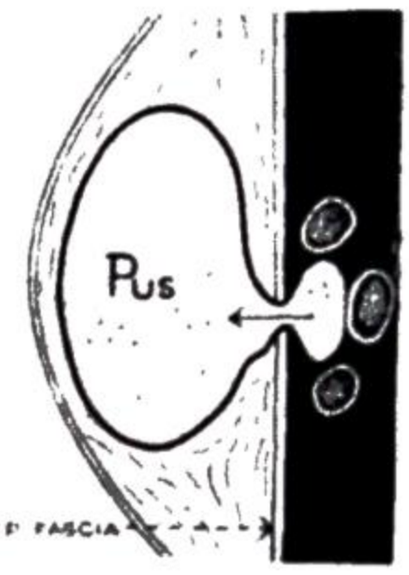

FIG. 275.—Showing the abscess and the source of the pus beneath the deep fascia.

[1] The human bacillus is responsible for 100 per cent. of cases among the Bantu urban population of South Africa (P. Keen).

Paul Keen, Contemporary. Surgeon, Non-European Hospital, Johannesburg.

FIG. 276.—Tuberculous cervical adenitis. Tonsillar lymph node chiefly involved.

FIG. 277.—Tuberculous collar-stud abscess. (Iodine has been applied to the skin.)

FIG. 278.—If the skin becomes involved and a discharging sinus results, sometimes, as in this case, the external opening of the sinus is at a distance from the original lesion (ringed).

ing, and before long a discharging sinus, with its attendant evils, is at hand.

The various clinical stages of the disease are well illustrated in figs. 276, 277, and 278.

DIFFERENTIAL DIAGNOSIS

When the swelling is solid, from
- Chronic non-tuberculous lymphadenitis.
- Hodgkin's disease.
- Reticulo-sarcoma.
- Secondary malignant disease.

When the swelling is cystic, from
- Branchial cyst.
- Extension of an abscess connected with a tuberculous cervical vertebra.

When a sinus or sinuses have formed, from
- Actinomycosis.
- An acquired branchial fistula.

Gummata of lymphatic nodes should also be included, but the condition is so rare that it is almost a pathological curiosity. Absolute symmetry is a characteristic feature, and in such cases other clinical evidence is sought and a Wassermann reaction is performed.

TREATMENT OF TUBERCULOUS LYMPHADENITIS[1]

General Treatment.—All agree that the patient should be placed under the best dietetic and hygienic conditions possible, the most important being open air, together with natural or artificial sunlight. Calciferol[2] in large doses is often beneficial, especially in children. Fifty thousand units (one ostelin high-potency tablet) is given twice daily for a child of eight, and continued for four months.

No matter what line of treatment is adopted, hypertrophied adenoids, infected tonsils, and carious teeth must receive appropriate attention.

Conservative Measures.—For more than half a century opinion has vacillated between conservative treatment—best carried out in a sanatorium

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[1] For 600 years the King's touch was believed to cure this prevalent disease. Charles II touched on an average 10,000 sufferers a year. In addition, he presented each with half a sovereign.

[2] Calciferol B.P. (*syn.* vitamin D_2) is ultra-violet irradiated ergosterol, an active principle of yeasts. A powerful antirachitic, its action in this instance is empirical.

August von Wassermann, 1866–1925. Director, Institute for Experimental Therapy, Berlin.

—and operative treatment. The introduction of antibiotic therapy added zest to non-operative treatment, but early hopes that it might supplant operative treatment have not been fulfilled.

Antibiotic Therapy.—Streptomycin, sodium *p*-aminosalycilate (P.A.S.), and isoniazid, given in combinations of two in two-monthly rotation for at least six months, have proved valuable in preventing both spread of the infection and recurrence after extirpation of the affected nodes.

Contraindications to Operative Treatment.—When there is active tuberculosis of another system, e.g. pulmonary tuberculosis, removal of tuberculous lymph nodes of the neck is, of course, illogical. In cases where enlarged nodes are not confined to one region in the neck, where there is much periadenitis, or any discharging sinuses, operative treatment is best avoided, at any rate for several months, during which time sanatorium treatment is advised. Repeated aspiration of a collar-stud abscess cannot be recommended unless the patient is under constant supervision in a sanatorium, because so frequently this predisposes to sinus formation and secondary infection.

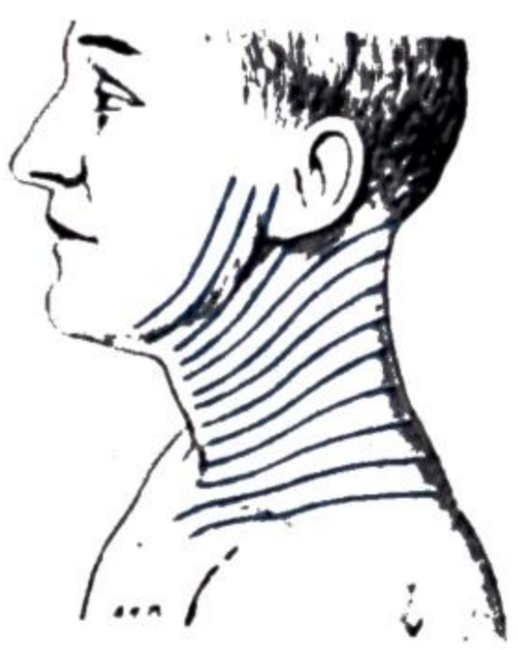

FIG. 279.—Langer's lines: cervical region.

Operative Treatment.—In the majority of cases the tuberculous process is limited to one group of lymph nodes. For this type extirpation of the affected nodes through an oblique incision, following one of Langer's lines (fig. 279), gives rapid and eminently satisfactory results.

There is no contraindication to dividing the sternomastoid muscle if, as is frequently the case, such a step facilitates access to the diseased nodes and enables the operator to visualise the spinal accessory nerve more easily. The divided muscle is subsequently reunited.

FIG. 280.—Seeking the opening in the deep fascia. The abscess cavity is lined by soft granulation tissue, called Volkmann's membrane, that tends to obscure the small hole in the deep fascia.

During the dissection of cervical lymphatic nodes no effort should be spared to preserve :
the spinal accessory nerve ;
the mandibular branch of the facial nerve ;
the hypoglossal nerve ;
which are the nerves most likely to be injured.

To minimise unnecessary injury to large veins, no tissue should be divided when stretched taut. Should the internal jugular vein prove to be involved in the pathological process to such an extent that freeing it is difficult or impossible, this great vessel can be ligated, or a portion of it can be resected, without any untoward effect at any age (cf. ligation of the common carotid artery, p. 95).

Even the presence of a collar-stud abscess does not jeopardise healing by first intention if the diseased lymph nodes lying beneath the deep cervical fascia are displayed by enlarging the small communicating opening (fig. 280), and excising them completely, provided the overlying skin is healthy and

Carl von Langer, 1819–1887. Professor of Anatomy, University of Vienna.
Richard von Volkmann, 1830–1889. Professor of Surgery, Halle.

hæmatoma formation is guarded against by careful hæmostasis and a pressure dressing.

When the overlying skin is involved and/or sinuses are present the unhealthy skin should be excised entirely, and after the diseased nodes have been removed completely the wound is packed with petroleum-jelly gauze and a viscopaste bandage is applied. Large gaping wounds often heal with a linear scar.

ACTINOMYCOSIS OF THE NECK

Two-thirds of all human cases of actinomycosis occur in the neck and face.

Ætiology.—More than half of the common organisms in soil are actinomyces,[1] but very few of them are pathological to man.

The species that attack man are the actinomyces I, II, III, and IV. In more than 50 per cent. of cases it is the actinomyces I, that until recently was known as *Actinomyces bovis* of Wolff-Israel, that is responsible; but it is not uncommon to recover more than one species from the same lesion. These actinomyces, which are Gram-positive and anaerobic, never occur alone in primary culture; they live in symbiosis with other anaerobic bacteria (M. Glahn). The usual habitat of actinomyces is within carious teeth—occasionally they reside in seemingly healthy tonsils. In the mouth they are harmless. It is certain that actinomyces and their cohabitators gain entrance to the soft parts, where they become pathological, through a wound in the buccal mucous membrane, particularly after tooth extraction.

FIG. 281.—Actinomycosis. Indurated sinuses extend from the neck to the orbit.

Clinical Features.—A sinus or sinuses about the upper part of the neck (fig. 281), particularly indurated sinuses, should arouse suspicion immediately. The skin about the sinus often appears somewhat bluish or violaceous in colour. On palpation each burrow feels hard, like a strand of whipcord. Lymph nodes are seldom enlarged except as the result of secondary infection. There is no pain unless the disease is advanced and nerves have become implicated in fibrous tissue. As the disease progresses the patient becomes increasingly anæmic. *The discharge* is extremely characteristic. It is thin and watery, and typically it contains 'sulphur granules.' Early in the course of the disease the granules are small and difficult to see macroscopically. A swab of the discharge is insufficient for the pathologist to make a definite diagnosis; the clinician should collect a few ml. of the purulent exudate in a sterile test-tube, and first examine it himself by holding it to the light. The presence of sulphur granules is extremely suspicious, but fragments of necrotic or caseous material can simulate them. The finding of sulphur granules containing

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[1] The powerful antibiotic, streptomycin, is prepared from the non-pathogenic *Actinomyces griseus*, now more usually called *Streptomyces griseus*.

Otto von Bollinger, 1843–1909, Professor of Pathology, Munich, first detected the branching mycelium in pus from the diseased jaw of a cow.

Max Wolff, 1844–1923. Physician, University Polyclinic for Diseases of the Lungs, Berlin.

James Israel, 1848–1926, first found 'sulphur granules' in pus from a discharging sinus of the neck in man. He afterwards became a famous Berlin Urologist.

Mogens Glahn, Contemporary. Department of Jaw Surgery, Rigshospitalet, Copenhagen.

Gram-positive mycelia, from which is isolated anaerobic actinomyces, is proof indeed that the lesion is actinomycotic and no other. Histological examination of tissue is far less accurate than bacteriological examination performed in this way. Biopsy is useless.

Modes of Spread.—The disease spreads by burrowing in the connective tissues, upwards towards the scalp and downwards into the supraclavicular region, whence the mediastinum and pleural cavities become involved. Spread by the lymphatic stream is practically unknown, and it is truly remarkable that this favourite channel for the dissemination of all other infective processes should enjoy such a degree of immunity in the case of the ray fungus. The usual explanation of this is that actinomyces are too large to pass along a lymphatic vessel. Late in the course of the disease blood-borne metastases are not very rare, the liver and the brain being the two regions most commonly invaded in this way. Untreated, the disease runs a chronic but surely fatal course.

Treatment.—The dental surgeon attends to carious teeth, erring on the side of extraction rather than repair.

Antibiotic Therapy.—A million units of penicillin daily for ten to twenty days, or more in advanced cases, followed by 300,000 units for the next eight to fourteen days, is curative in a number of cases, but it is necessary to be guided by the sensitivity tests as to which antibiotic to prescribe. Not a few strains of actinomyces are now, or always have been, resistant to penicillin. What is extremely important to realise is that penicillin-resistant associated bacteria are capable of maintaining activity of the lesion. Aureomycin or terramycin is therefore often the antibiotic of choice. In cases where the discharge does not dry up as expected a bottleneck sinus should be suspected, in which case the sinus or sinuses should be slit up and packed with gauze soaked in 2·5 per cent. tincture of iodine. In former days many cures resulted from giving 5 minims (0·3 ml.) of tinct. iodine in milk, and increasing the dose to 10 minims (0·6 ml.) t.d.s. In refractory cases this simple treatment should be tried. In all cases extra milk should be given.

BENIGN NEOPLASMS OF THE NECK

Deep Cavernous Hæmangioma.—Like a lymphatic cyst (see p. 189), a hæmangioma can be emptied by pressure, but of course it is non-translucent. In some instances it commences in the retropharyngeal space and extends into the neck (see p. 281).

Treatment.—The effect of injecting a sclerosing agent should be tried first. Excision may prove a difficult and dangerous undertaking; in cases that prove at operation to be less circumscribed than anticipated, multiple ligation is the safer course.

Neurilemmoma (*syn.* **Schwannoma**) is a tumour of the neurilemma, or nerve sheath of Schwann.

It is characteristically benign, smooth, encapsulated, soft, and gelatinous. It arises from the vagus, cervical sympathetic chain, or the glossopharyngeal nerves or, indeed, from any of the nerves of the neck. The tumour therefore is inconstant in position. Although innocent, it gives rise to compression of adjacent vital structures, and is often mistaken for a malignant tumour.

A neurilemmoma of the vagus should be suspected strongly if there is medial displacement of the internal carotid artery as well as dysphagia and hoarseness; the coughing and choking attacks that are often present are due to involvement of the

Theodor Schwann, 1810–1882. Professor of Anatomy Liège, Belgium.

superior laryngeal nerve. The tumour must be removed in its entirety which, except when situated in the supraclavicular fossa, does not present particular difficulties. These tumours are completely radio-resistant.

Lipoma.—The ubiquitous lipoma, usually subcutaneous, can appear in any of the triangles of the neck; however, a very common situation is in the nape of the neck.

PRIMARY MALIGNANT TUMOURS OF THE NECK

Carotid Body Tumour.—The carotid body, which is situated at the bifurcation of the carotid artery—most usually in its fork—is the most important moiety of the chemoreceptor system (fig. 282). Tumours of the carotid body, although rare, are the most common neurogenous neoplasms of the neck.

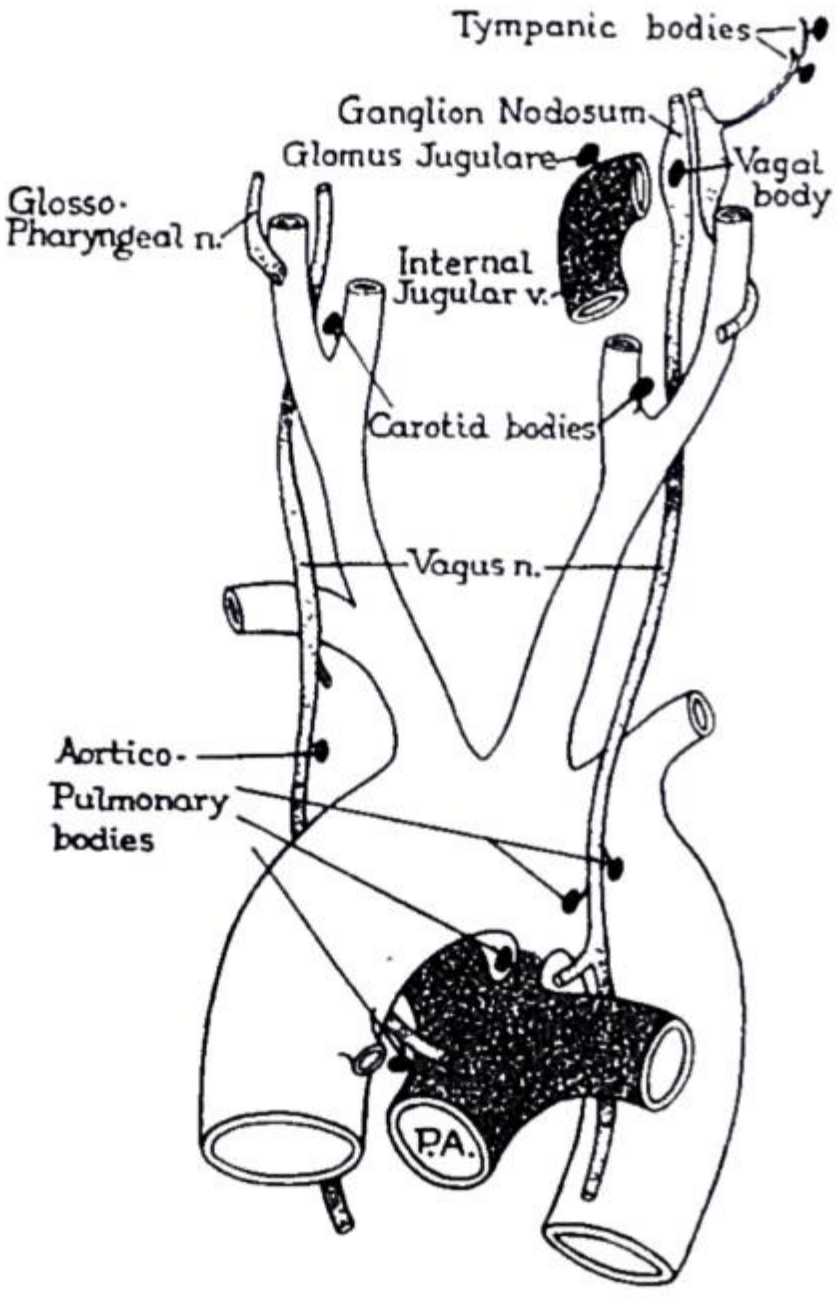

FIG. 282.—Sites where chemodectomas are known to occur. In addition, they have been found in the orbit, along the course of the inferior alveolar artery, and in proximity to the femoral artery. (*After S. O. Burman.*)

Pathology.—Histologically a non-chromaffin paraganglioma, a carotid body tumour is now classified as a chemodectoma. The former belief that this tumour is benign has been dissipated. Although, as a rule, the tumour remains localised for years, eventually regional metastases occur in about 20 per cent. of cases, and distant metastases somewhat less frequently.

Clinical Features.—Nearly always unilateral, a carotid body tumour is considered difficult to diagnose because, contrary to expectation, it often exhibits less transmitted pulsation than the solid lumps from which it has to be differentiated. Usually the tumour first becomes apparent in middle life, and increases in size very slowly; indeed, it behaves like a mixed parotid tumour (see p. 180). Unfortunately, as a rule the lump is at least the size of a plum before the patient seeks advice (fig. 283). Very occasionally difficulty in swallowing is experienced. Otherwise it is asymptomatic until it is advanced, although a small percentage of patients complain of attacks of faintness—the carotid sinus syndrome. The tumour is hard and tolerably regular in contour. It was descriptively called by Sir Jonathan Hutchinson ' the potato tumour.'

FIG. 283.—Carotid body tumour of twelve years' duration.

The Peculiar Danger of Excision of a Carotid Body Tumour.—While recurrence after complete excision is most unusual (only seven cases

Sir Jonathan Hutchinson, 1828–1913. Surgeon, The London Hospital.

have been recorded) it is of paramount importance to realise that if the tumour is large it is more than probable that it is so blended with the carotid tree that removal is impossible without resecting the fork of the carotid artery (fig. 284), and unless special precautions are taken ligation of the internal carotid artery is followed by death or hemiplegia in 33 per cent. of cases (F. H. Lahey).

FIG. 284.—Carotid body tumour removed successfully from a female aged forty-five. Glass rods are in the carotid tree.

Special Precautions:

(*a*) *Arteriography.*—The probable result of such ligation can be foretold by preliminary arteriography. If the arteriogram shows that the lumen of the internal carotid artery has been compressed or occluded by the tumour, the neoplasm can be extirpated together with the fork of the carotid artery without fear of cerebral complications. Should, however, the internal carotid artery possess a full lumen, and it is found at operation that it is impossible to remove the tumour without damaging the artery, steps must be taken to maintain the blood supply to the brain. This is best accomplished by an arterial graft and re-establishment of the common—internal—carotid artery continuity. For this purpose a carotid artery homograft is best; a femoral vein graft has proved satisfactory; the internal jugular vein would do, but it is often implicated in the tumour mass.

FIG. 285.—Poppen's method of ligating the common carotid artery. First stage, enfolding. Second stage, seven days later, secure total ligation.

(*b*) If facilities for arteriography and arterial grafting are not available, the danger referred to can be largely circumvented by semi-ligation of the common carotid artery seven days before removal of the tumour. A good method of semi-ligation is to enfold the artery by two layers of black silk sutures (fig. 285). Another method is to twist a piece of silver wire around the artery in such a way as to half occlude its lumen. By these devices the cerebral circulation is not *suddenly* deprived of half its blood supply.

Treatment.—Hardly any of these tumours are radio-sensitive. Extirpation should therefore be carried out in all cases except in the old and enfeebled, in whom it may be decided that it is best to let Nature take her course. The precautions detailed above having been taken, the tumour is explored through an ample incision:

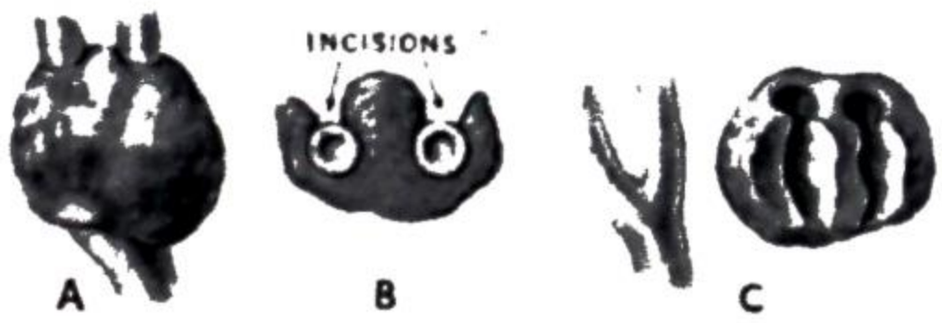

FIG. 286.—The tumour is split in the manner shown, so that it can be dissected from the arteries it envelops. (*After T. Farrar et al.*)

1. In a few cases (very few) it can be separated from the fork of the carotid artery by blunt and sharp dissection, and so removed.

2. In comparatively early cases sometimes excision can be effected in the manner shown in fig. 286. Should a main artery be wounded in the process it can, on occasions, be repaired.

3. When the tumour is large and inseparable from the fork of the carotid artery, resection with the arteries, as is shown in fig. 284, must be carried out.

HODGKIN'S DISEASE (*syn.* LYMPHADENOMA)

The accepted term lymphadenoma is particularly unfortunate, for as Trousseau pronounced, "Hodgkin's disease is a sentence of death." The condition is by no means uncommon, and in the majority of cases it is not eradicated early because it is confused with tuberculous cervical adenitis

Frank H. Lahey, 1880–1963. Head of the Department of Surgery, Lahey Clinic, Boston, Mass., U.S.A.
James L. Poppen, Contemporary. Neurological Surgeon, Lahey Clinic, Boston, Mass., U.S.A.
Armand Trousseau, 1801–1867. Physician, Hôtel-Dieu, Paris.
Thomas Hodgkin, 1798–1866, described seven cases of this affliction while he was Curator to the Museum, but he failed to obtain the post of Physician to Guy's Hospital, London.

superior laryngeal nerve. The tumour must be removed in its entirety which, except when situated in the supraclavicular fossa, does not present particular difficulties. These tumours are completely radio-resistant.

Lipoma.—The ubiquitous lipoma, usually subcutaneous, can appear in any of the triangles of the neck; however, a very common situation is in the nape of the neck.

PRIMARY MALIGNANT TUMOURS OF THE NECK

Carotid Body Tumour.—The carotid body, which is situated at the bifurcation of the carotid artery—most usually in its fork—is the most important moiety of the chemoreceptor system (fig. 282). Tumours of the carotid body, although rare, are the most common neurogenous neoplasms of the neck.

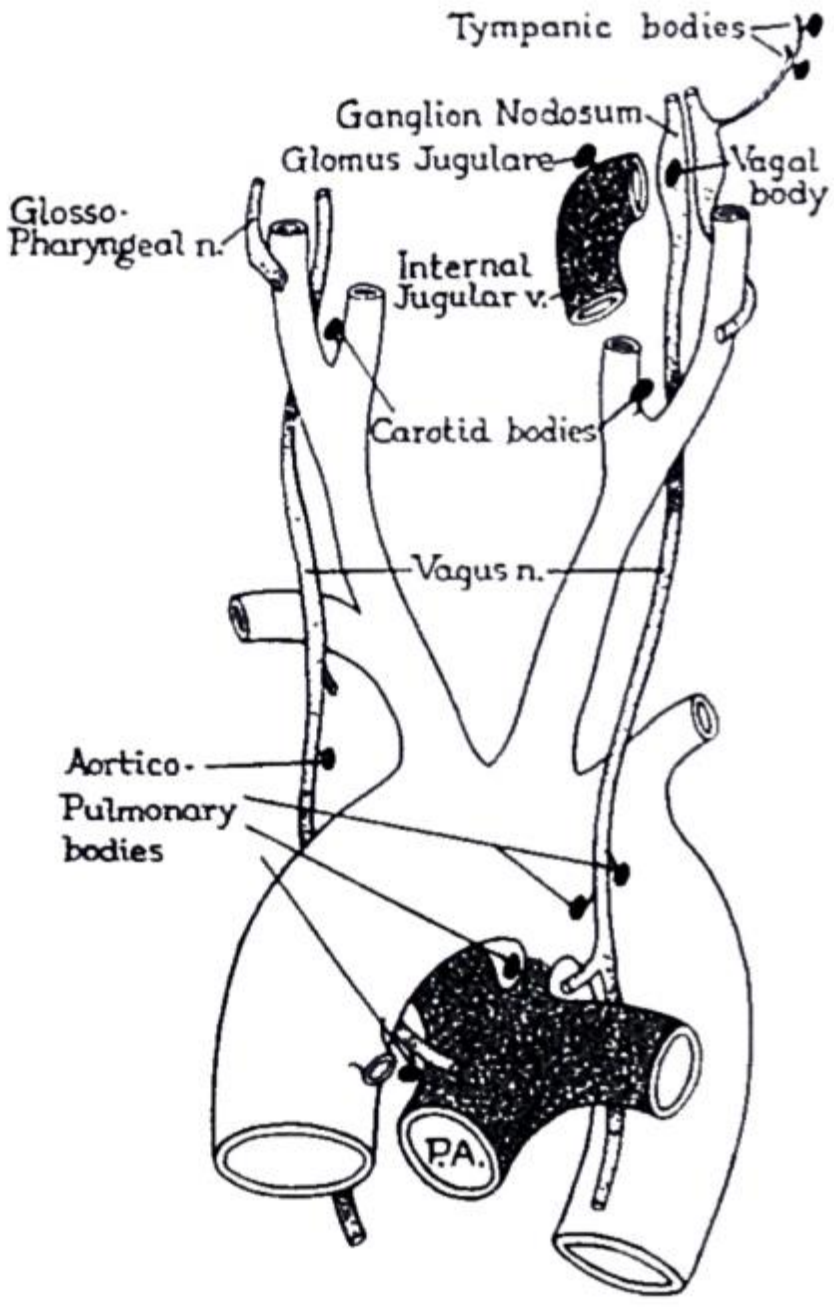

FIG. 282.—Sites where chemodectomas are known to occur. In addition, they have been found in the orbit, along the course of the inferior alveolar artery, and in proximity to the femoral artery. (*After S. O. Burman.*)

Pathology.—Histologically a non-chromaffin paraganglioma, a carotid body tumour is now classified as a chemodectoma. The former belief that this tumour is benign has been dissipated. Although, as a rule, the tumour remains localised for years, eventually regional metastases occur in about 20 per cent. of cases, and distant metastases somewhat less frequently.

Clinical Features.—Nearly always unilateral, a carotid body tumour is considered difficult to diagnose because, contrary to expectation, it often exhibits less transmitted pulsation than the solid lumps from which it has to be differentiated. Usually the tumour first becomes apparent in middle life, and increases in size very slowly; indeed, it behaves like a mixed parotid tumour (see p. 180). Unfortunately, as a rule the lump is at least the size of a plum before the patient seeks advice (fig. 283). Very occasionally difficulty in swallowing is experienced. Otherwise it is asymptomatic until it is advanced, although a small percentage of patients complain of attacks of faintness—the carotid sinus syndrome. The tumour is hard and tolerably regular in contour. It was descriptively called by Sir Jonathan Hutchinson ' the potato tumour.'

FIG. 283.—Carotid body tumour of twelve years' duration.

The Peculiar Danger of Excision of a Carotid Body Tumour.—While recurrence after complete excision is most unusual (only seven cases

Sir Jonathan Hutchinson, 1828–1913. Surgeon, The London Hospital.

fifteen years. These various types can be recognised histologically, grade 1 being the most benign and grade 3 the most malignant. The great majority of patients with Hodgkin's disease belong to grade 2.

Lesser-known Symptoms.—Pruritus, unassociated with eruption, is a frequent early symptom. It occurs some time in the course of the disease in 25 per cent. of cases. Pain induced by imbibing alcoholic beverages is a firmly established, but unexplained, symptom that is not infrequent, and is sometimes the first symptom of this fell disease. The pain, which is acute and lasts about twenty minutes, is located most often in the thorax; at other times it is experienced in the site of obvious lymphadenopathy. Late in the course of the disease intra-osseous metastases give rise to bone pain in 20 per cent. of cases.

Pyrexia is a comparatively rare and late symptom, and it occurs only when the deep, i.e. abdominal or mediastinal, lymph nodes are involved. A Pel-Ebstein temperature (see p. 114) is observed in a large proportion of the febrile cases. Secondary anæmia is a regular accompaniment of Hodgkin's disease; indeed, Hodgkin's lymphadenopathy has been epitomised as a disease characterised by enlargement of lymph nodes (fig. 289), secondary anæmia, and a bad prognosis. Often a terminal event is effusion into serous cavities.

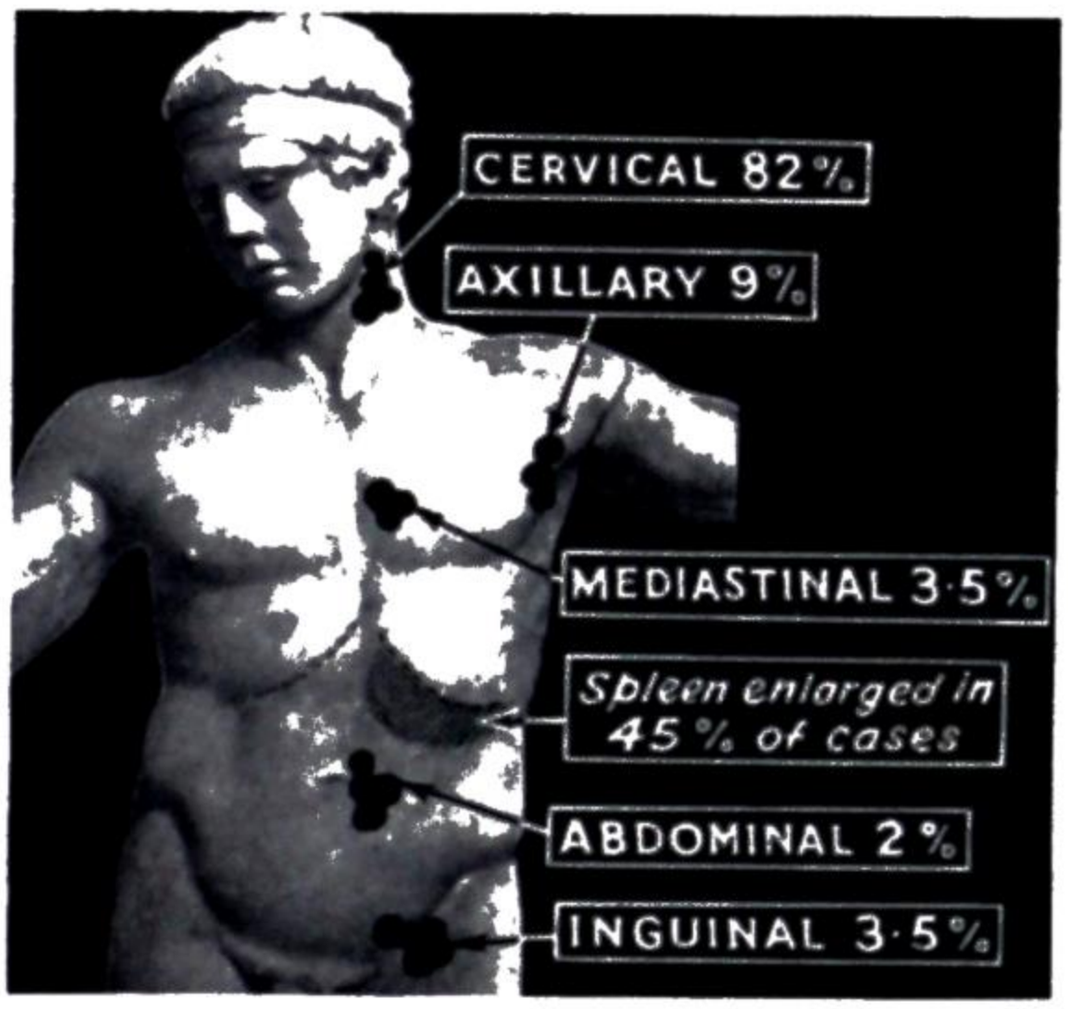

FIG. 289.—Showing the position of the lesion when the patient was seen first. In 14 per cent. of cases more than one region was involved. *(Baker and Mann's statistics.)*

Treatment:

Extirpation.—When the disease is still confined to one group of lymph nodes (fig. 289), eradication by excision is more than justified, because very occasionally a cure has resulted.

Possibly the extirpation of the thymus as well as the enlarged lymph nodes will increase the number of cures (see p. 255).

Deep X-ray therapy is the most usual form of treatment. The so-called 'bath' method, whereby the neck, thorax, abdomen, and pelvis are irradiated simultaneously, although often effective *pro tem.*, is not without danger. Preparations of iron, as well as liver extract, should be prescribed, and, if necessary, blood transfusion should be employed to combat the accompanying anæmia.

Nitrogen-mustard Therapy.—The active principle of mustard gas has produced a regression of lymphadenopathy in 83 per cent. of cases (J. F. Wilkinson). C.B. 1348[1] is the preparation most favoured at the present

time. It should not be employed within four weeks of radiotherapy if serious damage to the bone marrow is to be avoided. Advanced cases with probable metastases in the marrow are unsuitable for this treatment. The drug is given daily in doses of 2 to 20 mg. by mouth. If a favourable response is obtained after four weeks, the course is extended to eight weeks, and there is no objection to repeating it after an interval of several weeks. In some cases the treatment has to be terminated because of neutropenia or thrombocytopenia.

Actinomycin C (sanamycin), a substance derived from *Streptomyces chrysomalis*, has resulted in considerable remissions in some cases. It is given in gradually increasing doses from 100 to 1,200 μ G. per day. Each daily dose is given in an intravenous drip, lasting three or four hours.

Cortisone relieves effectively the accompanying pruritus of Hodgkin's disease. It should not be given internally if external application of the liquor relieves the itching.

RETICULOBLASTOMA (*syn.* LYMPHOBLASTOMA OF BRILL)

This lymphadenopathy is encountered approximately once for every six cases of Hodgkin's disease. Although the neck is frequently involved, typically there is general enlargement of lymph nodes with splenomegaly. Presumably there is but one site of origin, nearly always the neck or the groin, and the remainder are metastases.

The great difference between this condition and Hodgkin's disease is that the general condition does not deteriorate for a comparatively long period; even pleural and other effusions do not signify that the terminal phase has been reached. With deep X-ray therapy, the five-year survival rate is 59 per cent.

RETICULOSARCOMA (*including Lymphosarcoma*) (See also p. 49)

FIG. 290.—Reticulosarcoma, two months' duration. Proved by biopsy of an involved node.

Again the neck is a common site for this comparatively rare condition. It usually appears as a rapidly growing tumour. In its early stages the affected lymph nodes are discrete, movable, but less firm than those of Hodgkin's disease. In a matter of weeks the neoplasm (fig. 290) invades the capsules of the primarily affected lymph nodes and infiltrates surrounding structures. So rapid is the cellular activity that sometimes it is difficult to differentiate reticulosarcoma from a subacute inflammation. In such cases the centre of the tumour softens, and ultimately the skin gives way, producing deep sloughing ulcers that bleed freely. This can be avoided only by excision of a lymph node or nodes and biopsy, as a prelude to treatment —thereby avoiding the error of continuing to mistake the condition for an infection.

Treatment.—Contrary to expectation, with deep X-ray therapy given by an expert the five-year survival rate is higher than for Hodgkin's disease—30 per cent. Nitrogen-mustard therapy produces dramatic initial improvement, which is not maintained.

SECONDARY CARCINOMA OF THE NECK

Secondary carcinomatous infiltration of the cervical lymph nodes is only too common. When a patient presents with enlargement of cervical lymph nodes that are suspiciously indurated, search for a primary growth is imperative. Often the primary growth lies within the buccal cavity; when this is not the case, the search must continue. Among the sites that are

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[1] *p*-(di-2-chloroethylamino)-phenylbutyric acid.

John Frederick Wilkinson, Contemporary. Physician and Director of the Department of Hæmatology, Royal Infirmary, Manchester.
Nathan Edwin Brill, 1860–1925. Physician, Mount Sinai Hospital, New York.

prone to be overlooked are the pharynx and cervical œsophagus, the external auditory meatus, the bronchi, the stomach, and the testes.

The treatment of carcinoma of cervical lymph nodes secondary to a primary growth in the oral cavity is heartening because in these cases metastases usually remain confined to the nodes, and do not disseminate farther afield.

Management.—In as far as involved cervical lymph nodes are concerned, patients with oral, pharyngeal, or facial carcinoma can be categorised as follows:

Stage 1.—Those without clinical evidence of metastases. These patients are kept under careful (bi-monthly) observation, dissection of the neck being withheld unless the nodes become palpable. Exceptions to this rule are (1) melanoma, (2) papilliferous carcinoma of the thyroid, and (3) all cases of carcinoma of the tongue except those with an extremely early lesion of the anterior two-thirds of the organ.

Stage 2.—Those with palpable cervical nodes where the primary growth is operable, or can be destroyed with radium. It should be noted carefully that lymph-node enlargement, especially when the primary growth is foul, is not necessarily carcinomatous. After removal of the primary neoplasm a period of non-intervention and antibiotic therapy will determine whether or not the enlargement subsides. In the latter event block dissection of the neck is indicated, provided, of course, there is no clinical or X-ray evidence of distant metastases, and the involved cervical nodes have not progressed to a stage that it seems unlikely that they can be encompassed. Adherence to the mandible, or to the larynx, or to the skin, should not be regarded as constituting inoperability, for each of these structures can be sacrificed, provided the patient's general condition is such as to be able to withstand either of the first two procedures, which are extremely formidable.

Stage 3.—Those in whom the primary growth is inoperable or otherwise incurable, and/or the cervical metastases are fixed to deeper structures, and/or distant metastases are present. Palliative deep X-ray treatment is sometimes indicated, but there is always the risk that high dosage of irradiation will cause necrosis of the mandible or the laryngeal cartilages. In a number of instances irradiation is ill-advised, as it causes unnecessary suffering, without conferring unquestionable benefit.

Block dissections of the neck are of two varieties:

1. **Crile's block dissection** is conducted through the wide display afforded by skin incisions, such as are shown in fig. 291.

The skin flaps having been dissected up, the sternomastoid is divided about 1 inch above the clavicle. The muscle is freed and retracted upwards. Next, the internal jugular vein is divided between ligatures low down in the neck. The dissection proceeds upwards methodically and the muscle, fascia, fat, lymphatic nodes, the internal jugular vein, together with the submaxillary salivary gland, are dissected and removed *en bloc*. Attention must be directed to clearing the space between the parotid and the great vessels, and also the submental triangle between the hyoglossi, for it is in these areas that a lymph node can be easily overlooked. Bleeding vessels are ligated as they occur; finally the upper end of the internal jugular vein is ligated by transfixion, and divided. When the dissection has been completed, the carotid artery is laid bare, and lying with it is the vagus nerve, which has been preserved carefully. The

George W. Crile, 1864–1943. Founder and Surgeon-in-Chief, Crile's Clinic, Cleveland, Ohio, U.S.A.

operation aims at removing the whole of the lymphatic-bearing tissues on the affected side of the neck (fig. 292). The skin flaps are approximated and the wound drained. Surprisingly little deformity follows this extensive dissection, but the neck is stiff

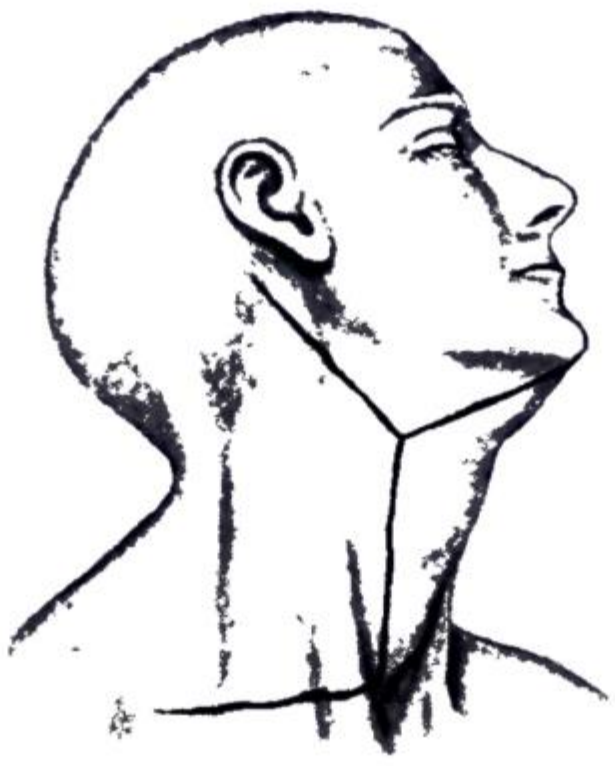

FIG. 291.—An incision for block dissection of the neck.

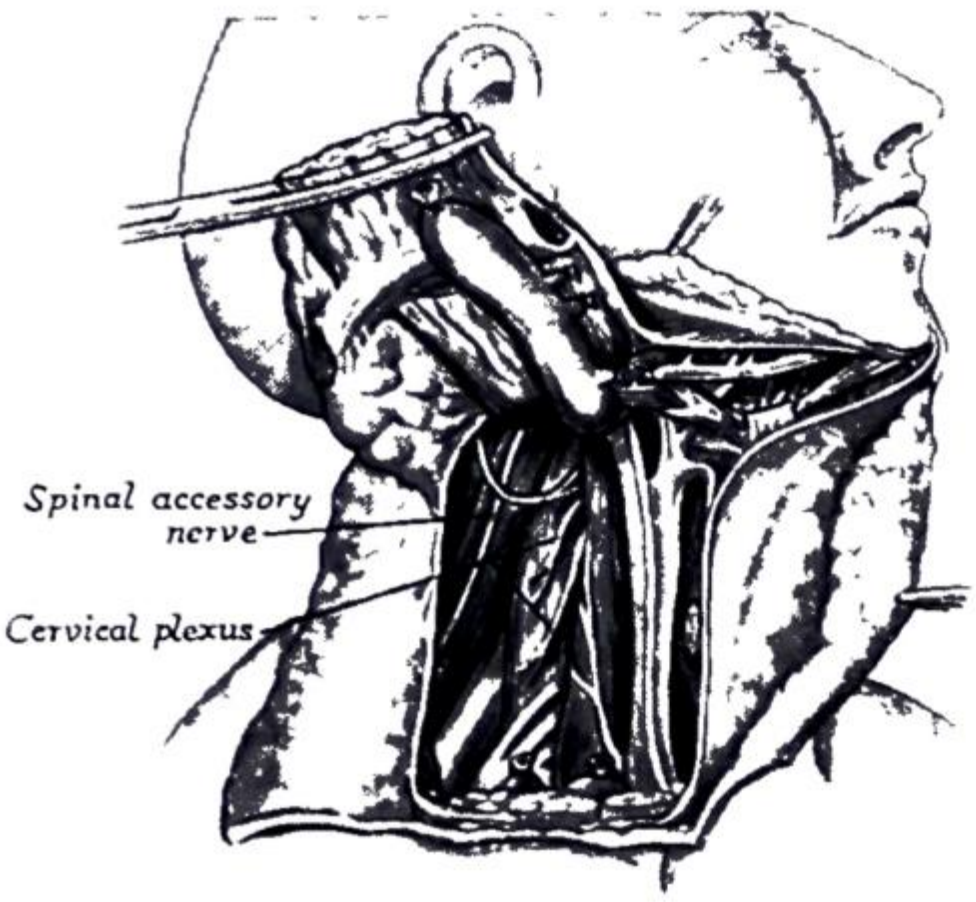

FIG. 292.—Crile's block dissection of the neck nearing completion. (*After W. W. Carroll.*)

and there is drooping of the corner of the mouth. (The cervical branch of the facial nerve is severed.) When *bilateral* block dissection is required it must be undertaken, not simultaneously, but consecutively with an interval of about three weeks. Experience has shown that removal of both internal jugular veins is not attended by the danger of inadequate cerebral circulation that was conjectured previously.

2. **Suprahyoid block dissection** of the neck is indicated in cases of carcinoma of the lower lip, early cases of carcinoma of the tip of the tongue, and carcinoma of the floor of the mouth. Its advantage is that both sides of the neck can be attended to at one operation (fig. 293).

FIG. 293.—Suprahyoid block dissection of the neck.

During these operations it is advisable to transfuse an amount of blood proportional to the estimated loss. Usually tracheostomy is required only when a monoblock (commando, see p. 170) operation is to be performed; in other circumstances tracheostomy should be avoided when possible, because it heightens the incidence of wound infection. Should it be required to keep the bronchial tree free from accumulating secretions during the post-operative period, this contraindication must be over-ridden.

Post-operative Treatment.—Suction-drainage of the wound for two or three days is best, for it reduces to zero the possibility of accumulated blood and blood-clot pressing on the larynx and trachea. Blood transfusion is continued for as long as is deemed necessary, and antibiotic therapy is given as a routine prophylactic measure.

The mortality of cervical-block dissection is, with modern anæsthesia which has done so much to facilitate it, about 3 per cent. The over-all five-year survival rate is 35 per cent.

CHAPTER XIII

THE THYROID GLAND AND THE THYROGLOSSAL TRACT

HAMILTON BAILEY

Embryology.—The thyroid gland is developed mainly from the median bud of the pharynx (the thyroglossal duct) which passes from the foramen cæcum at the base of the tongue to the isthmus of the thyroid. The isthmus and the major part of the lateral lobes arise from this structure ; a lateral bud from the fourth branchial cleft of each side amalgamates with and completes the corresponding lateral lobe.

Surgical Anatomy.—The fundamental secretory units of the thyroid gland are the follicles (alveoli), spherical vesicles lined by cubical epithelium surrounded by a rich network of capillaries and filled with colloid, which contain stored thyroid hormone. Twenty to forty follicles are bound together with connective tissue to form a lobule, and aggregations of lobules within the capsule form the lobes of the thyroid gland.

Blood Supply.—Not only does the thyroid possess an abundant blood supply but its glandular epithelium is brought into intimate relation with the vascular endothelium owing to the absence of a basement membrane. The sinusoidal character of the circulation is often such that the follicles can be said to be bathed in blood, and this accounts for the rather frequent dissemination of carcinoma of the thyroid to bones by the blood-stream. For the blood-vessels of the thyroid and the nerves in relation to the gland, see fig. 294.

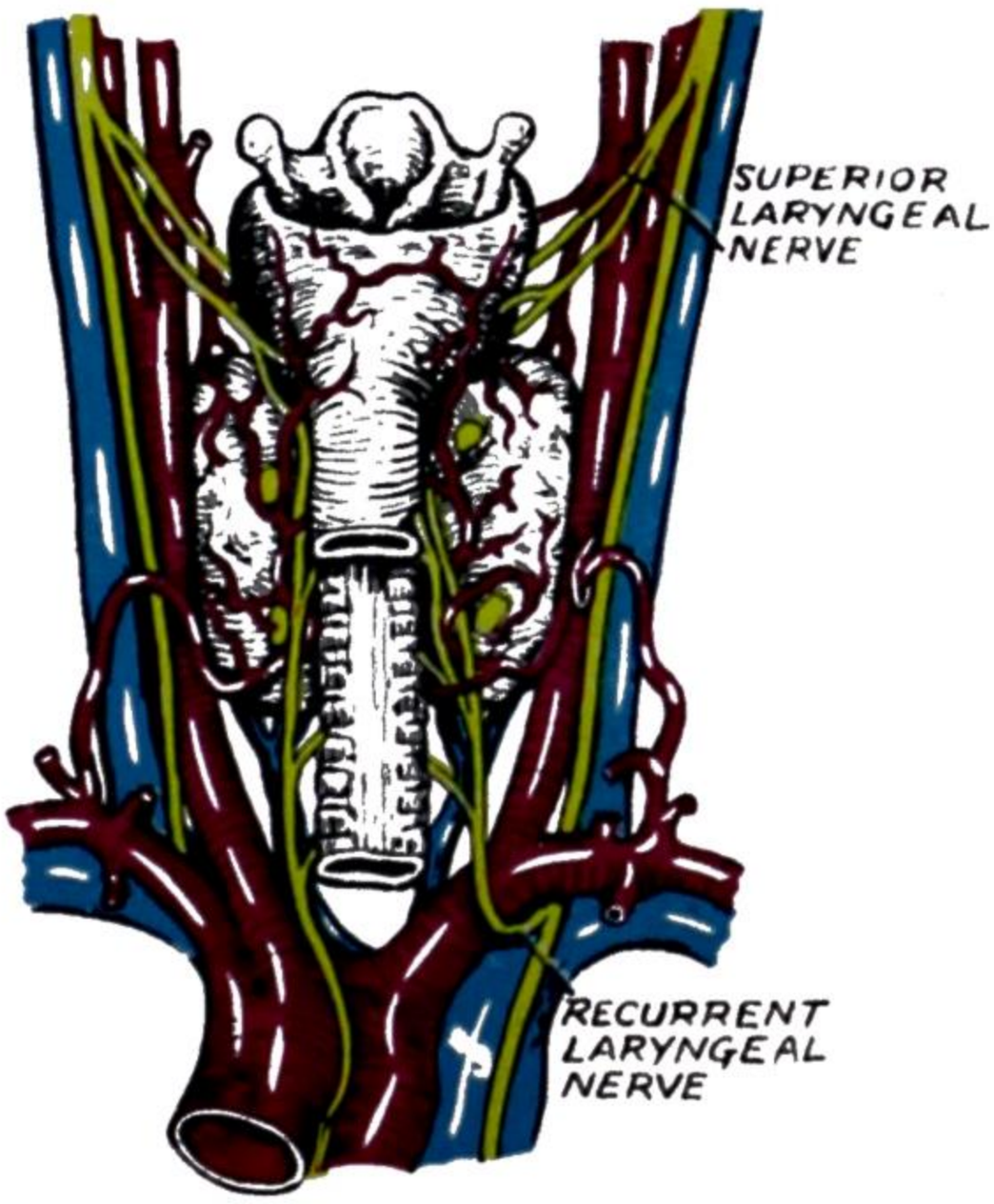

FIG. 294.—The thyroid gland from behind, showing the recurrent laryngeal nerves and the site of ligation in continuity of the right inferior thyroid artery. (*After Martin Norland.*)

Lymphatics.—The lymphatics of the thyroid drain into the lower two-thirds of the jugular chain. Sir Astley Cooper was the first to describe lymphatics of the thyroid that drain in a downward direction to the lymph nodes of the superior mediastinum. This important piece of surgical anatomy has been forgotten in most modern descriptions.

Surgical Physiology.—The thyroid gland extracts iodine from the blood avidly in direct proportion to the degree of thyroid function—hence the term 'the thyroid trap for iodine'—but in so doing the thyroid must compete with the kidneys for the iodine ingested in food, because normal kidneys excrete iodine that is brought to them at a prodigious rate.

The thyroid accomplishes iodine storage in two distinct steps : (1) Prompt clearance of iodine from the blood ; (2) The incorporation of the iodine into an organic compound. The first step is a reversible one ; the second is not. The basic iodine

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

requirements of the gland are greater in childhood, and especially at puberty, than at other times of life. The organic iodine compound that is synthesised by the thyroid is thyroxine,[1] a crystalline substance containing 65 per cent. of iodine. This is the thyroid hormone that regulates the metabolic activities of virtually every cell in the human body. Triiodothyronine, which has been isolated recently, is about 5 times as active as thyroxine, and it is liberated slowly from the body's reservoirs of thyroxine. Therapeutically 0·1 mg. daily is equivalent to ½ grain of thyroid.

The normal amount of iodine secreted by the thyroid as hormone is approximately 70μ G. per day and within the normal gland there is stored a reserve supply sufficient for approximately two months.

THE PITUITARY-THYROID AXIS

In succeeding pages several references will be made to the interrelation between the internal secretion of the thyroid gland (thyroxine) and that of the anterior lobe of the pituitary, the thyroid stimulating (*syn.* thyrotropic)[2] hormone (fig. 295). Production of the latter hormone is inhibited by thyroxine circulating in the blood. Should the secretion of the thyroid hormone become excessive, that of the thyroid-stimulating hormone (T.S.H.) is diminished to zero. To take a pertinent example :

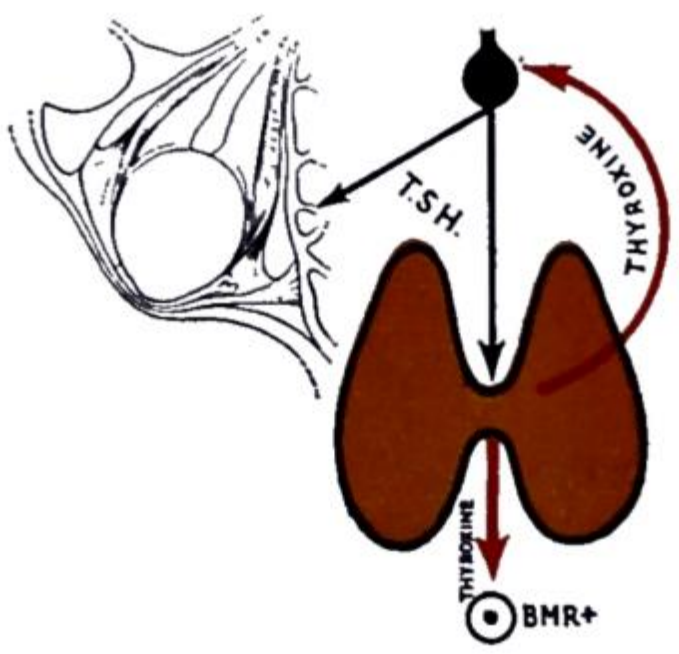

FIG. 295.—Reciprocal arrangement between the anterior lobe of the pituitary and the thyroid in the production of their respective hormones; the so-called pituitary-thyroid axis.

Thyrotoxicosis Factitia.—Sometimes taking too much desiccated thyroid for too long, e.g. for slimming, causes an excess of circulating (ingested) thyroxine and thyrotoxicosis factitia[3] results. In time, complete suppression of the thyrotropic hormone ensues. The thyroid gland, bereft of its stimulus, atrophies, and when the ingestion of thyroid extract is stopped, myxœdema results.

The Cause of Exophthalmos.—That T.S.H. is responsible for the production of exophthalmos is suggested by the following experiments :

Thyrotropic hormone injected into guinea-pigs and ducks causes exophthalmos, and a species of minnow nurtured on food containing this hormone develops extreme exophthalmos. Nonetheless, many consider that this hypothesis is not proven, and why the contents of the orbit becomes so œdematous as to cause the eyes to bulge in hyperthyroidism, has still to be elucidated. They agree that it seems probable that the pituitary has something to do with the production of exophthalmos, perhaps by the secretion of a separate 'exophthalmos producing factor.'

METHODS OF INVESTIGATING THYROID FUNCTION

1. **Basal metabolic rate** (**B.M.R.**) is a valuable method of confirming the diagnosis of hyperthyroidism and is the best index of the severity of the thyrotoxicosis, provided that the main limitation of this test—the difficulty of achieving the basal states, particularly with nervous patients—can be overcome by preparatory sedation. For this purpose a suitable dose of one of the slower-acting barbiturates is given. The basal metabolic rate is estimated most accurately by ascertaining the oxygen absorbed by the patient over a given time. This requires elaborate apparatus and highly skilled laboratory assistance. The basal metabolic rate can, however, be gauged approximately by the application of :

Read's formula.—Basal metabolic rate = 0·683 (pulse-rate plus nine-tenths pulse-pressure) minus 71·5. Ninety-five out of every 100 individuals below the age

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[1] Extracted by E. C. Kendall in 1916. [2] Tropic—Greek, $\tau\rho\acute{\epsilon}\pi\omega$ = turn towards, aim at.
[3] Factitia—Latin, *factitius* = to make by art, as opposed to what is natural.

Edward Calvin Kendall, Contemporary. Emeritus Member, Division of Biochemistry, Mayo Clinic, Rochester, Minn.
Fay Marion Read, Contemporary. Professor of Medicine, Stanford University School of Medicine, San Francisco California, U.S.A.

of fifty fall within the range of plus to minus 13·4. Figures over plus 15 are found in hyperthyroidism (thyrotoxicosis); below minus 15 are found in hypothyroidism (myxœdema).

2. **Tracer Dose of Radio-Iodine** (^{131}I).*—Radio-iodine has the same chemical and biochemical properties as stable iodine. Consequently it is trapped avidly by functioning thyroid tissue and launched through its metabolic pathways. A tracer dose of this substance is exceedingly helpful in confirming the diagnosis of primary toxic goitre (Graves' disease) in patients with early or anomalous symptoms. Regional scanning of the thyroid after the ingestion of radio-iodine is also particularly useful in determining the functional activity of thyroid nodules compared with the remaining thyroid tissue. By this means it is possible to distinguish a functioning adenoma ('hot nodule') which takes up iodine briskly, from a non-functioning adenoma ('cold nodule') which does not, although, to be sure, a certain number of 'luke-warm nodules' are likely to be encountered. Should a hot nodule be discovered one can assume that the chances of it being malignant are negligible, for the avidity of a thyroid carcinoma for iodine is low. This method of investigation is also of signal value for the localisation of functioning thyroid tissue situated elsewhere than in a normally placed thyroid gland. A retrosternal goitre (if it contains active thyroid tissue), a lingual thyroid, struma ovarii, and occasionally distant metastases of a thyroid carcinoma can be diagnosed with assurance in this way.

Radio-active iodine should never be given, even in the small doses required for diagnostic purposes, unless the information required is unobtainable by another method; for instance, it is quite unnecessary to employ this method of investigation in cases of non-toxic goitres. It should be remembered that it is impossible to demonstrate radio-activity within the thyroid without delivering radiation to the gland.

Technique.—The tracer dose for a normal-sized gland is 25 microcuries[1] (μc) of radio-active iodine given on an empty stomach in 100 ml. of water, the dose being varied up to 50 μc according to the estimated size of the gland when it is larger than normal. It is of paramount importance that no iodine medication should have been given to the patient for at least a month previously, otherwise the result will be invalid. It should also be noted that some expectorants, gall-bladder visualisation dye, and lipiodol contain iodine. Thiouracil compounds also vitiate the accuracy of this test. Dentures must be removed before the dose is imbibed because acrylic resin quickly absorbs radio-iodine.

Proceeding with the test: the percentage of ^{131}I concentrated in the thyroid gland is determined at one or more intervals. Frequently a single measurement is made in one of the following ways:

(*a*) *Directional Geiger Counter.*—Twenty-four hours after the dose of radio-iodine has been imbibed, a counter placed over the neck permits the

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* ^{131}I. Oxygen has an atomic weight of 16. This is the foundation of the atomic scale. The atomic weight of the radio-active isotope of iodine is 131, that of ordinary iodine 127.

[1] Microcurie—a millionth part of a curie (abbreviation μc). Millicurie—a thousandth part of a curie (abbreviation mc).

Pierre Curie, 1859–1906, and Marie Sklodowska Curie, 1867–1934. Co-discoverers of radium. Madame Curie succeeded her husband as Professor of Physics at the Sorbonne, Paris.
Hans Geiger, 1882–1945. German Physicist who worked in England.

amount of tracer dose arrested in the thyroid to be measured by the rate of emission of gamma rays. A collimated scintillometer is so sensitive that it permits an approximate estimation of the dimensions of an enlarged gland to be arrived at without exceeding a dose of 5–10 μc—such a small dose avoids radiation hazards.

(*b*) *Protein-bound Plasma Activity*.—Forty-eight hours after the ingestion of the tracer dose blood is collected, proteins are precipitated by trichloracetic acid, and, after washing, the protein-bound iodine is measured in a well-counter type of apparatus. This procedure gives an estimate of the thyroxine level, which is the best single test of thyroid activity. One of the limitations of the test is the liability of the readings to be abnormal in the presence of renal impairment.

(*c*) *Urinary output of* ^{131}I is also used in diagnosis.

Interpretation of Results :

An uptake of 55 per cent. or more of the iodine by the thyroid indicates hyperthyroidism. An uptake of 20 per cent. or less of the iodine by the thyroid indicates hypothyroidism. The border-line zone between high normal and hyperthyroid, and particularly low normal and hypothyroid, is difficult to ascertain by this study. A *chemical* estimation of the plasma level of protein-bound iodine (^{127}I) is the best confirmatory test in these cases, but is technically difficult because of the small amounts involved.

3. **Hypercreatinæmia.**—In differentiating a typical Graves' disease from anxiety states and cardiac disorders, the following test has proved valuable. A fasting serum creatine level of less than 0·6 mg. ($\frac{1}{100}$ grain) per 100 ml. excludes all but the mildest cases of thyrotoxicosis. A level higher than this (the upper normal limit), if it occurs with signs of hyperthyroidism, but not necessarily with a raised B.M.R., is convincing evidence of thyrotoxicosis. If the B.M.R. is also raised, the diagnosis is beyond doubt. When, as sometimes happens, the B.M.R. is within normal limits and the diagnosis remains uncertain in spite of hypercreatinæmia, a few days' treatment with Lugol's solution or a thiouracil compound should be given. If the serum creatine falls, the diagnosis is firmly established, for all other forms of hypercreatinæmia are unaffected by thiouracil (W. J. Griffiths).

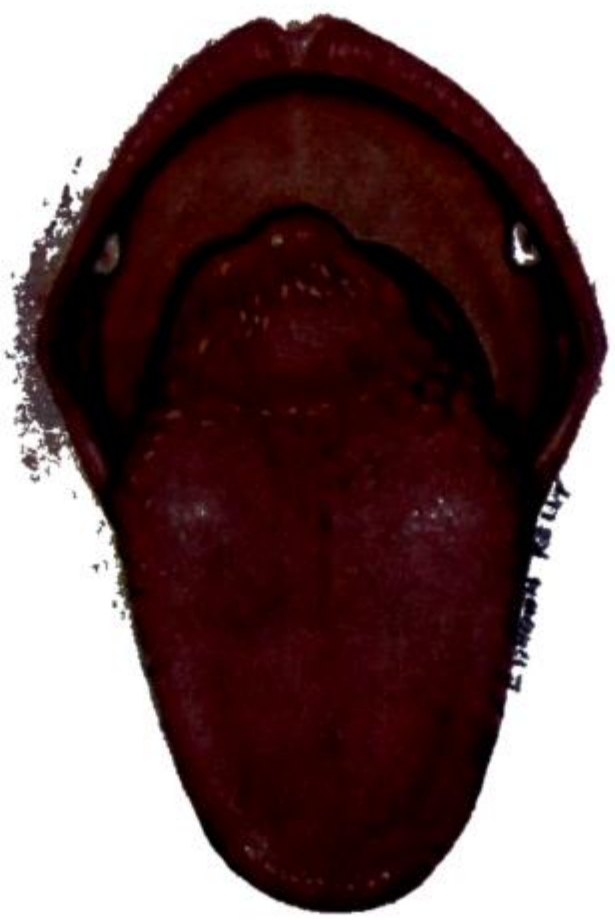

FIG. 296.—Lingual thyroid.
(*H. Wapshaw.*) (*British Journal of Surgery.*)

ECTOPIC AND ABERRANT THYROID TISSUE

The whole thyroid gland may be situated in some part of the thyroglossal tract, in which case the rings of the trachea can be palpated easily.

Lingual thyroid is the most common of these rare abnormalities. This variety of ectopic thyroid gland gives rise to a rounded swelling at the back of the tongue beneath the foramen cæcum (fig. 296), and produces dysphagia, impairment of speech, and occasionally compromises the airway. In about 10 per cent. of cases removal of a lingual thyroid is followed by myxœdema, for the abnormally situated gland is the only thyroid tissue present.

Median (Thyroglossal) Ectopic Thyroid.—In the case of an ectopic thyroid situated in the upper two-thirds of the neck (fig. 297B), the swelling it causes is usually mistaken for a thyroglossal cyst (p. 244), which is much more common.

William James Griffiths, Contemporary. Chemical Pathologist, St. Thomas's Hospital, London

When performing an operation for a supposed thyroglossal cyst, if the swelling is found to be solid and composed of thyroid substance, in order to prevent myxœdema a little of the thyroid tissue should be spared, because this type of ectopic thyroid is often the only thyroid tissue present.

Intrathoracic aberrant thyroid (fig. 297C), should it become diseased, is a precursor of a complete intrathoracic goitre (p. 234).

'Lateral aberrant thyroid' is an inaccurate and disastrous diagnosis. Over and over again, what was considered to be a lateral aberrant thyroid (often bolstered by a histological examination) is a metastasis in a cervical lymph node from a small occult and unsuspected primary carcinoma of the thyroid gland. There is no evidence developmentally that aberrant thyroid tissue ever occurs in a lateral position (R. A. Willis). It therefore becomes necessary to perform complete thyroidectomy, together with removal of the affected lymph nodes, in every case where lateral aberrant thyroid tissue is discovered.

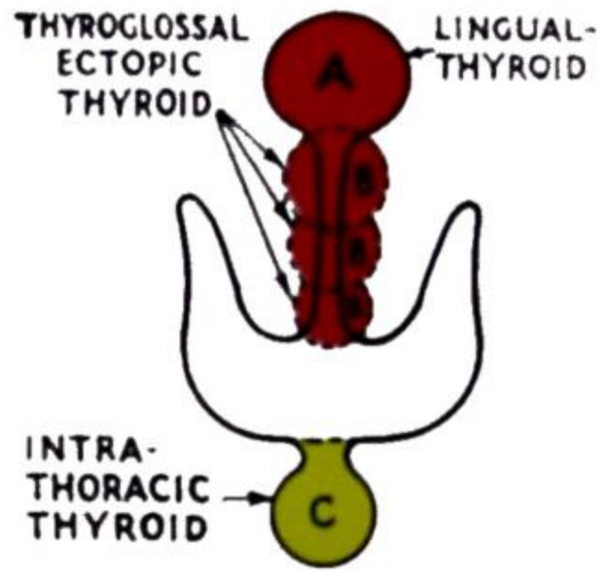

FIG. 297.—Ectopic and aberrant thyroids. A and B are ectopic thyroids, C intrathoracic aberrant thyroid (nearly always acquired).

Struma ovarii does not belong to the developmental anomalies of the thyroid; rather it is an anomaly of fœtal tissue as a whole—a teratoma. The misplaced thyroid tissue in the ovary can function and maintain euthyroidism, if not hyperthyroidism; it can also undergo non-toxic nodular changes, as well as malignant degeneration with metastases.

CONDITIONS DUE TO DEFICIENT THYROID SECRETION

CRETINISM (INFANTILE HYPOTHYROIDISM)

In Great Britain cretinism is sporadic. It appears in healthy families, the other children being normal and the parents presenting no thyroid disorder. The condition is due to a virtual absence of a functioning thyroid gland, although ^{131}I studies have revealed that sometimes there is a small amount of thyroid tissue in the neck.

FIG. 298.—An infant cretin. (*The late Professor de Quervain, Berne.*)

In the Fœtus.—The fœtus is dependent upon its own production of thyroxine; none passes across the placental barrier. Evidence of intrauterine athyroidism is found in the absence of epiphyses (lower end of femur, upper end of tibia), and the ossific centre of the cuboid, all of which should be apparent radiologically in a nine months' fœtus.

In Early Infancy.—Infant cretins are of two varieties, endemic (common) and sporadic (rare). They are similar in all respects save one. In areas where goitre is endemic, cretinism[1] with goitre is well known. Elsewhere a cretin usually, but not invariably,[2,3] has an atrophic thyroid gland.

In the first few months of life, when it is so necessary to diagnose this condition if it is to be remedied, it is easily overlooked. At this time the principal features are a protruding tongue (fig. 298) and a list-

[1] In the volcanic regions of Java cretins can be counted by the thousand; animals—domestic and wild—are affected also.

[2] Cretinism with goitre has been reported in infants of mothers receiving thiouracil compounds during the pregnancy.

[3] A number of non-endemic goitrous cretins have been born to a group of itinerant tinkers living in Scotland who intermarry (J. H. Hutchison).

Rupert Allan Willis, Contemporary. Formerly Professor of Pathology, University of Leeds.
James H. Hutchison, Contemporary. Physician, Royal Hospital for Sick Children, Glasgow.

less, constipated, pot-bellied infant with an umbilical hernia who seldom cries and is disinclined to take nourishment. The face is pale, puffy, and somewhat wrinkled. The skin is dry and cold. The child snores when asleep. On examination the hands seem thick and short. The anterior fontanelle is open widely. The temperature is subnormal, and, what is important in the sporadic variety, the rings of the trachea can be palpated easily. Radiography often shows dystrophia of the twelfth dorsal and first and second lumbar vertebræ (fig. 299), i.e. where spinal stress is greatest when the child sits up.

FIG. 299.—Showing dystrophy of the lumbar spine in a cretin aged ten months. (*Dr. Douglas Hubble, Derby.*)

In adolescent (fig. 300) *and adult life* cretinism can hardly be mistaken. The patient is a dwarf; the skin is dry, redundant, and wrinkled; pads of fat are often found in the supraclavicular region. The cretin's mentality is usually below normal, but not necessarily so.

FIG. 300.—A cretin boy aged thirteen. With thyroid extract he soon became nearly normal.

At post-mortem the cretin's pituitary fossa is often found to be enlarged, and histological studies have revealed extreme activity of the anterior pituitary.

Treatment.—Desiccated thyroid[1] must be given daily in the following dosage: $\frac{1}{10}$ grain (6 mg.) at two months, increasing the dose gradually. Most cretins under the age of two years require 1 to 2 grains (60 to 120 mg.) daily. Seldom should the dose of 3 grains (180 mg.) be exceeded, but occasionally more is required to attain euthyroidism. Continuing, the dose is increased until the age of twelve, when 2 to 3 grains (120 to 180 mg.) are required; this is the maintenance dose for life. Provided this treatment is commenced during the first year of life, fair results are obtained. The longer medication is delayed, the less response is obtained, especially in respect to the correction of mental retardation (J. H. Means). Throughout life the patient must take the correct amount of desiccated thyroid daily.

MYXŒDEMA (HYPOTHYROIDISM IN THE ADULT)

Myxœdema commonly arises idiopathically, but the same train of symptoms follows extirpation of too much of the thyroid gland. Myxœdema is also induced in 12 per cent. of thyrotoxic patients treated with radio-iodine. A hypothyroid state which frequently occurs as a result of over-treatment with antithyroid drugs is also a feature of Hashimoto's disease (see p. 236).

The prolonged exhibition of *para*-aminosalicylic acid (for tuberculosis), resorcinol ointment (for varicose ulcer), certain sulphonamides, and cobalt causes hypothyroidism to the point of myxœdema, usually with goitre. If the respective drug is stopped in time, the myxœdematous state is reversible.

[1] Alternatively, the equivalent dose of thyroxine can be prescribed.

James Howard Means, Contemporary. Jackson Professor of Clinical Medicine Emeritus, Harvard University, U.S.A.

Idiopathic myxœdema usually affects women between thirty and forty-five. Its onset is slow, and the patient becomes mentally and physically inert. She feels cold weather intensely. There is an increase in her weight, but the fat has an abnormal distribution; for instance, there is often a 'hump' over the seventh cervical and first dorsal vertebræ. The breasts themselves do not enlarge, but there are deposits immediately below them. The facies coarsens (fig. 301) and the complexion becomes sallow. The voice becomes low-pitched. In advanced cases much of the hair falls out, and that which remains is dry, lustreless, and prematurely grey. In well-established cases a diminished menstrual flow or amenorrhœa is usual. On palpation the skeletal muscles seem hard, and the 'mucin'[1] laden subcutaneous tissues feel adherent to them. Water retention is a constant feature of myxœdema (D. Hubble). The thyroid gland is impalpable.

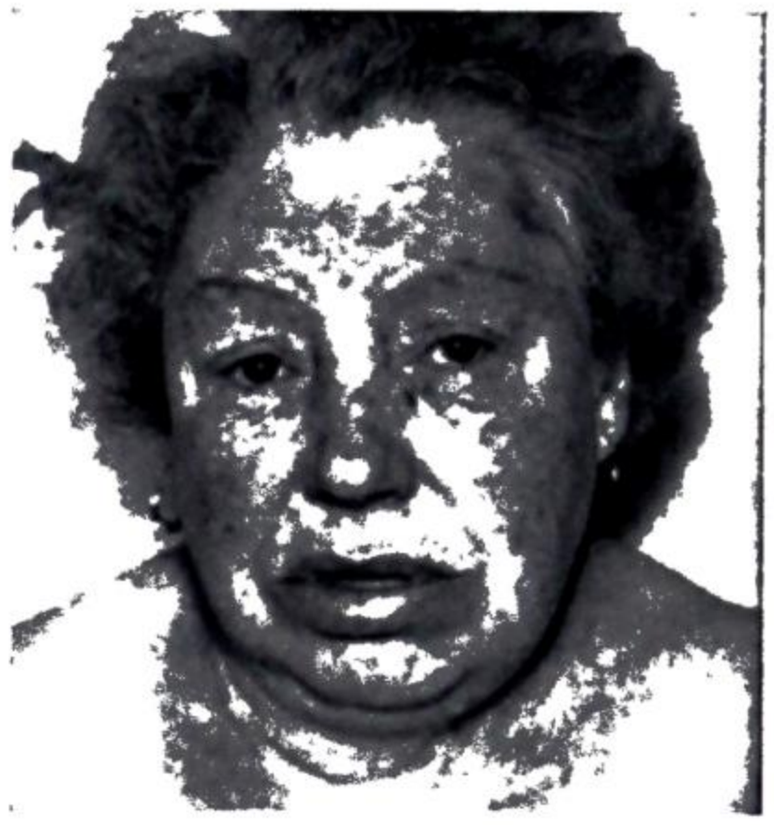

FIG. 301.—Myxœdema: note the bloated look and the dull expression. (*Dr. V. K. Summers, Liverpool.*)

Laboratory Tests.—While chemical estimation of protein-bound ^{127}I in the plasma is the most reliable confirmatory test for mild as well as severe myxœdema, as yet this estimation is possible in only a few hospital laboratories in Great Britain. On the other hand the serum cholesterol level in *hypo*thyroid states is accurate enough for practical purposes.

Treatment.—To bring an average case of myxœdema back to normal health costs less than 4d., which is the price of 100 1-grain (60 mg.) tablets of thyroid: dose ½ to 4 grains (30 to 240 mg.) daily.

Once a euthyroid state has been reached an appropriate dose of thyroid tablets must be taken for the rest of the patient's life. It is important that treatment be started with minute doses, e.g. $\frac{1}{8}$th grain; occasionally, larger doses produce failure in a weakened myocardium.

Pretibial myxœdema takes the form of œdema of the legs, and occurs at any stage in the course of *hyper*thyroidism, but usually after thyroidectomy, ^{131}I therapy, or prolonged thiotherapy for severe thyrotoxicosis. It is associated particularly with pronounced and progressive exophthalmos. The earliest manifestation is pitting œdema with orange-coloured pigmentation. Symmetrical in distribution, it involves the skin of the legs above the area constricted by the shoes to within a few inches of the knees. As time passes the colour changes to red, and then deep purple, closely resembling venous thrombosis. By this time the œdema is the solid type.

Treatment.—Pretibial myxœdema is not relieved by thyroid administration but given time it usually disappears spontaneously. In the meantime, if the swelling in the legs is considerable, pressure bandaging is indicated. Systemic cortisone has been tried with inconstant fleeting success.

Myxœdema Coma.—Hypothermic coma is a terminal complication of long-standing cases of untreated myxœdema. Nearly always it supervenes during the mid-winter and is sometimes preceded by epileptiform convulsions. What is so characteristic of the condition is that the unconscious patient's skin is reminiscent of

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[1] 'Mucin'—this is not mucin, but a fluid containing about 13 per cent. of (stored) protein. (Best and Taylor's *Physiology*.)

Sir William Gull, 1816–1890, Physician to Guy's Hospital, first described myxœdema.
Douglas Hubble, Contemporary. Physician, Derbyshire Royal Infirmary, Derby.

touching the skin of a toad—deadly cold. The rectal temperature falls to as low as 74° F. (23·3° C.). Despite warmth, cortisone, intravenous thyroxine with dextrose saline solution and antibiotics, the mortality remains very high.

ENLARGEMENTS OF THE THYROID GLAND

A goitre[1] is an enlarged thyroid gland.

CLASSIFICATION OF GOITRES

- **Non-toxic**
  - Physiological hyperplasia
    - Puberty.
    - Pregnancy.
    - Menopause.
  - Colloid.
  - Nodular
    - Multiple
      - Endemic.
      - Sporadic.
    - Solitary (= Adenoma).
- **Toxic**
  - Primary.
  - Secondary to non-toxic.

Struma[2] lymphomatosa (Hashimoto's disease).

Lymphadenoid.

Struma Fibrosa (*syn.* Riedel's Thyroiditis).

- **Carcinomatous**
  - Papillary.
  - Follicular.
  - Secondary to endemic goitre.
  - Anaplastic, arising in a normal gland.

PHYSIOLOGICAL HYPERPLASIA[3] (*syn.* GOITRE OF PUBERTY)

Clinical Features.—The only symptom is a swelling in the neck (fig. 302). The condition is almost confined to females. The thyroid gland is enlarged evenly and feels comparatively soft. Sometimes the deformity is considerable. Usually the enlargement subsides gradually, and has all but disappeared by the twentieth to twenty-second years. However, any enlargement that does not subside completely in the intermenstrual phase must be considered as abnormal, and as constituting a potential colloid goitre.

FIG. 302.—Physiological hyperplasia of the thyroid gland (goitre of puberty).

Treatment.—The adoption of hygienic measures, the elimination of septic foci, and the administration of a harmless iodine preparation, such as syr. ferri iod. ℥j (4 ml.) t.d.s., is all that is necessary. The use of thyroid extract, Lugol's solution (see p. 225), or other strong preparations of iodine, is discouraged, for not a few examples of thyrotoxicosis have been produced by their exhibition in these cases. (See Jodbasedow, p. 222.)

[1] Goitre—Latin, *guttur* = the throat.

[2] Struma. In the mountains of Bulgaria arises the River Struma that flows into the Ægean Sea. Along its banks, and those of its tributaries, dwell persons of several nationalities among whom endemic goitre has been for so long prevalent.

[3] Some physiological hyperplasia also occurs during pregnancy and at the menopause.

COLLOID GOITRE

The patient usually presents between the ages of twenty and thirty years, i.e. after physiological hyperplasia should have subsided. The whole of the thyroid gland is affected, and, as a rule, by the time the patient seeks advice the deformity is most obvious (fig. 303). To the palpating fingers the swelling feels elastic and tolerably smooth. Symptoms of pressure upon the trachea are infrequent. Occasionally this form of goitre becomes toxic.

FIG. 303. — Colloid goitre.

Microscopically, the thyroid vesicles are found to be greatly distended with colloid and lined by flattened epithelium (fig. 304).

FIG. 304.—Microscopical appearance of colloid goitre.

Treatment.—Medical treatment is sometimes effective. Thyroid extract causes a decreased avidity of the gland for iodine, and suitable doses of this preparation combined with small doses of sodium iodide give better results than either alone (S. C. Werner). If after a reasonable trial there is not a dramatic decrease in the size of the thyroid, operation similar to that for nodular goitre (see p. 226) should be undertaken.

NODULAR GOITRE

Multinodular goitre (*syn.* adenoparenchymatous goitre) is occasionally sporadic, but usually endemic.

Geographical Distribution.—The principal regions in which endemic goitre abounds are on the slopes and in the valleys of mountain ranges where, through countless centuries, glaciers of the ice-age and rain have washed away the iodine in the soil.

In Continental Europe—the Alps, the Pyrenees, Sweden, and the Struma Valley.

In North America—the Rocky Mountains, the shores of the Great Lakes, along the banks of the St. Lawrence River, and the Upper Mississippi Valley.

In South America—the Andes.

In India—the Himalayas.

In Australia—New South Wales, Tasmania.

In Africa—Sierre Leone and the north-west part of Cape Province, South Africa.

In England and Wales.—There is a goitre belt extending from Cornwall, northwards via the Cotswold Hills and the Chilterns into Derbyshire (the Pennine Chain) with offshoots into Cheshire and North Wales (fig. 305).

FIG. 305.—The goitre belt of England and Wales.

Unexpectedly, endemic goitre is rare in the Highlands of Scotland (C. Joll). The least goitrous portion of England is the Eastern Counties between the Humber and the Thames.

In Ireland—the slopes and valleys of the mountain ranges of County Tipperary, the rivers of which run through limestone, as in Derbyshire.

In spite of the emphasis that has been placed on mountainous districts, it must be known that some goitre regions are little, if at all, above sea level ; the reason why these lowlands are goitrous is that they depend upon far-away mountain ranges for

Sidney C. Werner, Contemporary. Associate Physician, Presbyterian Hospital, New York.
Cecil Joll, 1885–1945. Surgeon, Royal Free Hospital, London.

their water supply, e.g. Holland, the Plain of Lombardy, Egypt, the Congo, and the Great Plains east of the Southern Alps of New Zealand.[1]

Ætiology

Iodine Deficiency.—The hypothesis that iodine deficiency is a major factor in the production of endemic goitre is firmly established. In nearly all districts where endemic goitre is prevalent it has been proved that there is a very low iodine content in the water and food.

Goitrogens.—No known naturally occurring substance produces a goitre when the iodine intake is adequate, but if the iodine intake falls to a critical level the addition of one of the goitrogens can tip the scales in favour of thyroid enlargement. Examples of goitrogens are:

(*a*) *Calcium Excess*.—For centuries it has been known that there is an association between goitre and drinking water, a notable example being Derbyshire neck. The waters of the Derwent and the Dove pass through mountainous limestone.

(*b*) *Fluoride excess* in drinking water has also been deemed a factor in the causation of goitre. This seems to be a major cause in the production of goitre in the north-west of Cape Province.

(*c*) *Water Pollution*.—Water contaminated with human or animal excreta can cause enlargement of the thyroid (Sir Robert McCarrison).

Prophylaxis.—By supplying table salt[2] containing one part of potassium iodide to 10,000 parts of sodium chloride the incidence of goitre has been strikingly reduced in Switzerland, Detroit, Sweden, and New Zealand. In the State of Michigan and in County Tipperary, small doses of sodium iodide are given to schoolchildren during the winter months, with the same beneficial effect, whereas in Holland notable results have accrued from adding an iodising apparatus to the municipal water supplies in affected districts.

The incidence of goitre in Great Britain has diminished considerably in comparison with years gone by; a change that is usually attributed to the improved distribution of fish, with its high iodine content, and also to better water supplies.

Thus it seems that iodine deficiency can be overcome by so simple a matter as a weekly call to an isolated village by a fishmonger's van (M. Young).

Pathology.—Endemic goitre passes through a stage of diffuse epithelial hyperplasia, followed by involution and the formation of a colloid goitre. As a rule recurring cycles of hyperplasia and involution continue, and the unequal response by different portions of the gland results in gross nodularity. The nodules, although circumscribed by a delicate capsule, are difficult or impossible to enucleate. By the time the gland comes to be examined, most of the nodules are cysts filled with brown, green, or black watery fluid, or similarly coloured jelly-like material (fig. 306). Cholesterol crystals are generally present in large numbers in the contents of fluid cysts. In cases of some standing the stroma shows an overgrowth of fibrous tissue, and as

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[1] Paradoxically, the soil of New Zealand is heavily impregnated with iodine, but this does not prevent goitre in man, sheep, and other animals (Sir Charles Hercus).

[2] In England the Ministry of Health's agreement with the salt manufacturers for the addition of iodine to salt, promised in 1952, has not yet been implemented.

Sir Robert McCarrison, Contemporary. Major-General Indian Medical Service (Rtd). Consulting Physician, Radcliffe Infirmary, Oxford.
Matthew Young, 1884–1940. Lecturer in Anatomy, University College Hospital, London.
Sir Charles Ernest Hercus, Contemporary. Professor of Bacteriology and Public Health, University of Otago, New Zealand.

time passes irregular areas of calcification are wont to occur in it.

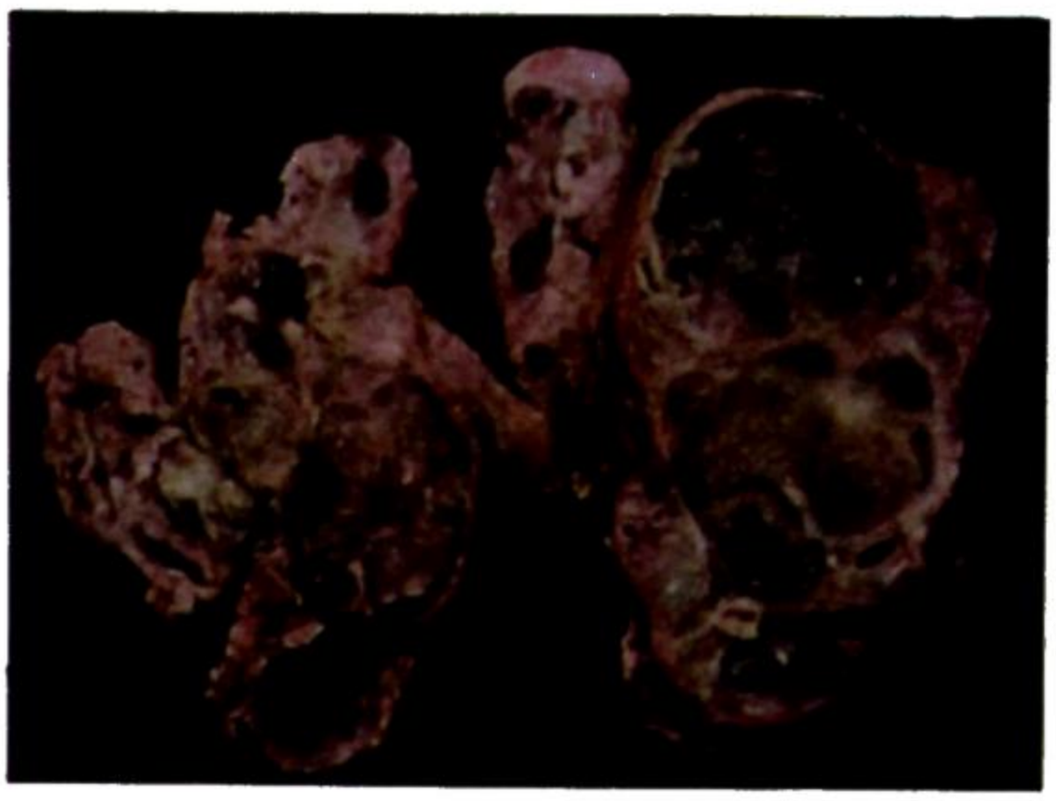

FIG. 306.—Multiple nodular goitre. Specimen removed at operation. Showing the cut lateral lobes and the pyramidal lobe.

Clinical Features.—Let us take the findings in a district where endemic goitre can be said to be of average severity. By the age of six, about 20 per cent. of the boys and 30 per cent. of the girls present a visible and palpable smooth, soft, and symmetrical enlargement of the thyroid gland. As the children become older, the number with goitre increases; so does the average size of the gland. After the age of puberty the total number presenting goitres declines, for in some of the boys the thyroid enlargement disappears. Among the girls the number and the size of the goitres continue to increase to the age of eighteen. After that time only exceptionally does an enlarged gland decrease in size sufficiently to become unnoticeable. Sometimes it remains stationary; often it continues to enlarge, and becomes multinodular (fig. 307).

FIG. 307.—Multinodular goitre.

Multinodular goitre is encountered most frequently in patients over thirty years of age. The whole gland is studded with rounded swellings of varying size. The unsightly swelling, when it has reached a distressing size, is the most common symptom that brings the patient to seek relief.

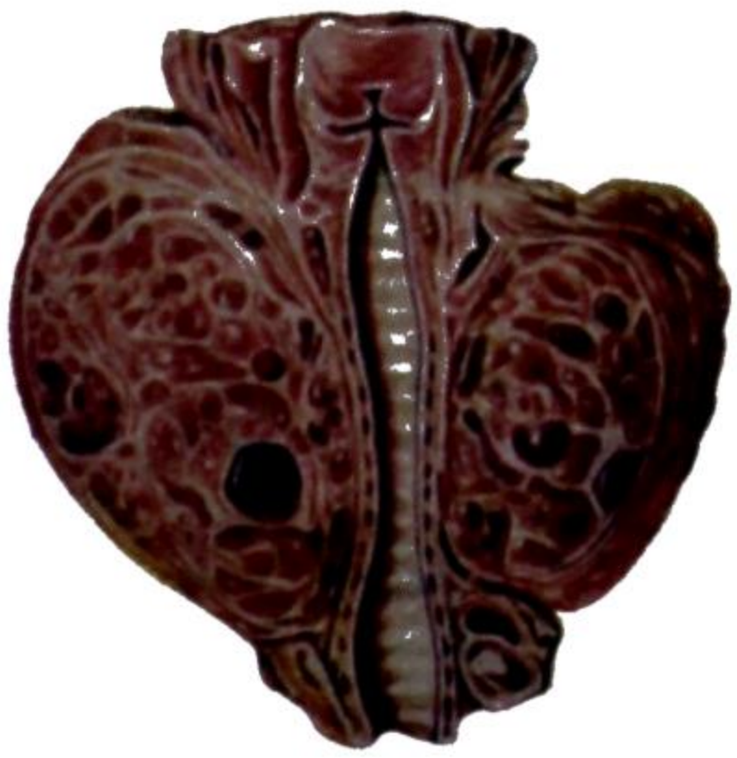

FIG. 308.—Scabbard trachea caused by a multinodular goitre. (*British Journal of Surgery.*)

Complications:

Pressure upon the trachea (fig. 308) may develop. When the goitre is mainly unilateral, the degree of tracheal displacement is sometimes fantastic. Nevertheless, it is not this type of deformity that produces dangerous dyspnœa; it is rather the bilateral, deep, but not obviously great, enlargement. Here the continuous compression of the sides of the trachea decreases its transverse diameter.

Secondary Thyrotoxicosis.—The prophylactic use of iodine is said to increase the incidence of secondary thyrotoxicosis occurring in cases of

endemic goitre. Secondary thyrotoxicosis arising in this way is known as Jodbasedow.[1]

Carcinoma.—Multinodular goitre of long standing, whether sporadic or endemic, is the seat of a malignant change in about 8 per cent. of cases.

FIG. 309.—Showing the approximate amount of the thyroid gland that is removed in nodular goitre *without thyrotoxicosis*. Shaded portion remains.

Treatment.—The only effective treatment of multinodular goitre is by operation, and partial thyroidectomy (fig. 309) should be recommended not only to rid the patient of the deformity, but to circumvent the complications considered above.

TOXIC GOITRE

Ætiology.—The cause of primary toxic goitre probably arises outside the thyroid from emotional and other hypothalamic stimuli leading to pituitary thyrotropic activity (see fig. 295) and so to thyrotoxicosis. In rare instances where the condition is congenital, invariably the mother has, or has had, a toxic goitre and almost certainly congenital hyperthyroidism is due to transplacental transmission of maternal thyrotropic hormone.

Primary Toxic Goitre (*syn.* Exophthalmic Goitre, Graves' Disease, Basedow's Disease).—The symptoms often appear in the third and fourth decades of life, but may occur earlier or later. Eighty-five per cent. of patients are females. The disease progresses by acute exacerbations and remissions; the exacerbations being most frequent in the spring, and least frequent in the autumn. It is well to remember that the exophthalmos or the goitre may be absent, but seldom both. In a typical case the protuberant eyeballs give a startled look that is unmistakable (fig. 310). Curiously, exophthalmos is sometimes mainly or entirely unilateral. Typically the thyroid gland is enlarged uniformly, and feels smooth and firm. Because of its vascularity, a 'thyroid thrill' is often obtained.

FIG. 310.—Primary toxic goitre. (*Professor A. J. Wayne, Glasgow.*)

In the early stages of the disease the appetite is voracious, but in spite of this the patient loses weight. Due to increased metabolism, there is polyuria, and the patient often complains of having to get up two or three times during the night to micturate. In well-established cases attacks of diarrhœa add to the general wasting. As the disease advances, muscular weakness progresses, and this applies to the myocardium as well as to the skeletal musculature.

Cardiovascular Disturbance.—Tachycardia is a leading symptom. In an acute exacerbation the pulse is very rapid. Usually the systolic blood-

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[1] J an for iodine + Basedow.

1797–1853. Physi h Hospital, Dublin.
edow, 1799–1854. tioner, Mersburg, Germany.

pressure is raised, and the slightest excitement accentuates the circulatory turmoil. Eventually the heart weakens: in advanced cases auricular fibrillation is a frequent accompaniment, and unless it can be controlled, congestive heart failure with anasarca is often the terminal complication.

The myocardium is exceptionally susceptible to thyrotoxin poison; yet in fatal cases no definite histological change is discernible in the cardiac muscle. Be it remembered that even slight thyrotoxicosis acting upon a heart the seat of mitral stenosis or other organic lesion, not uncommonly culminates in acute cardiac failure. There is no such thing as 'masked hyperthyroidism,' but often so much attention is focused on the heart that a seemingly minor lesion of the thyroid is overlooked. The hyperthyroidism is not masked, but missed (F. F. Rundle).

Nervous Symptoms.—Early cases, commonly misdiagnosed as neurasthenia, can be differentiated by the sleeping pulse rate. The patient is restless and highly strung. The extended hands shake, and the protruded tongue is tremulous.

Vasomotor disturbances are in evidence. The patient sweats readily, and may be subject to sudden flushing of the face and neck. Warm, moist hands are usual. She is intolerant of heat, and all symptoms become accentuated in the warmer weather. Insomnia is the rule, and weeping without provocation is one of the least of many mental abnormalities which may complicate the situation.

Laboratory methods for confirming the diagnosis are required only in very early or atypical cases. These tests are described on p. 212.

TREATMENT

(*a*) **Medical treatment** includes rest in bed, a light diet with copious fluids, and sufficient dextrose to ensure a total of 3,000 calories daily. A sedative, such as luminal 30 mg. (½ grain) twice daily, is prescribed. As was well known to the old-time physicians, natural remissions occur from time to time even when no effective treatment is given.

Thiouracil prevents the synthesis of thyroxine (fig. 311). A course of one of the preparations of thiouracil [1] frequently brings about substantial improvement. It is often effective in the control of auricular fibrillation of thyrotoxic origin.

FIG. 311.—Thiouracil acts as a barrier to the uptake of iodine by the thyroid gland. (*After Rawson, Tannheimer, and Peacock.*)

Methylthiouracil.—The dose given is usually 200 mg. (3 grains) rising to a maximum of 600 mg. (9 grains) daily, until a definite response is obtained, the criteria being a fall in the pulse-rate, an increase in weight, and a fall in the basal metabolic rate. After this response the dose is reduced to 200 mg. (3 grains) or even 100 mg. daily.

Propylthiouracil is a weaker antithyroid drug than methylthiouracil. The average dose is 200 to 300 mg. (3 to 5 grains) daily, and because its duration is shorter, it is given in divided doses three times a day and at bedtime. The great

[1] In 1943 E. B. Astwood first treated thyrotoxicosis successfully with thiourea.

Francis Felix Rundle, Contemporary. Head of Clinical Investigation Unit, Royal North Shore Hospital, Sydney, Australia.
Edwin Bennett Astwood Contemporary. Physician, New England Center Hospital, Boston, Mass., U.S.A.

advantage of propylthiouracil is that it is less liable to be accompanied by untoward reactions.

Carbimazole[1] (neomercazole) is administered in total daily doses of 20 to 40 mg., depending on the severity of the thyrotoxicosis. Ultimately neomercazole may prove as effective as the thiouracils as it is less toxic and less goitrogenic.

Potassium perchlorate in doses of 200 to 800 mg. in adults has been found to be clinically as effective as the thiourea compounds, but the response to this preparation is slower than other antithyroid drugs, which is a serious drawback. The use of potassium perchlorate alone for maintenance dosage after thyrotoxicosis has been controlled by one of the other antithyroid drugs has much to commend it.

Treatment by thiouracil does not reduce the size of the goitre ; indeed, in many cases the thyroid gland becomes larger, such enlargement persisting (thiouracil goitre). If the patient reacts favourably to thiouracil, a maintenance dose must be continued for many months. Even in carefully selected cases (those with a large goitre, those with severe thyrotoxicosis, and those with recurrent symptoms being excluded) 60 per cent. relapse after prolonged antithyroid drug therapy. Consequently, in patients under forty years of age, it is usual to advise—not long-term antithyroid drugs—but operation. This does not imply that antithyroid drugs are not invaluable for bringing the disease under control, and in some patients over forty years of age the result of this treatment is lasting.

Complications of Thiotherapy :

1. **Thiouracil Goitre.**—High dosage, if prolonged, will produce a hyperplastic gland—a thiouracil goitre. In spite of the fact that a large thiouracil goitre is frequently throbbing because of its extreme vascularity, the patient is usually subthyroid (V. Riddell). Ten to twenty-one days of pre-operative preparation with Lugol's solution, without thiotherapy, reduces considerably this vascularity which, however, is sometimes still formidable.

FIG. 312.—Transmitted thiouracil goitre.

Transmitted Thiouracil Goitre.—Thiotherapy must never be given during pregnancy; thiouracil medication causes a thyroxine deficiency that stimulates the pituitary to excessive thyrotropic hormone secretion. The transference of this hormone by the placenta to the fœtal thyroid sometimes causes formation of a thiouracil goitre with accompanying hypothyroidism in the fœtus and the infant (fig. 312).

2. **Compression of the Trachea.**—Thiotherapy causes the thyroid gland to become larger and harder, therefore this form of treatment should be avoided in cases of toxic goitre that can be demonstrated radiologically to be retrosternal or otherwise causing compression of the trachea. Its use in such cases can bring about a dangerous degree of respiratory obstruction.

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[1] British Schering Ltd.

Victor Horsley Riddell, Contemporary. Surgeon, St. George's Hospital, London.
Jean Guillaume Auguste Lugol, 1786–1851. Physician, Hôpital Saint-Louis, Paris.

3. **Myxomatous Infiltration of the Vocal Cords.**—In addition to causing the gland to become larger, overdosage with antithyroid agents also induces myxœdema which, in the early post-operative phase, is liable to produce thickening of the vocal cords and œdema of the glottis, necessitating tracheostomy, as occurred in three patients at the Lahey Clinic (R. B. Cattell).

4. **Agranulocytosis,** a condition in which there is an absence of, or a great diminution in, the granular form of leucocytes. It may occur at any time during the treatment, irrespective of the dosage. The leukopænia of severe thyrotoxicosis is suddenly transformed into agranulocytosis, with such catastrophic rapidity that repeated blood-counts are not an adequate safeguard. Sternal marrow examinations give more reliable information than an investigation of the blood, and should be carried out if agranulocytosis is suspected, and during its treatment. Any patient undergoing thiotherapy who develops a sore throat, pyrexia, and malaise, sometimes associated with a papulomacular rash, or one of the rarer symptoms—conjunctivitis, enlargement of the salivary glands, enlargement of lymph nodes, arthralgias, or hæmaturia—should be investigated without delay, the diagnosis of agranulocytosis being presumed until the contrary is proved. If agranulccytosis is present, the thio-agent is stopped forthwith. Penicillin and streptomycin are given as a prophylaxis against infective complications. In severe cases blood transfusion is necessary. No sulpha drugs or chloramphenicol must be given, as both these preparations increase agranulocytosis. In spite of treatment, the condition proves fatal in about a quarter of the patients affected.

(*b*) **Operative Treatment.**—Careful pre-operative preparation occupying at least fourteen days is essential. No patient should be operated upon for thyrotoxicosis until previously rendered euthyroid by medical treatment. As soon as the patient's general condition warrants it, the date of operation should be fixed. If the patient has been receiving thiouracil, this is discontinued. In any case, pre-operative medication with Lugol's solution is commenced. Lugol's solution, which is 5 per cent. of iodine[1] dissolved in 10 per cent. potassium iodide, is best given in milk or orange juice, either of which masks its taste and colour. In an average case, 10 minims (0·6 ml.) is given three times a day for twelve to fourteen days, when its maximum effect is reached. Lugol's solution usually controls thyrotoxicosis as effectively as thiouracil, but after fourteen days its beneficial effects commence to wane. Its great advantage over thiouracil as a pre-operative drug is that it renders the thyroid gland less vascular and friable.

This is a convenient place to emphasise that should the patient possess enlarged or infected tonsils or infected teeth, on no account must tonsillectomy or dental extraction be undertaken until the thyrotoxicosis has been fully controlled. Fatal thyroid crises have many times been precipitated by a minor operation upon a patient who is still thyrotoxic.

The vocal cords must always be inspected before operation, as in about 4 per cent. of patients paresis or paralysis is present, possibly due to toxic

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[1] *Circa* 1600 B.C. the Chinese used burnt sponge and seaweed for the treatment of thyrotoxicosis.

Richard B. Cattell, Contemporary. Surgeon, The Lahey Clinic, Boston, Mass.

neuritis during exanthemata in childhood. The presence of an impaired vocal cord must, for the surgeon's protection, be recorded in the notes before the operation.

Subtotal Thyroidectomy.—Due to better pre-operative preparation with thiouracil and Lugol's solution, local anæsthesia by infiltration or cervical nerve block is now considered less essential, and is being supplanted by general anæsthesia administered via an endotracheal tube. Nevertheless local anæsthesia is the safer in poor-risk and elderly patients.

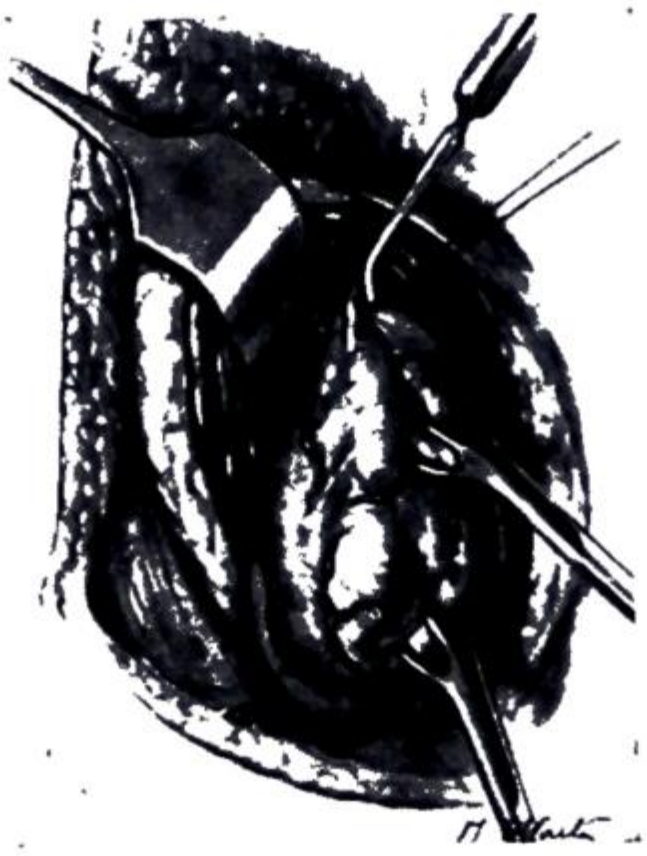

FIG. 313.—Ligation of the superior thyroid vessels.

Technique.—An almost transverse incision following a crease of the neck is made, and the flap is dissected up to the level of the pomum Adami. A vertical median incision is now made through the fascio-muscular planes from the hyoid bone to Burns's space. By suitable retraction it is possible to expose the lateral lobes. If the goitre is a large one, it is advisable to divide the pretracheal muscles as high as convenient, because their nerve supply enters the muscle inferiorly. Commencing usually on the right side, the middle thyroid vein is secured and divided between ligatures, allowing the lateral lobe to be dislocated forwards; this step permits identification of the inferior thyroid vein, which is dealt with similarly. Next the superior pole is freed and the superior thyroid vessels are ligated (fig. 313), care being taken not to injure the superior laryngeal nerve. After suitable dissection the lobe can be delivered into the wound. A special dissection for the inferior thyroid artery is not always required, but if this ligation is undertaken, the artery should be tied well away from the gland, to avoid the recurrent laryngeal nerve. This ligation is undertaken with No. 60 thread passed with a small aneurysm needle.

When all is in readiness, about nine-tenths of one lateral lobe is resected together with the isthmus (fig. 314) and the pyramidal lobe. The slice which remains protects the parathyroids and recurrent laryngeal nerve. Provided the patient's condition remains good, which is the rule, subtotal lobectomy is repeated on the other side. The wound is closed, usually with drainage.

Only if the patient's parlous condition demands it, is the second lobe left until a further course of medical treatment has been given. At the conclusion of the operation it is a wise precaution for the anæsthetist to inspect the vocal cords. If they are functioning normally, subsequent huskiness or aphonia will then assuredly only be temporary.

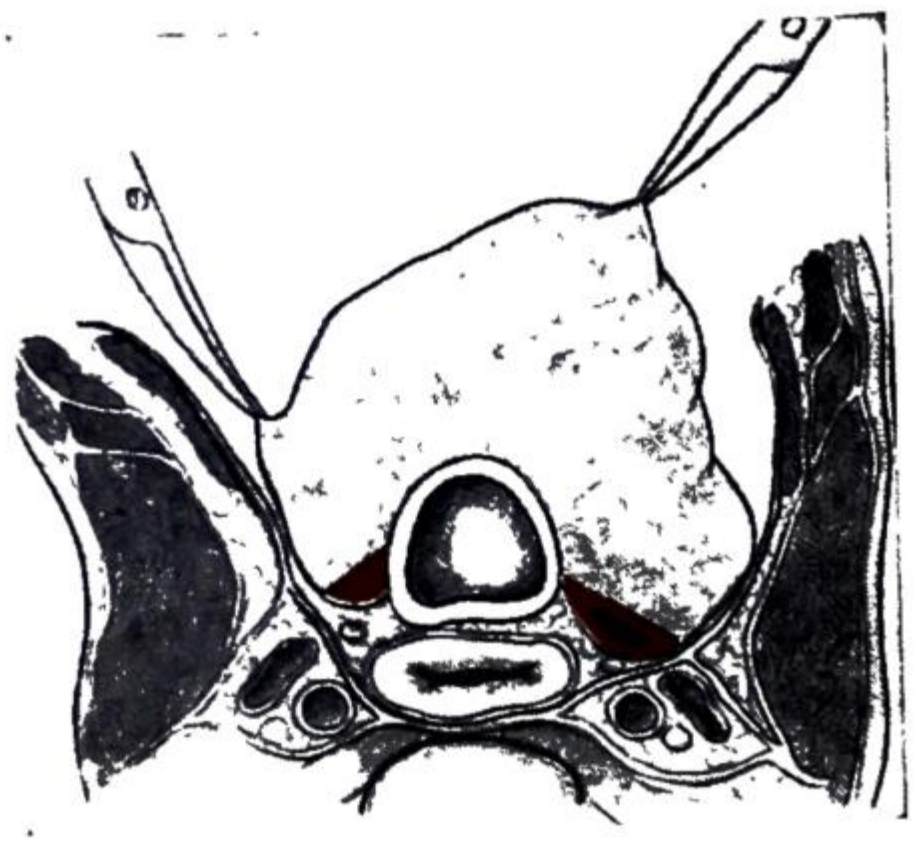

FIG. 314.—Transverse section showing the relative amount of the lateral lobes removed in toxic goitre, and the portion that remains protecting the parathyroid glands and the recurrent laryngeal nerves.

Injury of the Recurrent Laryngeal Nerves, with Special Reference to its Prevention.[1]—In order to keep well clear of the recurrent laryngeal nerves (see fig. 294, p. 211) the middle thyroid veins should be secured and divided half an inch (1·3 cm.) lateral to the vicinity of the nerves. Some operators, in order to avoid the recurrent laryngeal nerves, make no extracapsular ligation of the inferior thyroid arteries; others ligate the inferior thyroid arteries well away from the thyroid gland, viz. behind the common carotid artery (see fig. 294). Still others ligate the inferior

[1] It is essential that pre- and post-operative laryngoscopy be carried out as a routine.

The late Henry S. Plummer, 1874–1936, Physician, Mayo Clinic, Rochester, U.S.A., was the first to use Lugol's solution in the preparation of thyrotoxic patients for operation.
Allan Burns, 1781–1813. Extramural Lecturer in Surgery and Anatomy, Glasgow.

thyroid arteries only after at least one recurrent laryngeal nerve has been isolated. Injury to one recurrent laryngeal nerve is sometimes recognised at operation (*a*) by stridor; (*b*) by a change in the patient's voice, if the operation is being performed under local anæsthesia. Injury to both nerves may bring about sudden laryngeal obstruction, necessitating immediate tracheostomy; at other times the injury is not recognised until the early post-operative period (see p. 291).

Injury to the superior laryngeal nerve is best avoided by dissecting the medial aspect of the superior thyroid artery and the upper pole of the thyroid from below, upwards (fig. 315).

FIG. 315.—Separating the superior laryngeal nerve from the superior thyroid artery by dissection from below, upwards. *(After R. E. Moran and A. F. Castro.)*

Post-operative Treatment.—The patient is propped up gradually into the sitting position and suitable doses of omnopon and luminal are prescribed. The pulse must be watched closely. While it is important that the patient should have a high fluid intake, she should not receive the fluid intravenously, for fear of embarrassing the heart. Only if the necessary amount of fluid cannot be administered by mouth, via a transnasal intragastric tube, or per rectum, should the subcutaneous route be chosen. One drachm of Lugol's solution in milk is given per rectum a few hours after operation. Minims 10 (0·6 ml.) of Lugol's solution are given t.d.s. in fruit juice for five or six days. It is then discontinued.

Post-operative Complications:

Hæmorrhage.—The nurse should be instructed to watch for excessive hæmorrhage, particularly at the back of the dressing, for the blood tends to trickle posteriorly. Reactionary venous hæmorrhage is the usual type, particularly if the patient coughs or vomits. Hæmorrhage may be concealed owing to clotting. Any undue bulging of the neck must be reported and dealt with immediately.

FIG. 316.—Tension haematoma deep to the pretracheal muscles. *(After V. Riddell.)*

Deep arterial or venous reactionary hæmorrhage (fig. 316) comes on without warning, usually within six hours of operation. The patient holds her head in a peculiar fixed position, and finds it impossible to move her head without exaggerating the symptoms of suffocation. *So sudden and severe is this type of respiratory obstruction that more often than not it is impossible to get a doctor in time. Consequently the nurse must be taught how to open the wound, cut the muscle sutures, spread the muscles, and remove the clot—in this desperately urgent situation it is justifiable to carry out this measure with unsterilised hands.* If bleeding continues, the patient must be taken to the operating theatre and the bleeding vessel secured and ligated.

Dyspnœa.—Urgent dyspnœa can result from blood-clot pressing upon the trachea or from bilateral damage to the recurrent laryngeal nerves. If reopening the wound fails to relieve the dyspnœa, tracheostomy must be performed forthwith.

Alteration in the Voice.—After an extensive thyroidectomy, nearly all patients speak in a whisper for a few days, to spare undue movement in the region of the wound. If hoarseness or aphonia persists, it is probable that there has been damage to one or both recurrent laryngeal nerves.

Recurrent Laryngeal Nerve Damage (see p. 289).

Tracheitis frequently follows thyroidectomy. It is relieved by medicated steam inhalations.

Parathyroid Tetany (see p. 247).

Thyroid Crisis.—Since the advent of more effective pre-operative preparation by antithyroid drugs, post-operative thyroid crises have been extremely rare, but it should be noted that occasionally a patient who has neglected all treatment passes

into a crisis, and is seen for the first time in that condition. A thyroid crisis can be looked upon as a hyperacute phase of thyrotoxicosis. Rather suddenly the patient passes into an intensely toxic, confused state, with a pulse-rate of 150 to 200, and increasing mental symptoms. Usually there is considerable pyrexia (up to 106° F. (41·1° C.)). Frequent vomiting and diarrhœa is in evidence.

Treatment.—Ice-packs to the limbs, abdomen, and precordial region (but not the chest wall overlying the lungs) sometimes bring about a remarkable change for the better, but the mainstay of treatment is Lugol's solution (1·5 to 2·5 ml.) intravenously. This is repeated as necessary ; up to 100 minims of the solution can be given in the course of twenty-four hours. It should always be administered diluted with normal saline solution. Sedation by large doses of chloral hydrate is required. If the patient continues to vomit, intravenous dextrose-saline solution is administered with caution (cardiac weakness). Penicillin is given to avert intercurrent infection, especially of the lungs.

(*c*) **Radio-active Iodine(^{131}I) Treatment.** [1]—Like all radio-active elements, radio-iodine emits radio-activity for a specific period. The amounts emitted towards the end of that period are quite small, the greater part being discharged during the first half of the total period—the half-life of the element. Radio-active iodine has a half-life of eight days. Whereas its gamma rays, which are highly penetrating, are used for detection of thyroid tissue, its beta rays are highly destructive to tissues, and particularly to thyroid tissue, because the gland entraps the circulating radio-iodine.

Indications :

1. Patients with primary thyrotoxicosis over forty-five years of age.
2. Those in whom intercurrent disease reduces the expectancy of life to less than twenty years.
3. Those who are refractory to antithyroid drugs, and those who refuse operation.
4. Recurrence after operation, particularly after a second operation, when the risk of damage to the recurrent laryngeal nerves is increased.
5. Cases of primary thyrotoxicosis associated with uncompensated cardiac failure.

The reasons for not treating patients under forty-five years of age by radio-iodine, a rule that is observed by the highest authorities but is sometimes neglected by those with less knowledge, are (*a*) the possibility of detrimental genetic defects in future generations ; (*b*) the possibility that radio-iodine may induce carcinoma. Experts agree that were carcinoma to develop as a result of radio-iodine therapy, it would do so after twenty years. Consequently the news that it has not done so already is not conclusive (S. C. Werner). (*c*) In a patient who is pregnant, radio-iodine passes through the placental barrier to reach the fœtus, whose thyroid is especially vulnerable to this isotope.[2] Radio-iodine is also secreted in the milk. Therefore radio-iodine is contraindicated throughout pregnancy and during lactation, if the infant is to be breast-fed.

Administration.—It is now agreed that special precautions against

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[1] Radio-active iodine was first used in the treatment of thyrotoxicosis by Hertz and Roberts in 1942.

[2] Isotope—Greek, ισος = equal + τόπος = place. E.g. iodine and radio-active iodine are *chemically* identical.

Saul Hertz, Contemporary. Director of Radioactive Isotope Research Institute, Boston, Mass., U.S.A.
Arthur Roberts, Contemporary. Associate Professor of Physics, University of Iowa, U.S.A.

irradiation exposure are unnecessary with the doses used in treating primary thyrotoxicosis. Most patients can remain completely ambulatory and carry on their usual activities : patients who live within reasonable distance of the hospital can be treated as out-patients. The aim is to give one millicurie of ^{131}I per gramme of thyroid tissue. The estimation of the weight of the thyroid is a crucial factor for determining the dose, and the difficulties are partially overcome by the services of a physicist who makes calculations from the uptake of ^{131}I by the thyroid at the time of the administration of the tracer dose, but the radio-sensitivity of different glands is a biological variable. This results in some patients being treated inadequately, and others rendered myxœdematous. The prescription of an entirely accurate radiation dose being impracticable, there are many variations in the matter of administration in various centres. That used at the Royal Infirmary, Edinburgh, will be described. The patient drinks a small amount of water containing the dose requested from the central laboratory. This is sent in a screw-capped bottle containing between 1 and 2 ml., the dose requested being :

4 millicuries of radio-iodine if the thyroid is impalpable.

5 or 6 millicuries of radio-iodine if the thyroid enlargement is insignificant.

This dose is increased in accordance with the estimated size [1] of the gland, but 12 millicuries is seldom exceeded. A few of the most toxic patients are given a course of an antithyroid drug before the ^{131}I ; it should be noted that if an antithyroid drug is given, a relatively larger dose of ^{131}I is necessary. It is undesirable to give antithyroid drugs after ^{131}I therapy, except in very toxic patients as a preliminary to further isotope treatment. Should there be no clinical improvement within six to ten weeks after the administration a further dose is given (A. G. Macgregor).

When compared with operation, the results of ^{131}I treatment are slow : it is fully three months before substantial improvement is registered.

Untoward reactions are surprisingly few. Thyroid crises, including at least one fatal case, following the treatment have been reported, but they are rare. On the other hand mild flare-up of the disease is frequent. Muscular and joint rheumatic pain lasting months, or longer, are the chief complaint (E. J. Wayne). Hair sometimes falls out, but it grows again. The incidence of aggravation of exophthalmos is possibly lower than that following operation. The chief serious sequel of ^{131}I therapy is myxœdema due to an overdose.

In specialised centres this complication follows in about 12 per cent. of cases ; elsewhere it is higher. The symptoms can, of course, be controlled by tabellæ thyroid or triiodothyronine.

HYPERTHYROIDISM IN CHILDHOOD

Only about 1 to 2 per cent. of all cases of Graves' disease are found in children. It is highly important that such children should be treated correctly, for prolonged hypothyroidism from over-treatment retards growth, and conversely under-treatment is liable to result in accelerating growth. In congenital hyperthyroidism iodine is probably the drug of choice. On the whole the results of subtotal thyroidectomy in very early childhood are not encouraging, for the operation at this

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[1] The weight of the thyroid gland during the prime of life is between 20 and 60 gm. ($\frac{2}{3}$ to 2 ounces).

Alastair G. Macgregor, Contemporary. Associate Physician, Royal Infirmary, Edinburgh.
Edward Johnson Wayne, Contemporary. Regius Professor of Practice of Medicine, University of Glasgow.

time of life is especially difficult ; the risk of damage to the recurrent laryngeal nerves and to the parathyroids is great. Moreover, it is difficult to decide how much of the gland should be excised. It is thus expedient to postpone operation, at any rate for several months, and once the thyrotoxicosis has been controlled by medical measures, to maintain the euthyroid state by the exhibition of potassium perchlorate. Only if symptoms recrudesce after withdrawal of the drug should the advisability of surgical treatment be entertained.

THE EXOPHTHALMOS OF GRAVES' DISEASE

For purposes of treatment it is important to divide the exophthalmos of Graves' disease into three categories, mild, severe, and progressive.

Mild is the most frequent of the varying degrees of exophthalmos that accompany Graves' disease. There is hardly any true proptosis, minor degrees of which are best observed from above, viz :

The staring look is due mainly to exposure of the whites of the eyes by retraction of the upper lid. Lid-lag (von Graefe's sign), as tested by asking the patient to follow the examiner's finger moved up and down, is present.

Severe.—There are three components : (*a*) congestive features are the earliest and most easily recognised. Watering of the eyes is in evidence, especially in the morning, and is often mistaken for conjunctivitis.

(*b*) Protrusion of an eyeball and its lid is frequently more obvious on one side than on the other.

(*c*) Paresis of one or more of the extrinsic muscles of the eyeball due to œdema and round-celled infiltration of the muscles is at times revealed by diplopia. The superior rectus muscle is most commonly affected. When more than one muscle is involved the condition is known as ophthalmoplegia.

Progressive is clearly more than a part of the typical picture of Graves' disease. It occurs comparatively infrequently, and usually follows ablation of thyroid tissue for primary thyrotoxicosis, whether accomplished by operation, antithyroid drugs, or ^{131}I. Visual acuity deteriorates progressively; this is due to either corneal ulceration, excessive protrusion of the eyeballs, or pressure on the optic discs.

FIG. 317.—Progressive exophthalmos, with chemosis and exophthalmic ophthalmoplegia. (*Clinical Collection, the Lahey Clinic, Boston, Mass., U.S.A.*)

Often chemosis is pronounced (fig. 317). Unless arrested, the condition leads to corneal ulceration, papillœdema, dislocation of the eyeballs, and ultimately to panophthalmitis.

Treatment.—Hypothyroidism, if present, must be corrected, care being taken to avoid over-treatment; tablets of thyroid, 3 to 6 grains daily, or, preferably, large doses of triiodothyronine, should be prescribed and continued for three months after the danger of progressive exophthalmos appears to have passed. Other simple measures can also help—sleeping with the head elevated by several pillows to aid drainage, and a dehydrating regime, e.g. a low salt diet, being followed. When diplopia is the main disability spec-

Albrecht von Graefe, 1828–1870. Professor of Ophthalmology, Berlin.

tacles with one lens frosted are often helpful, provided the ear-pieces have a universal joint, so that the lens can be reversed (Russell Fraser).

The intravenous administration of corticotrophin (ACTH) in large doses cures some patients, especially those in whom congestive features predominate.

In at least 50 per cent. of cases these measures are ineffective.

Operative Treatment :

Tarsorrhaphy (suturing together the eyelids) is of great value, not only in protecting the cornea and restraining the exophthalmos, but in gaining time in which to try to bring the exophthalmos under control by conservative measures without invoking the risk of irreparable damage.

Orbital decompression is a method of preserving the eyes when the above measures have failed to arrest progressive exophthalmos.

Rowbotham's Operation.—The incision commences half an inch (1·3 cm.) posterior to the outer margin of the bony orbit, and extends upwards to the lateral end of the eyebrow, and then along the margin of the origin of the temporal muscle for 3 inches (7·5 cm.). After the scalp flap has been reflected, the temporal muscle and its fascia are dissected downwards. With a perforator, and then with a burr, an opening is made through the orbital plates of the sphenoid and the zygomatic bone, thus exposing the peri-orbital fascia (fig. 318). The opening in the bone is enlarged with nibbling forceps so that the lateral wall and the roof of the orbit are removed, the dura of both the anterior and the middle cranial fossæ being exposed. In severe cases the outer margin of the orbit also is sacrificed. The peri-orbital fascia is incised, and the orbital contents bulge forth. The wound is closed with drainage for twenty-four hours. The original operation for decompression of the orbit was devised by H. C. Naffziger, who employs the frontal route to remove the roof of the orbit.

FIG. 318.—Orbital decompression completed. (*After G. F. Rowbotham.*)

Section of the pituitary stalk is the most recent method of treating progressive exophthalmos that fails to be halted by conservative measure, and in the few cases in which it has been carried out, it has proved remarkably successful (E. P. McCullagh).

SECONDARY THYROTOXICOSIS

Thyrotoxicosis may be secondary to some form of pre-existing simple goitre. It is encountered most frequently in women over forty years of age who have had a solitary adenoma of the thyroid (see below)—often since their 'teens. Secondary thyrotoxicosis is also prone to occur in retrosternal goitres. Although the initial symptoms are less severe than those of primary toxic goitre, the condition is steadily progressive, and remissions are absent. Eventually cardiovascular symptoms (see p. 222) become very much in evidence, and many of these patients have myocardial degeneration. Exophthalmos is nearly always absent. The basal metabolic rate is higher than normal, but not as high as it is in Graves' disease. That an adenoma of the thyroid is hyperfunctioning often can be proved by a tracer dose of radio-iodine (' hot nodule ').

Thomas Russell Cumming Fraser, Contemporary. Professor of Medicine, Post-Graduate Medical School, London.
George Frederick Rowbotham, Contemporary. Surgeon-in-Charge, Department of Neurological Surgery, Newcastle General Hospital.
Howard C. Naffziger, Contemporary. Emeritus Surgeon-in-Chief, University of California, San Francisco, U.S.A.
Ernest Perry McCullagh, Contemporary. Head of the Section of Endocrinology, The Cleveland Clinic, Cleveland Ohio, U.S.A.

Solitary Toxic Adenoma.—Long over-production of thyroxine by an adenoma causes the anterior pituitary virtually to close down as far as the production of thyrotropic hormone is concerned. Without its wonted stimulus normal thyroid tissue ceases to function and eventually atrophies (fig. 319). Consequently, while it is essential to remove the adenoma intact within its capsule, without squeezing it, it is contraindicated to excise the contralateral lobe. Atraumatic removal of the adenoma can be carried out most conveniently by unilateral subtotal lobectomy.

FIG. 319.—Hyperfunctioning solitary adenoma with atrophic uninvolved gland. (*After O. Cope et al.*)

Toxic Multinodular Goitre.—Thyrotoxicosis is an infrequent, late, complication of multinodular goitre. Radio-active iodine studies indicate that it is the internodular parenchyma rather than the nodes (which are almost bereft of function) that gives rise to thyrotoxicosis. Here subtotal thyroidectomy is the only regularly curative treatment.

Unless the patient is an exceptionally poor surgical risk a toxic nodular goitre (solitary or multinodular) is not treated with radio-iodine because :

1. The recurrence rate is higher than in cases of diffuse toxic goitre.
2. Larger doses are required for a remission—often twice that necessary for a diffuse toxic goitre.
3. A small percentage (1 per cent.) are or will become malignant.

SOLITARY NODULAR GOITRE

(*syn.* ADENOMA OF THE THYROID $<^{\text{Solid.}}_{\text{Cystic.}}$)

Solitary adenoma of the thyroid is rare in endemic districts but very common elsewhere.

Pathology.—This discrete swelling has a complete capsule composed of fibrous tissue, which in old-standing cases sometimes shows calcareous or, very rarely, osseous changes. The colour of the interior is often variegated from pale yellow to deep purple. Apart from the capsule, the chief microscopical difference between a solid adenoma of the thyroid and the gland proper is the presence in the latter of well-developed fibrovascular trabeculæ. Some believe that a solitary encapsulated nodule (fig. 320) occurring in an otherwise healthy thyroid is a benign new-growth—to wit, an adenoma; others that it is a solitary nodular goitre.

FIG. 320.—Adenoma of the thyroid removed by resection —enucleation.

Cystic Degeneration.—Within the adenoma one or more cystic cavities are wont to occur ; should they coalesce, a cyst is produced. At first filled with clear straw-coloured fluid, not infrequently hæmorrhage occurs into it from one of the thin-walled blood-vessels that so richly supply the scanty stroma ; consequently the content is often brown, and may contain cholesterol crystals.

Clinical Features.—The adenoma is nearly always solitary; occasionally two are present. The favourite site for a solitary adenoma is at the junction of the isthmus with one lateral lobe. Females greatly predominate and the patient may present at any age over ten years, with one or more of the following :

FIG. 321.—A large adenoma of the thyroid.

Deformity.—The projection produced by the swelling (fig. 321) is the most common symptom that brings the patient to seek advice.

Dyspnœa occurs when the adenoma presses upon the trachea. This is the second most common complaint and by far the most important. In the early stages dyspnœa is noticed only upon exertion ; later it worries the patient at night. *Urgent dyspnœa* sometimes comes unheralded from a sudden hæmorrhage into a cystadenoma.

The parents of one of our patients, a girl of eighteen, desired a course of medical treatment in order to ascertain if operation could be avoided. Fourteen days later she died in the street from a sudden hæmorrhage into the cystadenoma.

Thyrotoxic symptoms tend to develop in old-standing solid adenomata about the age of forty. These symptoms (see p. 231) are to be expected in at least 20 per cent. of such cases : some would go as far as to state that sooner or later some toxic features develop in every case (J. W. Linnell).

Alteration in the Voice.—Occasionally an adenoma causes pressure on a recurrent laryngeal nerve.

Treatment.—Unquestionably, removal of an adenoma of the thyroid should be urged in all cases for the following reasons :

Firstly, there is a possibility of a malignant change,[1] even in youth (see p. 238).

Secondly, there is the possibility of thyrotoxic complications.

Thirdly, there is the danger of suffocation (see above) ; and

Fourthly, for cosmetic reasons.

FIG. 322.—Thyroid gland exposed, showing an adenoma suitable for resection-enucleation.

If the adenoma is well encapsulated the operation of resection-enucleation (fig. 322) with careful hæmostasis is adequate, but if there is any doubt the whole of the affected lobe and the isthmus should be excised.

Before leaving this subject, we must deal with the important question of what to do in a case of impending suffocation from a sudden hæmorrhage into a cystadenoma of the thyroid. The treatment must be immediate. Aspiration of a cyst with a wide-bore needle

[1] Some observers voice the opinion that an adenoma which turns malignant in less than ten years from its initial appearance is in reality malignant from the start, but there is no proof of this statement.

John Wycliffe Linnell, Contemporary. Consulting Physician, Thyroid Clinic, New End Hospital, Hampstead, London.

is often effective, but in less favourable circumstances, or when such a measure fails, an incision over the swelling, *dividing the pretracheal cervical fascia* thereby allowing the adenoma to bulge into the wound (instead of pressing upon the trachea), has proved a life-saving measure.

Hürthle-cell adenoma, though rare, is of considerable interest and importance, for it represents a proven example where an adenoma, if not removed intact within its capsule, becomes a carcinoma. These tumours probably arise from normal thyroid epithelium. Microscopically they consist of large eosinophilic, finely granular, or foamy polygonal cells.

RETROSTERNAL GOITRE

Most retrosternal goitres are acquired. A few are congenital, due to the thyroglossal bud being carried too far downward (see p. 215). The acquired form arises as an extension downward of a nodule in the lower pole of either lobe. There are three varieties :

1. **Substernal.**—There is a prolongation of a cervical goitre downwards behind the sternum : this is the most common form. On rare occasions the prolongation proves to extend not only downwards, but backwards behind the trachea, and sometimes behind the œsophagus.

2. **Intrathoracic.**—The whole goitre—indeed, in the congenital variety, the whole thyroid—is situated within the thorax between the great veins, and resting upon the aorta.

3. **Plunging Goitre.**—The goitre is wholly intrathoracic, but from time to time it is forced into the neck by raised intrathoracic pressure due to coughing.

Ætiology of acquired cases. Cervical goitres of all kinds are much more common in women ; retrosternal goitre is more common in men, particularly stocky, short-necked individuals. The sternohyoid and sternothyroid muscles prevent forward expansion, and direct the swelling into the superior mediastinum. For a long time the adenoma can rise with deglutition, and descend again through the thoracic inlet. Finally, because of increase in its size, it becomes imprisoned in the thorax.

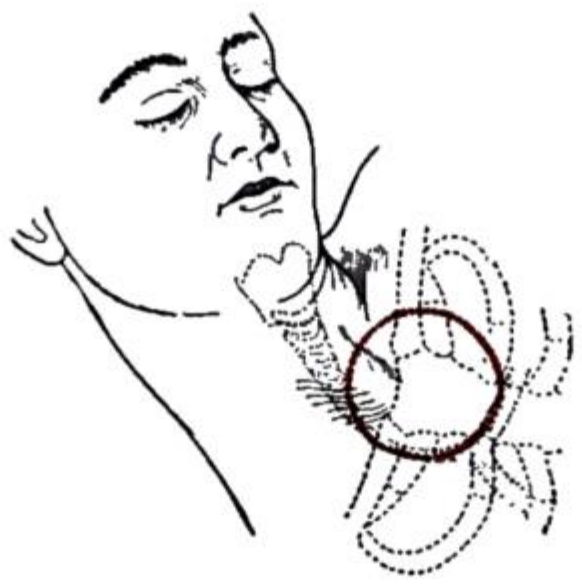


FIG. 323.—Intrathoracic goitre, showing the reason for the dyspnœa. (*After Frank Lahey.*)

Clinical Features.—As a rule an intrathoracic goitre remains symptomless for years, and consequently it is exceptional for the patient to present before the meridian of life has been passed.

Masked.—A goitre wholly within the thorax is frequently overlooked, and because it is very liable to become toxic, the symptoms to which it gives rise are mistaken for asthma or heart disease.

Dyspnœa and cough are the chief presenting symptoms. Oft-times dyspnœa is severe, and is associated with noisy or stridorous breathing : the stridorous breathing is due to deviation and compression or kinking of the trachea. Particularly characteristic is *nocturnal dyspnœa.* Sometimes the patient complains that an attempt to sleep on one side, usually the right, produces such difficulty in breathing (fig. 323) that he always sleeps on the other side.

Karl Hürthle, 1860–1945. Professor of Physiology, Breslau.

Dysphagia is not uncommon. It is due to pressure on the œsophagus. It is seldom severe enough to be incapacitating.

Hoarseness due to paralysis of a recurrent laryngeal nerve, usually the left, occurred in approximately 10 per cent. of cases in some series.

Venous Engorgement.—As a retrosternal goitre enlarges, dilatation of the superficial thoracic veins over the upper part of the chest wall (fig. 324), due to pressure upon one or both innominate veins, is liable to occur. Occasionally venous obstruction gives rise to œdema of the face.

FIG. 324.—Engorgement of the superficial thoracic veins in a case of intrathoracic goitre. *(The late Professor Rendle Short, Bristol.)*

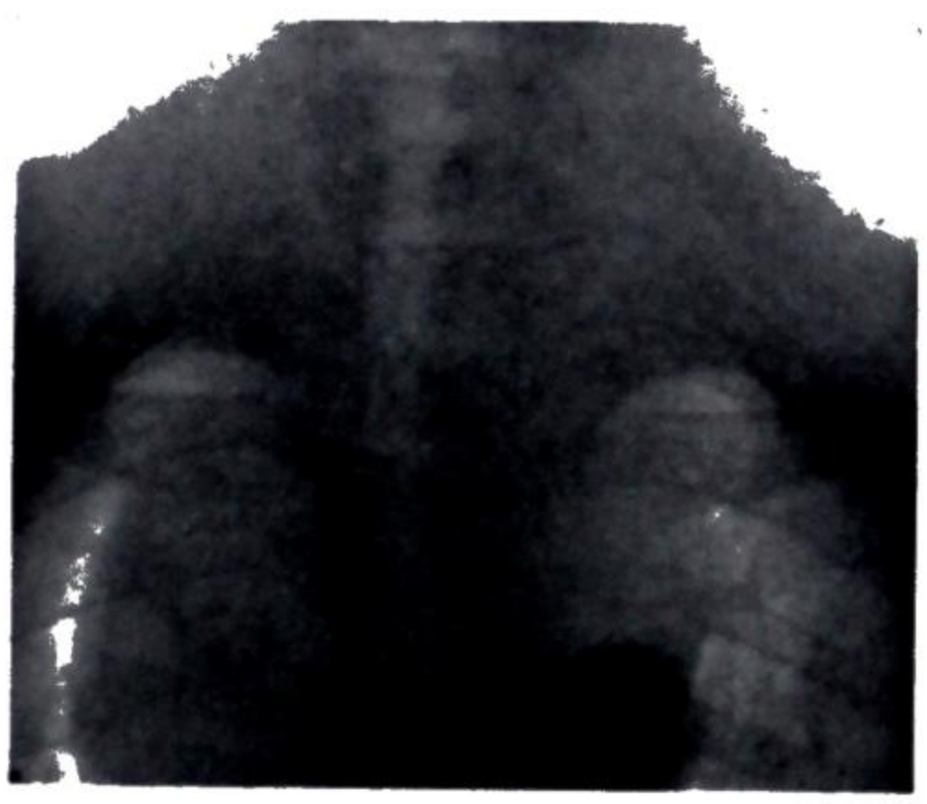


FIG. 325.—Retrosternal goitre causing deviation and compression of the trachea. *(Professor Carl Krebs, Aarhus, Denmark.)*

Hæmoptysis, unmixed with sputum and rather copious, occasionally is a presenting symptom. It is due to rupture of an engorged tracheal vein (P. Burgess).

Radiography is particularly valuable as a means of displaying deviation and compression of the trachea (fig. 325). Owing to years of delay in diagnosis, calcification sometimes occurs in the walls of an intrathoracic goitre, rendering radiological diagnosis unquestionable.

However, radiographs are usually of little value in differentiating a retrosternal goitre from a thymoma or other neoplasm of the mediastinum, a not infrequent problem.

Radio-iodine studies with a Geiger counter have proved helpful in segregating an intrathoracic goitre from a mediastinal neoplasm, provided, of course, the retrosternal goitre possesses sufficient normal thyroid tissue to take up ^{131}I.

Treatment.—On no account should treatment with antithyroid drugs or ^{131}I be even considered. These cause the goitre to swell, and in this instance the clinician who advises either of them virtually dons the black cap. Operative treatment is indicated in all cases giving rise to symptoms as soon as thyrotoxicosis, if present, is under control. Regional anæsthesia is particularly desirable in this instance because of the danger of post-operative tracheitis, and other pulmonary complications engendered by the passage of an endotracheal tube that may be difficult to introduce. When compared

Peter Burgess, Contemporary. Surgical House Officer, Royal Infirmary, Manchester.

with that of a cervical goitre of corresponding size, removal of a large intrathoracic goitre is hazardous. The risks are greater because of the location; because of the greater hæmorrhage that is often difficult to control, and the resultant shock; because the patients are usually older; and because often they are subjects of cardiovascular disease.

Through a standard collar incision the tumour is approached as for subtotal thyroidectomy (see p. 226). The blood supply of a retrosternal goitre comes from above. The first step, therefore, is to ligate and divide the superior thyroid vessels; the second, to ligate and divide the middle thyroid veins. Usually, after the cervical portion of the goitre has been mobilised, the delivery and removal of the retrosternal extension presents no insuperable difficulty. When they can be found, the inferior thyroid arteries are ligated well away from the thyroid gland. Gentle traction is exerted on the lateral lobes. The isthmus of the thyroid is brought into view and divided between hæmostats. By further gentle traction on the mobilised affected lobe, it is now possible to deliver the retrosternal portion of the goitre on to the surface in the great majority of cases. Should it be necessary to aid delivery, it is safe to insert a finger below and behind the retrosternal extension (fig. 326). In a few instances when the tumour cannot be brought through the thoracic inlet, its upper part can be incised and enough of its interior removed piecemeal to render it small enough to be delivered and resected. Should there be considerable oozing from the cavity, it can be packed with absorbable gauze followed by ribbon gauze. In other circumstances the wound is closed with drainage. When packing has been employed, it is removed after forty-eight hours.

FIG. 326.—A stage in the delivery of an intrathoracic goitre.

If the above technique is employed, splitting the sternum (see fig. 350, p. 253) in order to get access is rarely necessary.

HASHIMOTO'S DISEASE (*syn.* STRUMA LYMPHOMATOSA)

Reports from many parts of the world indicate that there has been a notable increase in the number of cases of this condition in the post-World-War II era, but the incidence varies from country to country.

Ætiology.—One thing is certain—Hashimoto's disease is not a chronic inflammation. It is surmised that possibly it results from the increased stress of modern life causing over-stimulation of the thyroid gland. Auto-antibodies seem to play a part in its production (see p. 237).

FIG. 327.—Complete thyroidectomy specimen removed from patient shown in fig. 328.

Pathology.—Macroscopically the colour of the thyroid is pale pink (fig. 327) ranging to yellowish white, according to the amount of fibrosis present. In early cases it gives the impression of being semi-translucent.

Microscopically.—As a rule there is no normal thyroid tissue present, the thyroid epithelium being replaced by cells that are finely granular and faintly eosinophilic,

Hakaru Hashimoto, 1881–1934. Director of the Hashimoto Hospital, Miyo, Japan.

with giant cells interspersed. Throughout the gland lymphoid follicles abound, The amount of fibrosis is variable but it never dominates the histological field.

Complications.—There is a possible relationship between Hashimoto's disease and carcinoma. When carcinoma develops it is usually papillary and of low malignancy, and such a change occurs in 10 per cent. of cases. Furthermore, occasionally lymphosarcoma or reticulosarcoma arise in struma lymphomatosa. Hürthle-celled adenoma is found in glands with Hashimoto's disease with greater frequency than in other varieties of goitre. Finally, in a series of thirty-five cases, seven had Paget's disease of bone, and there seems to be some predisposing factor common to both disorders (R. W. Luxton).

Clinical Features.—Females are affected almost exclusively; they are nearly always middle-aged, and usually present at the time of the menopause. The commonest complaint is fullness of the throat. Some dysphagia is not unusual, and the majority of the patients have slight hoarseness. Clinical evidence of hypothyroidism is uncommon pre-operatively, but not infrequently the patient's first visit is on account of lassitude, muscle pains, increasing weight, and a change of facial expression.

On examination the whole gland is enlarged, often one lobe, the isthmus (fig. 328) or the pyramidal lobe more so than the remainder. The gland is well described as feeling like india-rubber. It is a characteristic of Hashimoto's disease that the contour of the gland can be clearly defined. Each lobe may be bosselated, the bosses being larger in comparison to the nodules of a multinodular goitre. Very seldom the gland is tender. In one-quarter of the cases the liver and the spleen are enlarged (cirrhosis) (R. W. Luxton): certainly these organs should be examined in every case.

FIG. 328.—Hashimoto's disease, involving particularly the thyroid isthmus.

Differential Diagnosis.—When tenderness is present subacute thyroiditis must be excluded. Struma lymphomatosa is often mistaken for carcinoma of the thyroid, and in the absence of open biopsy the differential diagnosis is sometimes well-nigh impossible. Should the case be one of carcinoma, as in the breast, needle biopsy is fraught with unwarrantable dangers (see Chapter 42).

Laboratory Confirmatory Tests:

A serum colloidal gold test is a reliable test in this condition; fifteen of nineteen cases with Hashimoto's disease gave a positive result (George Crile Jnr.).

The basal metabolic rate is usually below normal.

The blood cholesterol is raised, and certain liver function tests, notably the thymol turbidity test (see p. 395), are usually positive (R. T. Cooke), which is indicative of concomitant hepatitis.

Precipitin test.—Specific antibodies are produced in the serum of patients with Hashimoto's disease. When mixed with thyroglobulin or a saline extract of human thyroid gland, these antibodies are precipitated. It is possible that this test will prove so reliable as to become the chief method of confirming the diagnosis of a suspected case of Hashimoto's disease.

Sir James Paget, 1814–1897. Surgeon, St. Bartholomew's Hospital, London.
Reginald William Luxton, Contemporary. Physician, Christie Hospital, Manchester.
George Crile Jnr., Contemporary. Chief Surgeon, Cleveland Clinic, Cleveland, Ohio, U.S.A.
Richard Theodore Cooke, Contemporary. Pathologist, Hartlepools Hospital, Hartlepool, Durham.

Treatment.—When the diagnosis can be established with some degree of certainty, large doses of desiccated thyroid, 3 grains (200 mg.) daily sometimes cause a diminution in the size of the goitre, and render the patient symptom-free. If the patient cannot tolerate this dose, it is reduced to 2 grains. Desiccated thyroid should be given permanently, as no one can predict when clinical decompensation will occur.

George Crile Jnr. found that struma lymphomatosa was more resistant to thyroid therapy than lymphadenoid goitre (see below). Desiccated thyroid combined with cortisone has also been employed with some success. In cases where there are pressure symptoms, or the possibility of carcinoma cannot be ruled out, subtotal or total thyroidectomy is the correct course.

LYMPHADENOID GOITRE

Lymphadenoid goitre is often called inaccurately lymphatic thyroiditis. The condition, which occurs almost exclusively in female children and young women, is not uncommon.

Ætiology is unknown. It is suggested that it is due to a disordered synthesis and release of thyroid hormone.

Pathology.—The gross specimen is similar in appearance to Hashimoto's disease, but as a rule the gland is smoother in outline.

Histologically there is extensive lymphocytic infiltration, but the epithelium is without eosinophilic cells (J. B. Hazard). In this respect the condition differs from Hashimoto's disease, although some believe that it is a precursor of that condition.

Clinical Features.—The sole complaint is the goitre, which is comparatively smooth and firm. The absence of bosselation helps to distinguish the condition from Hashimoto's disease. Pressure symptoms, if they occur, are mild.

Treatment.—The immediate response to the administration of desiccated thyroid, 3 grains (200 mg.), is dramatic; the gland becomes smaller, often within a month, and within three months it may be no longer palpable, but sometimes the goitre returns if the treatment is stopped. Such treatment, is so satisfactory that there is no call for alternative measures.

CARCINOMA OF THE THYROID

Pathology.—Carcinoma of the thyroid displays a remarkable range of malignancy. At one end of the scale there are growths scarcely distinguishable histologically from normal thyroid tissue; at the other there are highly anaplastic carcinomata that are fatal within a few months of recognition.

Three pathological varieties of carcinoma of the thyroid are recognised, but it must be understood that they are not invariably distinct, because intermediate forms occur.

1. **Papilliferous** (35 per cent.[1]) occurs most frequently in young persons,

[1] For an unknown reason papilliferous carcinoma is becoming more common, and in some series it heads the list.

John B. Hazard, Contemporary. Pathologist, The Cleveland Clinic, Ohio, U.S.A.

even in children, a solitary nodule (adenoma) being the site of predilection. Thirty per cent. show one or more intraglandular seedlings (fig. 329). Often while the primary growth is still small, this variety of carcinoma metastasizes to the cervical lymph nodes, where it may remain localised for from five to twenty years prior to remote dissemination. Consequently, as a rule, this variety is relatively benign.

FIG. 329.—Papilliferous carcinoma of the thyroid, showing an intraglandular seedling. This specimen demonstrates how necessary it is to remove the whole lobe, if not the whole gland. *(Mr. F. F. Rundle, Sydney, Australia.)*

2. **Follicular** (40 per cent.) usually arises in middle-aged persons, and is appreciably more malignant than the foregoing. Commencing as a circumscribed lesion macroscopically indistinguishable from an adenoma, or as a malignant change commencing in a nodule of a multinodular goitre, invasion occurs into and through the capsule, from whence local spread is characteristically into the venules, where intra-luminar clumps of growth can often be seen microscopically. This explains why this neoplasm metastasises via the blood-stream to bones and the lungs.

3. **Anaplastic** (25 per cent.) occurs mainly in elderly people. Unlike other varieties, this tumour commonly arises in a normal thyroid gland. It spreads by direct extension and invasion on a broad front, and metastasises early to the cervical and mediastinal lymph nodes and the viscera. These growths consist for the most part of sheets of undifferentiated cells, either spheroidal, cuboidal, polygonal, or spindle-shaped. Some show considerable pleomorphism. Those exhibiting multinuclear giant cells are devastatingly malignant.

Carcinoma of the Thyroid Resulting from Radiotherapy.—A considerable increase in the number of cases of carcinoma of the thyroid, often, but not necessarily, papilliferous in type, appearing under the age of eighteen is undoubtedly in part due to a wave of enthusiasm for radiotherapy for the treatment of tuberculous cervical adenitis, enlargements of the thymus, and even enlarged tonsils, that perhaps reached its zenith about ten years ago. In many series of cases of carcinoma of the thyroid occurring in children no less than 50 per cent. had received X-ray treatment for one or other of the conditions listed.

Clinical Features.—The profession is becoming more carcinoma-conscious with regard to localised swellings of the thyroid. A solitary nodule (adenoma) is looked upon with suspicion, especially when it occurs in a male (such nodules are relatively more often carcinomatous in the male). Likewise a similar swelling in childhood or youth is a potential source of malignancy; indeed, 33 per cent. of such nodules are carcinomatous (J. de J. Pemberton). It is coming to be recognised that the doctrine ' No removal unless symptoms ' is a very dangerous one (fig. 330), and the practitioner is

John de J. Pemberton, Contemporary. Surgeon, Mayo Clinic, Rochester, Minnesota, U.S.A.

FIG. 330.—Carcinoma of the thyroid that commenced in an adenoma of many years' standing. (*The late Professor Rendle Short, Bristol.*)

exhorted to exercise the same vigilance in urging the removal and histological examination in the case of these swellings as he has been taught to do in the case of a lump in the breast. The target is to recognise carcinoma of the thyroid early or even in its premalignant state, when a cure can be anticipated. Doubtless a great improvement in results will accrue if and when this principle is accepted generally.

In cases where the thyroid is enlarged, and there is one area more indurated than the remainder of the gland, particularly when the major enlargement is not of long duration, malignancy should be assumed (R. B. Cattell). Fixation of the gland (when not due to thyroiditis) causing limitation of movements on deglutition, is an unfavourable sign. Hoarseness not due to thyroiditis usually denotes a fairly advanced stage.

FIG. 331.—Metastasis in the left parietal bone from a carcinoma of the thyroid. (*Professor A. K. Toufeeq, Lahore, Pakistan.*)

Metastases as a First Symptom.—Sometimes the patient presents with enlarged lymph nodes, usually unilateral, and possibly the primary growth in the thyroid is so small that it is impalpable. (See Lateral Aberrant Thyroid, p. 215.) Biopsy is then the only method of arriving at the correct diagnosis.

It is not very unusual for a patient with a carcinoma of the thyroid to present on account of a swelling of a bone (fig. 331) or a pathological fracture thereof. Quite often the primary in the thyroid is overlooked through forgetting the diagnostic rule *Always examine the thyroid, breasts, kidneys and prostate*, and think of the bronchi when confronted with a case of this kind.

FIG. 332.—Metastasis from a carcinoma of the thyroid in a humerus. (*Dr. S. Devadatta, Vellore, South India.*)

As a rule, such a metastasis is apparently solitary, osteolytic, intensely vascular, may pulsate, and frequently gives rise to great pain. Occasionally metastases of a carcinoma of the thyroid (fig. 332) exhibit sufficient excretory activity to produce mild hyperthyroidism; often they contain enough functional thyroid tissue to enable them to be identified by a tracer dose of radio-iodine.

Carcinoma Secondary to Multinodular Goitre.—As a rule the patient has had an irregular enlargement of the thyroid for over twenty years. She seeks advice because of recent progressive increase in the size of the swelling (fig. 333) not infrequently accompanied by dyspnœa or dysphagia, and

occasionally by pain. Often, however, it is impossible to diagnose a malignant change in these grossly irregular goitres until they have been subjected to histological scrutiny.

FIG. 333. — Carcinoma that originated in a multinodular goitre.

Anaplastic Carcinoma of the Thyroid.—It is seldom that there is difficulty in diagnosing an anaplastic tumour of the thyroid, for it is hard, fixed, bulging (fig. 334), and usually associated with pressure symptoms of recent origin. One-third of these patients have unilateral vocal cord paralysis when they first present (Selwyn Taylor).

FIG. 334. — Anaplastic carcinoma of the thyroid. Stony hard neoplasm implicating right sternomastoid. Four months' history.

Stump Recurrence after Operations for Carcinoma of the Thyroid.—Generally a stump recurrence must be regarded as a surgeon's failure; there has been insufficiently wide extirpation of the gland, or the surgeon has shrunk from the risk of injuring the recurrent laryngeal nerves and parathyroids, or carcinoma was unsuspected and histological examination of the specimen was not undertaken. The frequency of local recurrence after operation for papillary carcinoma is high. From a radiotherapeutic clinic B. W. Windeyer reported that a quarter of the patients were referred because of local recurrence after previous operation for papillary carcinoma. The interval between the operation and the manifestation of recurrence sometimes is a matter of years.

TREATMENT OF CARCINOMA OF THE THYROID

Operation is the treatment of election, and if performed reasonably early and in accordance with the principles about to be set forth, the prognosis is good, except in anaplastic growths. In doubtful cases, and for that matter in all instances where carcinoma is even a remote possibility, resection of the lump with a reasonably wide margin of healthy tissue should be followed by an immediate frozen section and pathological report, in the same way as doubtful lumps of the breast are diagnosed. When there are no facilities for this most desirable practice, or the pathological report by this method is equivocal, paraffin sections should be available in forty-eight hours. In event of carcinoma being found as the result of the second method of histological examination, undesirable as it may appear from many points of view, the only safe course is to re-operate forthwith before adhesions make the venture hazardous. The modern principles in operating for carcinoma of the thyroid are as follows:

In respect to the surgical management of its malignant neoplasms the thyroid should be regarded as a single organ, not as a compartmental,

Selwyn Francis Taylor, Contemporary. Surgeon, King's College Hospital, London.
Brian Wellingham Windeyer, Contemporary. Director of the Meyerstein Institute of Radiotherapy, The Middlesex Hospital, London.

bilobate structure (I. MacDonald); consequently the organ must be removed *in toto*.

No Palpable Cervical Metastases on Opening the Neck.—Total extracapsular thyroidectomy, with preservation of as much extracapsular parathyroid tissue as possible, is performed. When the pretracheal muscles are implicated, they should be excised, together with the thyroid.

In cases of papillary carcinoma bilateral dissection of the lymph nodes and adjacent tissues is carried out as far laterally as the carotid sheath. J. C. McClintock advises that the sternum be split with a Lebsche knife, to enable *en bloc* excision of the lymphatic field in the superior mediastinum (see p. 254).

When the growth is of the follicular type the internal jugular vein is resected on the side of the lesion. In all cases of follicular carcinoma it is fundamental to ligate the jugular veins, more particularly the internal jugular vein on the side of the lesion, at the outset if the risk of neoplastic embolus is to be avoided.

Palpable Cervical Metastases are Present.—In addition to total thyroidectomy, block dissection of the neck (see p. 209) on the side of the lesion, including the pretracheal muscles but sparing the submaxillary triangles, which are never implicated (M. Dargent), is carried out, together with dissection on the contralateral side but, in cases of papillary carcinoma, sparing the internal jugular vein.

Post-operative X-ray Therapy.—So-called prophylactic irradiation has no place after an operation for malignant disease of the thyroid (B. W. Windeyer). To perform subtotal instead of total thyroidectomy and then expect radiotherapy to complete the extirpation usually results in a recurrence. Moreover, trachea and pharyngo-œsophagus always receive a heavy dose, causing great and prolonged discomfort. Should the rays be directed on a recently healed operation wound, breaking down with discharge of suture material is likely to occur.

Radio-Iodine Treatment :

Indications.—Provided the patient has a good hold on life, any patient with inoperable carcinoma of the thyroid that takes up radio-iodine and retains it, or can be induced to retain it by the administration of antithyroid drugs should have the benefit of radio-iodine treatment. Undifferentiated carcinomata seldom take up the isotope to a useful extent, and consequently should be treated with deep X-rays.

Stage 1.—Because even highly differentiated neoplasms are unlikely to take up much ^{131}I when they are in competition with normal thyroid tissue, the first step is ablation of all such tissue. When feasible, total thyroidectomy is the best and quickest way of achieving this objective. In other circumstances ablation by radio-iodine is carried out, a dose of 80 millicuries being adequate for this purpose in most cases (Gwen Hilton). By employing the latter method, full myxœdema, which is necessary before effective radio-iodine treatment of the growth can be undertaken, is not reached before eight to twelve weeks.

Stage 2.—A dose of the isotope commensurate with the total volume of the primary growth, if present, and its metastases is administered. Be-

Ian MacDonald, Contemporary. Surgeon, Los Angeles County Hospital, California, U.S.A.
John C. McClintock, Contemporary. Surgeon, Albany Hospital, New York.
Max Lebsche, Contemporary. Professor of Surgery, Munich.
Marcel Dargent, Contemporary. Surgeon to the Hospitals of Lyons, France.
Gwen Hilton, Contemporary. Director of the Radio-Therapeutic Department, University College Hospital, London.

cause of the high dosage the patient's excretions become dangerously radio-active, and it is compulsory to carry out this treatment in a special building where, among other precautions, all the staff wear rubber gloves and long white coats. Even the patient's bed-linen and the staff's white coats must be laundered in a separate washing-machine. Usually after ten days it is safe to permit the patient to leave the building. Periodic examinations are made, and after two or three months further doses are often required. In cases where there is a favourable response, intermittent treatment of this kind is continued, often for two or three years.

Untoward Reactions.—A few patients suffer from irradiation sickness (fatigue, headache, loss of appetite, and vomiting). Irradiation parotitis, including dryness of the mouth (consequent upon diminished secretion of the salivary glands which always concentrate radio-iodine), painful swelling of the thyroid, if present, and of the metastases, and the rheumatic pains referred to on p. 229 are rather frequent. Very occasionally myeloid leukæmia supervenes.

Among the most encouraging results of this treatment are cases of remote metastases of papillary carcinoma.

Of those cases where radio-iodine treatment is indicated, the duration of life of patients with bone metastases is the shortest.

Deep X-ray Treatment.—Anaplastic growths (which do not take up sufficient radio-iodine for that treatment) often show a good initial response but early recurrence is almost inevitable.

INFLAMMATIONS OF THE THYROID GLAND

- Subacute
  - Subacute (Granulomatous) Thyroiditis.
- Chronic
  - Riedel's Thyroiditis (Struma fibrosa).
  - Syphilis.
  - Tuberculosis.

SUBACUTE (GRANULOMATOUS) THYROIDITIS

Subacute thyroiditis has become fairly common in some parts of the United States, but is still exceedingly rare in the United Kingdom. It is thought to be due to a virus infection and nearly always attacks a previously normal gland. Instances arising during the course of mumps—itself a virus disease—have been recorded. The onset may be fulminating, but usually is mild and there is not sufficient malaise for the patient to take to bed. In one-quarter of the cases the condition follows an upper respiratory tract infection. Middle-aged women are the usual sufferers. Pain on swallowing, and pain radiating to the ear, are constant symptoms. The temperature is elevated and the thyroid gland somewhat enlarged and quite tender. The uptake of radio-iodine by the thyroid gland is almost negligible during the attack. Invariably the sedimentation rate is raised. Subacute thyroiditis is a self-limiting disease of an average duration of eleven weeks.

Pathology.—The gland is infiltrated with leucocytes and numerous foreign body giant cells are present ; it culminates in some degree of fibrosis of the thyroid gland.

Treatment.—There is a marvellous response to cortisone, 25 mg. four times daily. After a week of this treatment, and sometimes before that time, all symptoms disappear and the gland is no longer palpable (G. Crile Jnr.). Following discontinuance of the drug, recrudescence of the symptoms is not unusual, but X-ray treatment then brings about a permanent remission of symptoms and signs. It should be noted that antibiotics, antithyroid drugs, and iodine are without value in subacute thyroiditis.

RIEDEL'S THYROIDITIS (*syn.* STRUMA FIBROSA)

This condition has become very rare indeed. For instance, in frequency it constitutes about 1 per cent. of the incidence of Hashimoto's disease. Recent reports of the disease have been sparse.

Ætiology is unknown. The condition is essentially a primary inflammatory process in the thyroid gland of a very chronic character. Microscopically the thyroid is converted into a mass of fibrous tissue.

Pathology.—The lesion extends beyond the thyroid capsule so that the muscles, trachea, and the carotid sheath are involved together with the thyroid in a diffuse fibrosis.

Clinical features are characterised by severe pressure symptoms in the presence of a small goitre that is always stony hard (iron-hard struma). The principal, indeed the only, differential diagnosis to be made is that from malignant disease of the thyroid, which can often be refuted or confirmed only by operation and adequate biopsy.

Treatment.—Because of the invasion of muscles, nerves, and blood-vessels in an inflammatory mass, thyroidectomy is difficult, if not impossible. Bleeding from the perithyroid tissue is profuse, the gland itself is comparatively avascular. Moreover, the thyroid tissue is of a hardness that blunts the knife. If, as is frequently the case, pressure symptoms on the trachea are in evidence, a wedge resection of the isthmus should be carried out. In other circumstances discretion is the better part of valour, and having removed an adequate portion for histological scrutiny, the wound should be closed with drainage. In this condition drugs and radiotherapy are without value. In some cases that have been followed, death has occurred because of severe tracheal compression ; in others the disease appears to have been arrested.

Syphilis of the thyroid is very infrequent, and it is usually mistaken for a malignant tumour. Whenever malignancy is suspected, the possibility of syphilis should be eliminated.

Tuberculosis of the thyroid is exceedingly uncommon. It is sometimes associated with thyrotoxicosis.

ANOMALIES OF THE THYROGLOSSAL TRACT

Thyroglossal cyst may be present in any part of the thyroglossal tract (fig. 335). The common situations, in order of frequency, are beneath the hyoid (fig. 336), in the region of the thyroid cartilage (fig. 337), and above the

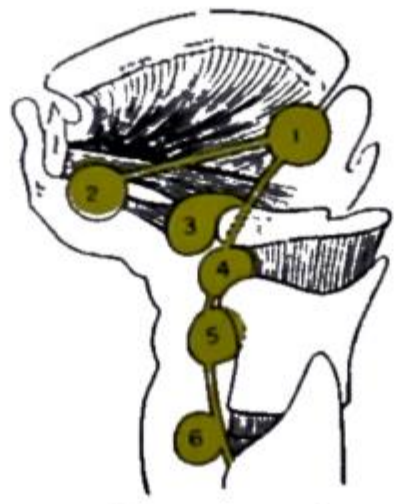


FIG. 335.—Possible sites of a thyroglossal cyst : (1) Beneath the foramen cæcum. (2) In the floor of the mouth. (3) Suprahyoid. (4) Subhyoid. (5) On the thyroid cartilage. (6) At the level of the cricoid cartilage.

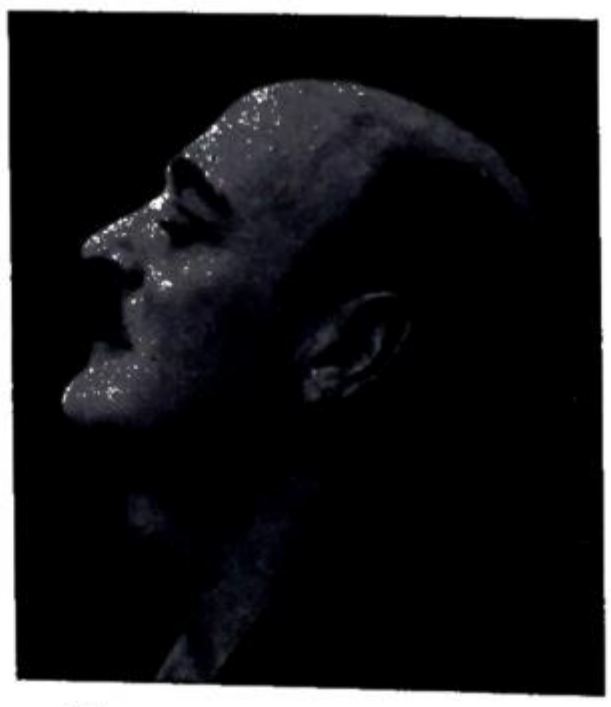


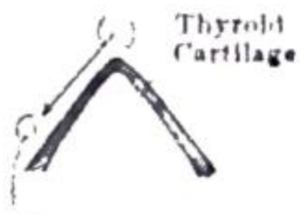
FIG. 336.—Subhyoid thyroglossal cyst. The commonest variety.

FIG. 337.—Thyroglossal cyst in relation to the thyroid cartilage.

FIG. 338.—Suprahyoid thyroglossal cyst.

Bernhard Moritz Carl Riedel, 1846–1916. Professor of Surgery, Jena, Germany.

hyoid bone (fig. 338). Such a cyst occupies the middle line, except in the region of the thyroid cartilage, where the thyroglossal tract is pushed to one side, usually to the left, viz. :—→



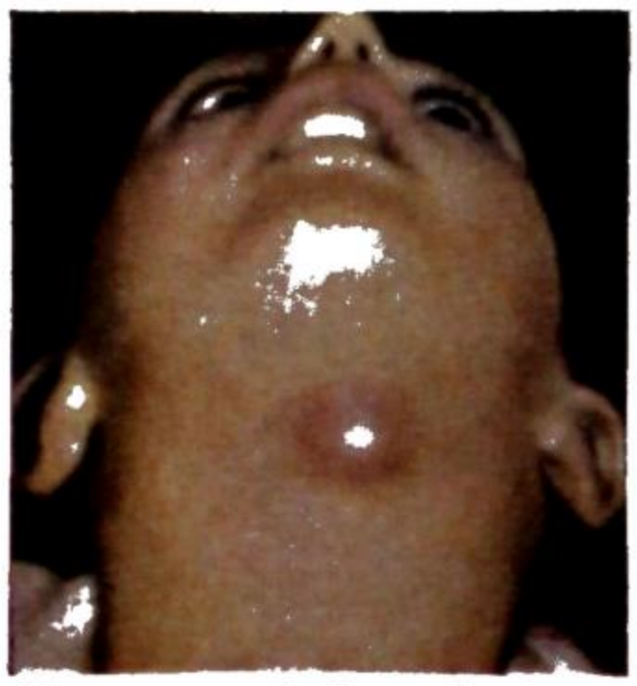


FIG. 339.—Inflamed thyroglossal cyst.

Thyroglossal cysts are the seat of recurrent attacks of inflammation (fig. 339), and when inflamed they are often mistaken for abscesses and incised. This is one way in which a thyroglossal fistula arises.

Thyroglossal fistula is never congenital. It follows purely local extirpation (fig. 340) or incision of a thyroglossal cyst. Long-standing fistulæ are inclined to be situated low down in the neck, and fig. 341 shows an example that had been present for twenty years. The hood of skin, with its concavity downwards (due to uneven rates of growth of the neck as a whole and of the thyroglossal tract), is characteristic. A thyroglossal fistula is lined by columnar epithelium, discharges mucus, and is the seat of recurrent attacks of inflammation.

FIG. 340.—A thyroglossal fistula following local excision of a thyroglossal cyst.

Treatment of a thyroglossal cyst and a thyroglossal fistula is essentially the same. Every vestige of the thyroglossal tract must be removed right up to the foramen cæcum, otherwise a discharging fistula is almost inevitable. Because of difficulty in defining the tract in the region of the hyoid bone, the centre of this bone is resected in the course of the dissection (Sistrunk's operation) (fig. 342). Before embarking upon the removal of a supposed thyroglossal cyst, it is well to make sure that there is a thyroid gland present in the normal position, for the swelling in question may be an ectopic thyroid (see p. 214).

FIG. 341.—A long-standing thyroglossal fistula. The semilunar fold is characteristic.

FIG. 342.—Complete extirpation of the thyroglossal tract. Note that a portion of the body of the hyoid bone has been removed, and the dissection is proceeding towards the foramen cæcum.

Walter E. Sistrunk, 1880–1933. Surgeon, Mayo Clinic, Rochester, U.S.A.

CHAPTER XIV

THE PARATHYROID GLANDS, THE THYMUS, AND THE ADRENAL GLANDS

HAMILTON BAILEY

THE PARATHYROID GLANDS

Surgical Anatomy.—Like man, most animals have four parathyroid glands, except the rat, which has two only. These small glands, oval in shape, each about the size of a small pea, are arranged in two pairs. In colour they are pink in the young, coffee-brown to reddish-yellow at puberty, and from puberty onwards varying shades of yellow, depending upon the amount of fat deposition in the particular individual. The superior pair are developed from the fourth branchial clefts while, paradoxically, the inferior pair arise (together with the thymus) from the third branchial clefts, and migrate caudally. For this reason the superior pair are sometimes known as parathyroids IV, and the inferior pair as parathyroids III. In 95 per cent. of cases the blood supply of both sets of parathyroid glands comes directly or indirectly from the inferior thyroid artery.

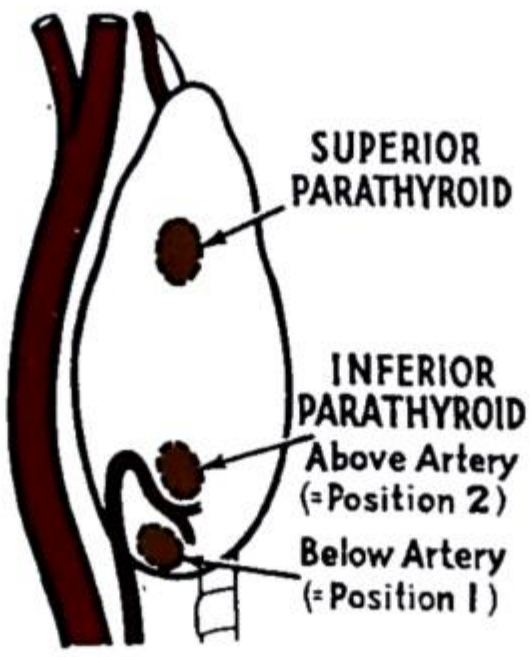


FIG. 343.—Posterior view of the left lobe of the thyroid, depicting the typical locations of parathyroid glands. (*After Sir James Walton.*)

The parathyroid glands are situated outside the thyroid capsule, although not infrequently one or more of them, particularly a superior parathyroid, lies deeply within a furrow of the thyroid gland. It is improbable that a parathyroid is ever actually inside the thyroid capsule; nevertheless, for reasons stated, in 8 per cent. of subtotal thyroidectomies a portion of parathyroid tissue is found within the extirpated material. The upper pair are situated most often behind the junction of the upper third with the lower two-thirds of the thyroid gland (fig. 343); the inferior pair are inconstant in position (see p. 249) but are always related to the inferior thyroid artery or a branch thereof.

Histology.—Each gland is made up of (1) principal (basophilic) cells; (2) water-clear cells; (3) oxyphilic cells. The last variety is found in increasing numbers as age advances.

Function.—The parathyroid glands, by virtue of their hormone—parathormone—exercise a controlling influence upon the metabolism of phosphorus and calcium. The hormone stimulates the kidneys to excrete phosphorus. Hyperparathyroidism results in increased excretion of phosphorus in the urine and a corresponding decrease of inorganic phosphorus in the blood. As there is reciprocity between serum phosphorus and serum calcium, when the former is lowered, because of decreased saturation, more calcium enters the blood from the body's storehouse—the bones. So it comes about that in hyperparathyroidism the serum calcium is raised, as also is the excretion of calcium in the urine.

It seems proved that another function of the parathyroids is to activate osteoclasts to secrete their enzyme (alkaline phosphatase), which mobilises calcium phosphate from bones.

Blood Chemistry.—The normal serum calcium level is 9 to 11 mg. per 100 ml. (4·5 to 5·5 mEq. per litre). Fifty per cent. of the serum calcium is inorganic and diffusible; the remainder protein-bound and non-diffusible. The normal serum phosphorus level is 3 to 4·5 mg. per 100 ml. (1·8 to 2·7 mEq. per litre). Both serum calcium and phosphorus are slightly higher in children.

Cerebro-spinal fluid, which has a normal calcium content range of 4·5 to 5·5 mg.

per cent., is altered little or not at all in abnormal parathyroid states, while in all other conditions causing hypercalcæmia there is evidence of elevation of the cerebro-spinal fluid calcium level.

HYPOPARATHYROIDISM

Parathyroid tetany is a rare complication of thyroidectomy which occurs most frequently from one to five days after operation, but occasionally mild forms are not recognised for several weeks. In 50 per cent. of cases in which parathyroid tetany occurs two or more parathyroids are found embedded in the specimen removed; in the remainder it must be assumed that a like number of these little glands were deprived of their blood supply at operation.

Clinical Features.—The first symptoms of parathyroid deficiency are tingling and numbness of the lips, nose, and the extremities, sometimes accompanied by circum-oral pallor.

Chvostek's sign.—With a percussion hammer gently tap the seventh nerve as it courses in front of the external auditory meatus. When tetany exists, the tapping of the hyper-excitable nerve provokes a brisk muscular twitch on the same side of the face.

Trousseau's sign.—A pneumatic tourniquet is placed around the arm, and the pressure is raised to 200 mm.Hg. If tetany is present, within three to five minutes typical contractions of the hand are seen. The fingers are extended, except at the metacarpo-phalangeal joints, and all the fingers and the thumb are abducted to produce the 'obstetrician's hand' (fig. 344).

FIG. 344.—The 'obstetrician's hand' seen in parathyroid tetany.

In severe cases painful cramp of the hands, feet, and indeed any of the muscles of the body occurs. Strong adduction of the thumbs is almost always present, and this, coupled with extension of the feet, constitutes the so-called carpo-pedal spasm, which typifies parathyroid tetany. Occasionally spasm of the muscles of respiration results in severe dyspnœa, and the patient is not only in great pain, but is in mortal dread of suffocation. Blurring of vision due to spasm of the intra-ocular muscles is common; even if the symptoms are mild, cataracts due to prolonged hypocalcæmia are a frequent late complication of the condition.

Differential Diagnosis.—Tetany, a state of neuromotor excitability dependent upon hypocalcæmia, also occurs occasionally (*a*) in the new-born idiopathically, (*b*) in adults with long-continued vomiting due to pyloric obstruction, (*c*) rarely after operations upon the stomach, or (*d*) as a late complication of hypertrophic pyloric stenosis or diarrhœa and vomiting of infants. None of the groups (*a*), (*b*), (*c*), (*d*) has been proved to be associated with parathyroid deficiency. It is possible that the tetany in all these conditions, unlike that of parathyroid tetany, is due to alkalosis, consequent upon loss of hydrochloric acid from the stomach.

The symptoms of hypoparathyroidism may bear a remarkable resemblance to epilepsy, and the former condition should be thought of in idiopathic convulsions.

Frantisek Chvostek, 1835–1884. Physician, Josefsakademie, Vienna.
Armand Trousseau, 1801–1867. Physician, Hôtel Dieu, Paris.

Treatment.—*Prophylactic Treatment.*—When a parathyroid gland is excised inadvertently during subtotal thyroidectomy for a benign condition, the little gland should be separated from the extirpated thyroid tissue and embedded in a sternomastoid muscle. The graft survives only a short time, but it may tide the patient over a critical period.

Immediate treatment of parathyroid tetany is to inject 10 to 20 ml. of a 10 per cent. solution of calcium gluconate or calcium chloride intravenously.[1] The injection should be made very slowly, and it causes almost immediate relaxation of the spasms. A few minutes after the intravenous injection a similar injection of calcium gluconate is given intramuscularly, to give a more prolonged effect.

When spasms make intravenous injection difficult, 5 to 10 ml. of paraldehyde can be injected intramuscularly twenty minutes before the intravenous injection of calcium. In an unusually severe case it is necessary to repeat the dose until satisfactory control of the spasm has been obtained.

Maintenance treatment is then commenced, and there is a choice of three alternatives, each having advantages, special indications, and disadvantages.

1. *Parathyroid Extract* (parathormone).—Thirty units intramuscularly twice daily is usually sufficient. While the treatment by parathyroid extract is in progress, either a diet rich in calcium is given, or 2 drachms (8 G.) of calcium lactate is added to the diet. Parathyroid extract has the disadvantages that it is expensive, it must be given by injection, and it loses its effect after a few weeks or months, so that then even large doses will have no therapeutic action.

2. *Vitamin D_2 (Calciferol) and Oral Calcium.*—The usual dose of these substances is 50,000 to 200,000 units of calciferol and calcium lactate powder, 5 to 15 G. daily. Serum calcium estimations will be required only infrequently if the disorder proves permanent, but they must be continued throughout life, the correct dosages being determined in this way; also the patient should be trained to use the Sulkowitch urine test (see p. 250). In addition to vitamin D_2 and calcium, it is most important to place the patient on a low phosphorus-containing diet. Intake of meat, fish, and cereals and dairy products, all relatively high in phosphorus, should be limited to basic requirements. The treatment set out in this paragraph is the standard long-term treatment of hypoparathyroidism.

After a varying time, some patients with post-operative hypoparathyroidism, when taking the daily dose of calciferol that has been sufficient to maintain their plasma calcium levels, for no apparent reason become insensitive to this dose, and remain insensitive even when the dose is greatly increased.

3. *Dihydrotachysterol* (antitetanic preparation No. 10–AT 10) is a potent vitamin D derivative. The effect of dihydrotachysterol is about midway between parathormone and vitamin D_2. The dose is 2 to 8 capsules per day, which must be determined carefully by calcium and phosphorus serum levels, because this drug has a dangerous cumulative effect and easily raises

[1] If any escapes into the subcutaneous tissues it causes necrosis. For this reason calcium chloride must never be given intramuscularly.

the blood calcium to a toxic or even a fatal level, which constitutes its great disadvantage: also it is expensive. Nevertheless when chronic parathyroid tetany proves resistant to other forms of treatment, AT 10 is indicated.

Precautions to be taken in all Forms of Treatment of Parathyroid Tetany.—Control of the treatment by serial calcium estimations of the blood is important because hypercalcæmia can give rise to calcification, renal damage, and toxæmia culminating in coma and death. Purgatives should not be given to patients with tetany, because catharsis causes loss of calcium and an exacerbation of symptoms. A lactating mother should not suckle her child, because this causes loss of calcium in the milk.

Fortunately, in over half the cases in about a month the tetany disappears spontaneously. In a few of the remaining cases it is found that treatment can be dispensed with after a longer period, but more usually it must be continued indefinitely.

HYPERPARATHYROIDISM

Admittedly a rare condition, hyperparathyroidism is less uncommon in smoky industrial areas, possibly because the low incidence of sunshine calls forth an over-production of parathormone. Hyperparathyroidism can result from an adenoma (rarely a carcinoma) of one, exceptionally of two, parathyroids, or, on much rarer occasions, from primary hyperplasia of all.

A parathyroid adenoma is a small, well-encapsulated tumour 2 to 4 cm. ($\frac{3}{4}$ to $1\frac{1}{2}$ inches) in diameter, dark red in early cases, yellow in those of some standing. An *inferior* parathyroid gland has been the seat of this neoplasm in 80 per cent. of the reported cases. In 20 per cent. of cases the neoplasm occupies an aberrant position, viz. in the mediastinum, within the thyroid gland, and behind the œsophagus, in that order (fig. 345). In structure the neoplasm closely resembles normal parathyroid tissue. The sex incidence of the neoplasm is three females to one male.

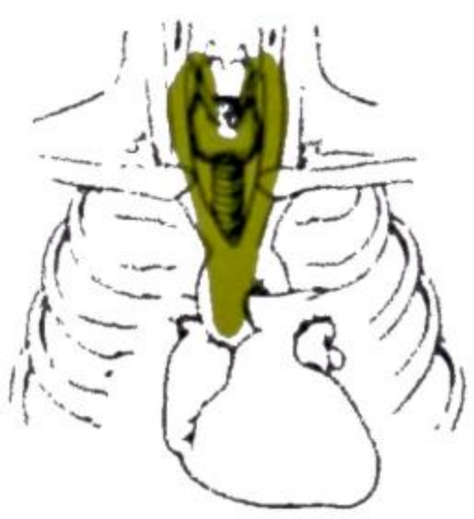


FIG. 345.—A parathyroid adenoma may be situated in any part of the area shaded yellow. Ectopic positions are explained by (1) embryological migration and (2) thoracic suction. (*After W. F. Rienhoff Jnr.*)

Parathyroid hyperplasia presents a characteristic histological picture—a large proportion of water-clear cells. Such hyperplasia can be primary, or secondary to renal insufficiency. In primary hyperplasia there is considerable enlargement of all the parathyroid glands. In secondary hyperplasia there is slight or moderate enlargement, but as at all times an excessive urinary output of calcium and phosphorus leads to a deposition of calcium phosphate within the renal tubules, and thus to renal insufficiency, it is sometimes a moot point as to which is the primary lesion. This is a post-mortem room problem. Here it is more opportune to impress upon the reader that unless he bears hyperparathyroidism in mind, he is likely to miss a case, perhaps until it is too late to remedy.

Clinical Features.—Hyperparathyroidism comes in several guises :

1. Osteitis fibrosa cystica (von Recklinghausen's disease) (see Chapter 47).

Friedrich Daniel von Recklinghausen. 1833–1910. Professor of Pathology, Strasbourg.

2. The so-called 'brown tumour' of hyperparathyroidism, particularly of the mandible and maxilla.

3. Urinary calculi. While hyperparathyroidism is responsible for less than 1 per cent., investigations into the possibility of this condition should be undertaken in all cases of renal calculi. More cases of hyperparathyroidism are discovered in this way than all the others put together (F. Albright).

Nephrocalcinosis, radiologically demonstrable as calcified streaks in the line of the tubules, is characteristic.

4. Diagnostic problems—patients with nausea, vomiting, anorexia, and weakness.

5. Peptic ulceration is a not uncommon complication of hyperparathyroidism. The only characteristic symptom is that the pain is made worse by alkalis. Fatal hæmatemesis is relatively frequent.

6. Renal rickets and renal dwarfism. In these conditions the associated parathyroid hyperplasia is *secondary* to the renal condition.

7. Steatorrhœa from any cause, e.g. fibrocystic disease of the pancreas, with its loss of calcium from the alimentary canal in the form of soaps may, by reason of low blood calcium and the body's call to raise the low calcium level, provoke *secondary* parathyroid hyperplasia, or a parathyroid adenoma.

Men are three times more often affected than women. In the majority of cases symptoms have been present for two or more years before the correct diagnosis has been made and confirmed, and the average age of the patients at the time of establishing the diagnosis is forty-four. As it is impossible to detect a parathyroid tumour by palpation, and as such a tumour is rarely sufficiently dense to cast a shadow on radiological examination, and as there are no local signs in the case of parathyroid hyperplasia, the only methods of confirming a possible diagnosis of hyperparathyroidism are by :

Radiographic Skeletal Changes.—The most characteristic X-ray finding is subperiosteal resorption of bone, best seen in the middle phalanges ; this change is often accompanied by resorption of the tufts of the terminal phalanges (fig. 346).

FIG. 346.—Erosion of the tuft of a terminal phalanx. (*Mr. D. R. Davies, London.*) (*British Medical Journal.*)

Biochemical Investigations.—These show :

1. An increased excretion of phosphorus in the urine.
2. An increased excretion of calcium in the urine.
3. Elevation of serum calcium above the normal 9–11 to as much as 18 mg. per 100 ml. (not consistent).
4. Diminution of serum phosphorus below 3 mg. per 100 ml. (reliable when renal function is good).
5. The serum alkaline phosphatase is elevated only when there is bone involvement.
6 *The Sulkowitch test* is positive in the majority of cases of hyperparathyroidism. The patient is given a diet containing 125 mg. of calcium daily for three days. The test is positive when more than 200 mg. of calcium per day is excreted in the urine. In normal individuals less than 100 mg. is excreted under these conditions.

Treatment.—The only curative treatment is parathyroidectomy (see below).

Parathyroidectomy.—The patient is instructed to take 4 gm. (60 grains) of calcium lactate and 10,000 units of calciferol, together with 2 pints (1·1 l.) of milk daily for three days before the operation and, if all goes well, for six months after-

Fuller Albright, Contemporary. Physician, Massachusetts General Hospital, Boston, Mass., U.S.A.
Hirsh Wolf Sulkowitch, Contemporary. Physician, Massachusetts General Hospital, Boston, Mass., U.S.A.

wards. The thyroid gland is exposed as for thyroidectomy, and the parathyroid tumour is sought by sight and touch. If it is not soon apparent the superior pole is mobilised by ligating and dividing the superior thyroid vessels first on one side and then, if necessary, on the other. *If a parathyroid tumour is found* (fig. 347), it is dissected out or, should it be buried in thyroid tissue, the lateral lobe of the thyroid in which it is embedded is resected: this completed, the operator must not rest content. It is essential to continue a systematic search, because sometimes more than one parathyroid is the seat of an adenoma. *When a parathyroid tumour is not found*, and all or several of the parathyroid glands are larger than normal, parathyroid hyperplasia must be assumed, for should a hidden parathyroid tumour be present, the other parathyroids would be not larger but smaller than normal (from disuse atrophy). If hyperplasia seems assured, three, or even three and a half, of the parathyroid glands should be excised.

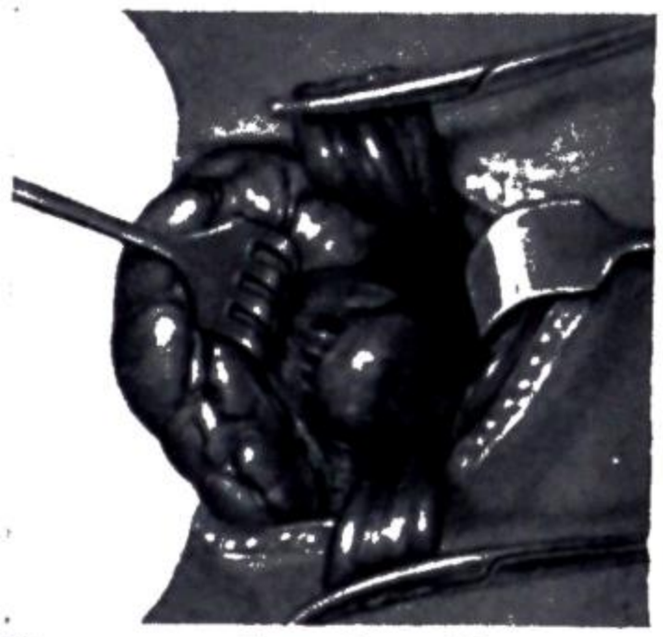


FIG. 347.—Parathyroid tumour exposed.

When the parathyroids appear normal, or smaller than would be expected, and an ectopic parathyroid tumour cannot be located by palpation and blunt dissection in the region of the cervical œsophagus, even if a branch of one inferior thyroid artery temptingly enters the superior mediastinum, it is good judgment to close the cervical wound and postpone exploration of the superior mediastinum for about fourteen days. At the second operation the sternum is split and the tumour is sought in the anterior mediastinum, removing the thymus if necessary (see p. 253). After parathyroidectomy for adenoma, tetany is not uncommon, and precautions to guard against this complication must be taken by giving calcium and parathormone, or its substitute (see p. 248), until the remaining parathyroids recommence to function. Frequent serum calcium estimations should be performed.

Prognosis.—When a parathyroid tumour is found and removed in the comparatively early stages of the disease, the outcome is often striking. Skeletal decalcification, if present, gives place to recalcification; a 'brown tumour' of bone-marrow resorbs, and it is improbable that urinary calculi, if removed *in toto*, will recur. On the other hand, extirpation of parathyroid glands that are the seat of hyperplasia, although ameliorating symptoms of hyperparathyroidism, is rarely curative.

Carcinoma of a parathyroid is very rare. The tumour is usually larger than an adenoma, and is sometimes palpable at a clinical examination. Usually these tumours secrete parathormone; they metastasise early. Radiotherapy has been employed for recurrences, without success.

THE THYMUS

Embryology.—The gland originates as a diverticulum of the third and sometimes the fourth branchial cleft on each side. Epithelial in origin, it soon assumes a lymphoid character.

Surgical Anatomy.—The body of the thymus is substantial and consists of two lobes closely applied to one another in the middle line. They overlie the upper part of the pericardium and the great vessels and extend upwards into the base of the neck. The body of each lobe is overlapped by pleura and above this level has a slender pole passing to the isthmus of the thyroid. The blood supply of the gland is derived mainly from the internal mammary arteries. After puberty the thymus commences to atrophy, and is replaced by fat, but even up to, and after, the age of fifty, the gland still contains a considerable amount of characteristic lymphoid tissue with epithelial elements, notably Hassall's corpuscles.

Hypertrophy of the thymus occurs in animals from which the adrenals have been removed. Injections of adrenal extracts bring about rapid involution of the thymus thus enlarged.

Hyperplasia of the thymus occurs in toxic goitre, acromegaly, in some cases of Addison's disease, after castration, after bilateral adrenalectomy, and in myasthenia

Arthur Hill Hassall, 1817–1894. Physician, Royal Free Hospital, London.

gravis. It also occurs idiopathically in children and adolescents (status thymo-lymphaticus).

Status thymo-lymphaticus, as its name implies, is a condition of the enlargement of the thymus, tonsils, and lymphatic nodes occurring in children. A commission appointed to investigate this condition as a cause of sudden death under anæsthesia denied its existence. In spite of this it is advisable to have a pale, fat baby or young child radiographed for an enlarged thymus before an anæsthetic for an elective operation is undertaken.

Thymic asthma occurs in babies and young children. There are recurrent attacks of laryngeal spasm, engendering threatened asphyxia due to pressure on the trachea by an enlarged thymus. The diagnosis is made on radiographic examination, when a shadow in the region of the thymus is disclosed. If given in time, X-ray therapy cures the condition : a single dose of 50r usually suffices.

Dubois' 'abscess' is a cyst of the thymus due to persistence of part of the embryological duct of the thymus. There is little to substantiate the assertion that this condition is due to inherited syphilis.

Myasthenia gravis is a disease in which transmission of motor-nerve impulses at the neuromuscular junctions is blocked by interference with the action of the transmitter—acetylcholine—upon the muscle fibres.

Clinical Features.—The disease occurs in both sexes and commences, as a rule, in early adult life. The essential symptoms are profound fatigue after modest exertion, and transient paresis of voluntary muscles. Muscles supplied both by the cranial and spinal nerves are affected, the extrinsic ocular muscles being involved most constantly. Usually ptosis (fig. 348),

FIG. 348.—Myasthenia gravis. Before neostigmin.

FIG. 349.—Myasthenia gravis. Ten minutes after an injection of neostigmin.

a squint, and diplopia are the first symptoms. Later manifestations are drooping of the mandible, with weakness of mastication and difficulty in swallowing. The patient exhibits extreme fatigue on the least exertion, rendering her incapable of almost any sustained activity. The voice becomes weak, and in some cases death occurs within a few months from involvement of the muscles of respiration. In the majority of cases the disease runs a chronic course ; in all, it is progressive, but usually partial remissions occur. The reflexes remain normal, and there is no sensory loss. Occasionally myasthenia gravis complicates primary Graves' disease.

Should a patient with myasthenia gravis become pregnant, total remission of symptoms during pregnancy is the rule.

Paul Dubois, 1797–1871. Professor of Obstetrics, University of Paris.

Confirmatory Tests.—(1) Two mg. of neostigmin with $\frac{1}{100}$ grain (0·65 mg.) of atropine sulphate (to check increased peristalsis), are injected hypodermically. In about half an hour (in comparatively early cases) pareses disappear (fig. 349) for a few hours. (2) The affected muscles often show the myasthenic reaction—fatigue with faradic, but not with galvanic, stimulation.

Radiography, particularly a lateral radiograph, of the superior mediastinum, should always be undertaken. In 12 per cent. of cases a thymic neoplasm is revealed. Apart from tumours, there is no X-ray evidence of a thymus gland in myasthenic patients.

Treatment.—Medical.—Orally from 4 to 15 tablets (15 mg. each) of neostigmin can be given in the twenty-four hours. They should be so spaced as to enable meals to be taken without difficulty in mastication. In addition desoxycorticosterone acetate pellets (150 mg.) implanted into the subcutaneous tissues of the abdominal wall are sometimes beneficial. In critical cases neostigmin may be given in a slow drip infusion.

X-ray Therapy.—If no remission follows treatment by drugs, a trial of irradiation to the thymic area can be given. If this is unsuccessful thymectomy should not be delayed, except in cases where a neoplasm of the thymus is demonstrated by radiography, in which case the radiotherapy is continued for three months before thymectomy is undertaken.

Operative.—*Thymectomy.*—A longitudinal incision is made in the middle line from just below the cricoid cartilage to the level of the fourth costal cartilage. The sternohyoid muscles are separated, the index finger is inserted under the manubrium, and on each side the layers of the pleura are displaced postero-laterally. The sternum is split by sawing through the outer table with a Hey's saw, and dividing the inner table with a Sauerbruch's sternum splitter. The divided bone edges are separated with bone hooks and the pleura is pushed away from the sternum until the level of the fourth costal cartilage is reached. The sternum is then divided transversely at the level of the third interspace, which permits the divided edges of the sternum to be separated by a strong self-retaining retractor, exposing the anterior mediastinum (fig. 350). The pleuræ are dissected still farther away from the middle line, thus displaying the thymus, which is attached by tissue that is not very dense to the ascending aorta and the pericardium. Thymic arteries and veins from the internal mammary and inferior thyroid vessels require ligation. The gland is liberated, avoiding the pleuræ, and both lobes are removed. The divided sternum is approximated with two encircling sutures, and the soft parts are reunited, usually without drainage.

FIG. 350.—Exposure of a tumour of the thymus by splitting the sternum. (*Sir Geoffrey Keynes.*) (*British Journal of Surgery.*)

Results of Thymectomy.—The best results are obtained in the younger patients with long histories (Sir Geoffrey Keynes). Poorer results accrue when an adenoma is present, and unless a pre-operative course of radio-therapy, lasting about three months, is given in such cases, the operative mortality is high. In the majority of cases,

Alfred Blalock, Contemporary, Surgeon-in-Chief, Johns Hopkins Hospital, Baltimore, U.S.A., was the first to perform thymectomy successfully for myasthenia gravis in 1936.
William Hey, 1736-1819. Surgeon, the General Infirmary at Leeds.
Ferdinand Sauerbruch, 1875-1951. Professor of Surgery, Berlin.
Sir Geoffrey Langdon Keynes, Contemporary. Emeritus Surgeon, St. Bartholomew's Hospital, London.

although the thymus on histological examination proves to be normal, the results of thymectomy are good. Thirty per cent. are cured completely; of the remainder, many are improved considerably. The operative mortality is about 10 per cent. What is of abiding interest and importance is that if an extract made from these apparently normal glands is injected into normal animals or persons, temporary muscular paresis results (Andrew Wilson).

Cysts and Tumours of the Thymus are rare, malignant tumours being less uncommon than the benign.

A cyst is nearly always a lymphangioma akin to cystic hygroma (p. 187). Sometimes it grows to an immense size.

A benign tumour is an adenoma, and usually it is unassociated with myasthenia, although a thymic adenoma is present in 10 per cent. of cases of myasthenia. The size of the adenoma varies within wide limits.

A malignant tumour of the thymus is known as a thymoma. It usually occurs comparatively early in life (before the age of twenty-five years), when histologically it is lympho-sarcomatous. Infrequently (2 : 9) the neoplasm is frankly carcinomatous, in which case it occurs after the age of fifty years. Giant-cell formations are commonly seen in the sarcomatous variety, and a multinucleated form gives rise to a mirror image, or 'owl eye' appearance. A thymoma is highly malignant, and unless treated early it compresses the trachea, invades the lung, and metastasises in the bronchial, cervical and axillary glands, and sometimes in distant organs.

FIG. 351. — Tracing of a radiograph showing unilateral thymic tumour. The patient was radiographed because he had pneumonia. (*After H. E. Sorensen.*)

Clinical Features.—Many benign tumours are symptomless and are discovered accidentally on X-ray examination of the thorax (fig. 351); occasionally the presenting feature is profound anæmia. Large tumours, usually malignant, by pressing on the trachea cause stridulous breathing, dysphagia, prominent veins over the thoracic inlet, and sometimes cyanosis of the face and upper extremities.

Radiography.—Thymic tumours projecting to one side of the mediastinum are benign histologically as well as clinically. Tumours projecting into both sides of the superior mediastinum prove malignant clinically as well as histologically. X-ray examination is therefore diagnostic, and is an aid to distinguishing between benign and malignant tumours.

Biopsy, if deemed necessary, can be performed under local anæsthesia through a small trephine hole in the sternum.

Treatment.—Most thymomas are radio-sensitive, but are not radio-curable. Therefore after a course of X-ray treatment (multiple superficial doses give better results than intense deep radiation) an attempt to remove the tumour should be made. Tumours situated on one side of the mediastinum only can be removed through a standard thoracotomy incision with resection of one rib : when necessary the incision can be extended by transection of the sternum. An attempt to remove a tumour that projects into both sides is made through a sternum-splitting incision, but it is not always possible to remove the growth *in toto* by this route. Post-operative irradiation is advisable in all cases.

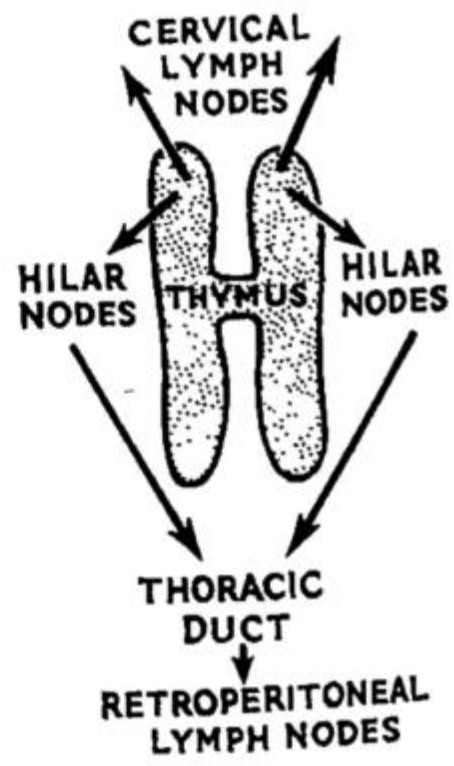


FIG. 352.—Lymphatic drainage of the thymus. (*After A. D. Thomson.*)

Is Hodgkin's Disease a Thymic Tumour?—Some believe that Hodgkin's disease is a tumour arising in the thymus gland, and metastasising from this site. The hypothesis has not been disproved. "Are not many mediastinal masses seen at radiography thymic tumours, rather than enlarged mediastinal lymph nodes?" asks A. D. Thomson. It is a pathological possibility that most, if not all, examples of Hodgkin's disease arise in the thymus (fig. 352) or in ectopic thymus tissue in the

Andrew Wilson, Contemporary. *Professor of Pharmacology, University of Liverpool.*
Thomas Hodgkin, 1798–1866. *Curator of the Museum, Guy's Hospital, London.*
Andrew Douglas Thomson, Contemporary. *Assistant Pathologist, Bland-Sutton Institute, The Middlesex Hospital, London.*

neck or the thorax. In no other way can it be explained that the 'owl eye' cells of a lymphogenous thymoma are indistinguishable from the Dorothy Reed cells of Hodgkin's disease. The advent of the thymic hypothesis of the origin of Hodgkin's disease brings the possibility of a cure of early cases of this fell disease by extirpation of the primary growth, together with (limited) metastases. One should, however, temper this sanguine hope by the knowledge that quite half the patients with Hodgkin's disease present themselves only when the disease has become disseminated widely.

THE ADRENAL GLANDS

Surgical Anatomy.—At birth, the adrenal glands have attained nearly adult proportions. Fully developed, each weighs about 1 drachm (4 gm.), but the left is a little larger than the right. A deeper yellow colour and a firmer consistency enables the gland to be distinguished from the adjacent fat. Each rests on the superior, anterior, and medial aspects of the superior pole of the corresponding kidney, and presents the appearance of a Liberty cap worn at a rakish angle.

The intimate anatomical relationship of the cortex to the medulla of an adrenal gland is the only good reason for considering the two portions of the gland as one and the same structure. Embryologically, histologically, and functionally, the adrenal cortex and the adrenal medulla are separate internal secretory glands. Likewise, the diseases to which they are subject, for the most part, are entirely distinct.

The adrenal glands are supplied by several adrenal arteries (fig. 353), rendering them remarkably vascular,[1] but only one vein drains each gland. On the right side the adrenal vein is short and so only enters the inferior vena cava just distal to the hepatic vein, while on the left it empties into the left renal vein, which in turn communicates through the azygos vein with the left intercostal, internal mammary, and vertebral veins (B. J. Anson). In all probability the dissimilarity of the right and left venous flow determines, to some extent, the location of metastases from malignant tumours of these glands. The adrenal veins are comparatively thick-walled and muscular.

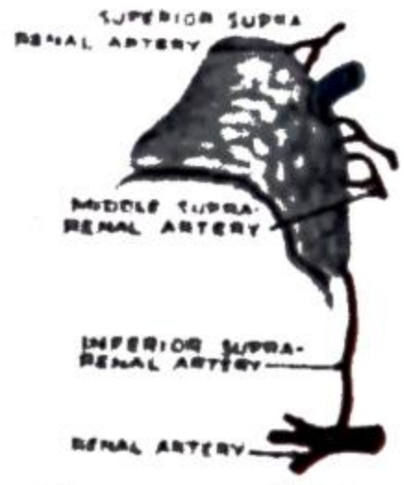


FIG. 353.—Right adrenal gland, viewed from in front.

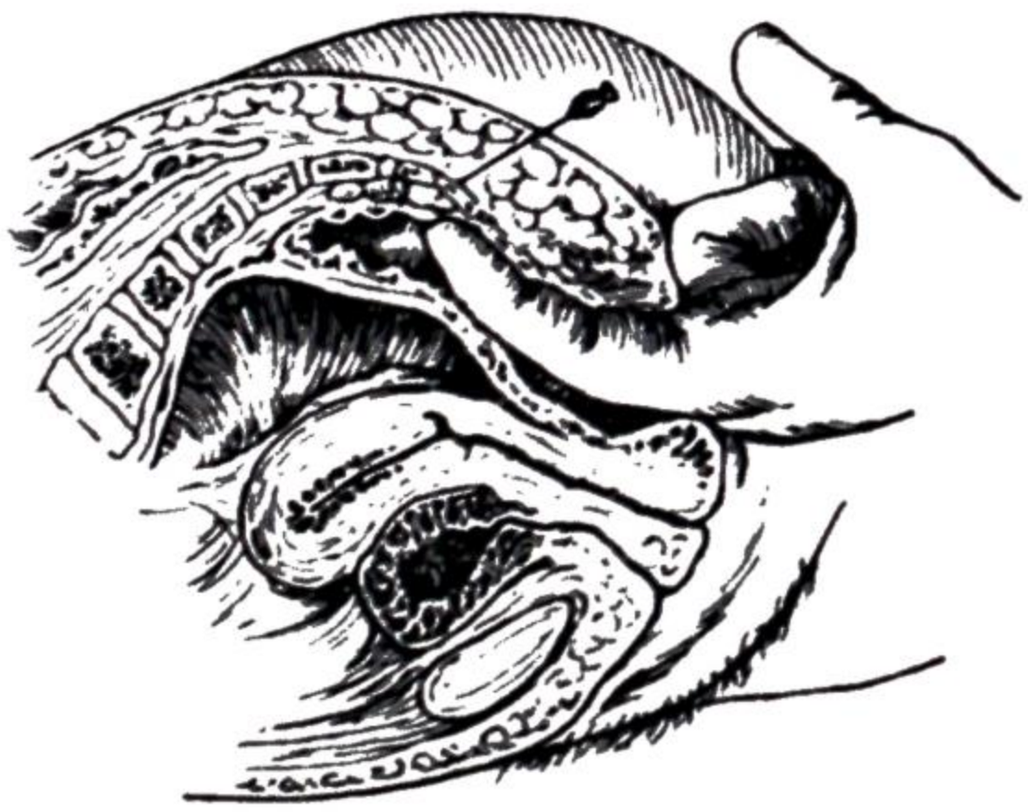


FIG. 354.—Method of introducing a lumbar puncture needle into the retroperitoneal space for insufflation of *oxygen* via a pneumothorax apparatus. Five hundred ml. of oxygen is injected.
(*After F. H. Rothfeld.*)

Radiography of the Adrenal Glands

Delineation of an Adrenal Tumour.—Because of their protected position, very few adrenal tumours can be discovered by palpation. In a few fairly advanced cases pyelography shows a deformity of the upper calyx of the corresponding kidney that is impossible to distinguish from a renal neoplasm. To delineate the adrenal by a perinephric insufflation of air before taking a radiograph is often illuminating,

[1] Just as thiouracil renders the thyroid more vascular and friable at operation, so preoperative cortisone causes the adrenals to become œdematous and friable.

Dorothy Reed (Mrs. Mendenhall), Contemporary. Formerly Fellow in Pathology, Johns Hopkins Hospital, Baltimore, U.S.A.
Barry J. Anson, Contemporary. Professor of Anatomy, Northwestern University Medical School Chicago.

but it should never be performed because of the danger of air embolism: para-coccygeal (fig. 354) injection of oxygen into the retroperitoneal tissues is free from danger and, combined with excretory pyelography, is helpful in defining an adrenal tumour. However, the clearest visualisation of the adrenal gland has been obtained by a combination of aortography and the retroperitoneal injection of oxygen.

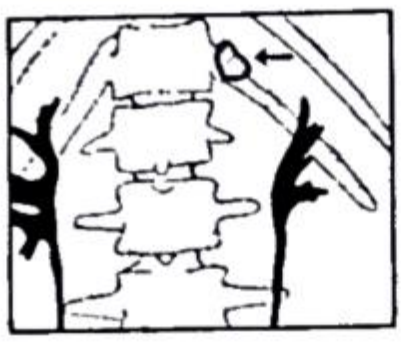


FIG. 355.—Tracing of a radiograph, showing calcification of the left adrenal gland.

Calcification in an adrenal gland is difficult to interpret in a radiograph. It is liable to be confused with a renal calculus (fig. 355). Areas of calcification in the adrenal glands are sometimes present in Addison's disease (see p. 259).

THE ADRENAL CORTEX

Embryology.—The cortex of the adrenal glands arises as an invagination of cœlomic mesoderm, and from without inwards, is made up of the following layers: the zona glomerulosa, the zona fasciculata, and the zona reticularis.

Surgical Physiology.—No fewer than twenty-eight steroid hormones have been isolated from the adrenal cortex. These potent hormones exhibit various types of activity which, for practical purposes, can be arranged in three groups, with a possible fourth:

1. **The desoxycorticosterones** are concerned in the maintenance of water and electrolytic balance. A deficiency of these hormones produces sodium diuresis, potassium retention and dehydration; an excess results in hypertension, œdema, cardiac dilatation, and hypopotassæmia. The preparation used most widely is desoxycorticosterone acetate. The latest addition to be isolated in a crystalline form is aldosterone, a potent 'salt-regulating' hormone.

2. **The cortisones** are concerned with the metabolism of proteins and carbohydrates, favouring the formation of the latter from the body's storehouse of the former. This conversion is known as gluconeogenesis. Consequently hormones belonging to this group are called glucocorticoids. The best known of these are corticosterone (compound B), cortisone (compound E), and hydrocortisone (compound F). The therapeutic application of glucocorticoids falls into two headings:

(*a*) *In Endocrine Deficiencies.*—Cortisone is the logical need in adrenocortical insufficiency.

(*b*) *In Non-endocrine Disease.*—Used initially with dramatic success in rheumatoid arthritis, the long-term results have led many to conclude that the results of cortisone therapy in this condition are no better than those obtained by aspirin. Cortisone is, however, an effective anti-allergic agent in a number of skin diseases and eye conditions. It is also a valuable anti-inflammatory agent when used in addition to antibiotic therapy, e.g. in acute pancreatitis, but in any inflammatory conditions it must be used with extreme caution, as it delays healing.

3. **Sex Hormones.**—Both androgenic and œstrogenic hormones are produced by the adrenal cortex. Excessive secretion of androgens causes virilism in females, while on rare occasions excessive secretion of œstrogens brings about effeminacy in males.

4. **Fat-controlling Hormone.**—The administration of compound A has been found to cause an increased deposition of fat.

Inter-hormonic Action.—The anterior lobe of the pituitary gland secretes adrenocorticotropic hormone (ACTH) that accelerates the secretory activity of the adrenal cortex, whereas corticosterone of the adrenal cortex inhibits the secretion of ACTH (fig. 356).

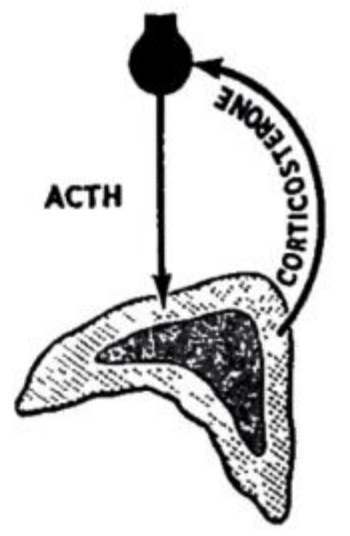


FIG. 356.—Pituitary ACTH stimulates the adrenals to activity. Corticosterone of the adrenals inhibits the output of ACTH.

The best general test of adrenal cortical activity is an estimation of the

ADRENOCORTICAL HORMONES

Type of Hormone	*Possible Site of Elaboration*	*Metabolic Action*	*Laboratory Tests*
Mineralocorticoid (desoxycorti-costerone-like ; aldosterone)	Zona glomerulosa	Maintains water and salt balance	Serum sodium ; serum potassium; plasma chloride
Glucocorticoid (cortisone ; hydro-cortisone)	Zona fasciculata	Gluconeogenesis; anti-anabolic ; anti-inflam-matory	Urinary 17-keto-genic steroids excretion ; dextrose tolerance
Androgen and oestrogen	Zona reticularis	Virilisation ; feminisation	Urinary 17-keto-steroid[1] excretion; urinary oestro-gens

amount of 17-ketosteroids in the urine, the twenty-four-hour normal excretion of which is :

10 to 20 mg. for men
5 to 15 mg. for women
2 to 4 mg. for a child of six to eleven years.

Adult levels are reached at about eighteen years of age. The average excretion is lower in coloured than in white males. After administration of cortisone acetate by mouth, about 50 per cent. of the increased 17-ketogenic steroids is excreted in four hours.

After the age of forty urinary steroid excretion gradually falls, and at seventy is approximately halved.

* * *

The two most common disorders of adrenocortical function are chronic insufficiency (Addison's disease) and chronic over-activity (Cushing's syndrome) (G. W. Thorne).

HYPOCORTICALISM

Acute :

1. **Adrenal Apoplexy in the Newborn.**—Extensive hæmorrhage into one (fig. 357) or both adrenals is found to be a not uncommon cause of death in infants who succumb within the first few days of birth. The condition is prone to occur after long and difficult labour, and particularly when traumatic resuscitative procedures have to be employed to combat asphyxia neonatorum. The hæmorrhage into the adrenals follows necrosis of the innermost layer of the cortex, which always occurs at birth, possibly as a

FIG. 357.—Kidney and adrenal of a newly born infant showing hæmorrhage into the adrenal gland.

[1] Urinary 17-ketosteroids in the male are derived from the adrenal cortices and the testes, while in the female there is but the one source—the adrenals.

George W. Thorne, Contemporary. Physician-in-Chief, Peter Bent Brigham Hospital, Boston, Mass., U.S.A.

result of sudden withdrawal of the female sex hormone (œstrogen). Adrenal crises in the newborn produce signs of profound shock. A mass is palpable in one or both renal regions. Fluid therapy with hydrocortisone, or, failing the latter, cortisone intramuscularly, offers the only hope of survival.

2. **Waterhouse-Friderichsen Syndrome.**—Massive bilateral adrenal cortical hæmorrhage, due in 75 per cent. of cases to a fulminating meningococcal septicæmia and in the remainder to a streptococcal, staphylococcal, or pneumococcal septicæmia, is the cause of the condition. It should be noted that even at post-mortem examination evidence of meningitis is lacking. The majority of cases occur in infants and young children, but it is not exceptional in adults. The onset is catastrophic, with rigors, hyperpyrexia, cyanosis, and vomiting. Petechial hæmorrhages into the skin which coalesce rapidly into purpuric blotches are a constant feature. Profound shock follows, and before long the patient passes into coma. The condition is one of overwhelming sepsis that pursues a galloping course, death occurring in most cases within forty-eight hours of the onset of symptoms unless correct treatment is given without delay.

Confirming the Diagnosis.—It is futile to await the result of a blood culture. Bilateral tenderness 2 in. (5 cm.) below the costal margin, and well lateral to the umbilicus, clear urine (oliguria is often present), and an absence of signs in the lungs help to call attention to the adrenal glands. A normal eosinophil count is almost diagnostic, for in all patients with a fulminating infection and intact adrenal cortical function there is a significant degree of eosinopænia. In some cases the meningococcus can be demonstrated by Gram-stained smears obtained from a carefully punctured petechial spot.

Treatment.—Antibiotic therapy *per se* is without avail, but it must be given intensively, as also a slow intravenous injection of sodium sulphadiazine 0·3 G. per Kg. of body weight, but not exceeding 5 G. The life-saving measure is, in addition, to give a suitable amount of intravenous infusion of dextrose-saline solution containing hydrocortisone 100–200 mg. per 1000 ml. In the absence of hydrocortisone, cortisone can be given intramuscularly, but its action is slower and less certain. Oxygen should also be administered. Cortisone therapy should be continued in diminishing doses for a week. Following such treatment, often improvement sets in within three hours, and a number of patients have recovered.

3. **Crises of Congenital Adrenogenital Syndrome** (see p. 262).

4. **Following Bilateral Adrenalectomy.**—While, if due precautions are taken (see p. 263), acute hypocorticalism is most unusual in the immediate post-operative period, in the months that follow crises are liable to occur because for some reason or another the correct dose of cortisone replacement is not given. The treatment is to support the blood pressure with desoxycorticosterone acetate, 5 to 20 mg. intramuscularly, and then administer 3 litres of dextrose-saline solution per twenty-four hours, 50 to 200 mg. of hydrocortisone being added to each flask or, failing hydrocortisone, to give cortisone intramuscularly.

Rupert Waterhouse, Contemporary. *Consulting Physician, Royal United Hospital, Bath, England.*
Carl Friderichsen, Contemporary. *Director of the Children's Department, Sundby Hospital, Copenhagen.*

Chronic :

Addison's disease is due to adreno-cortical insufficiency consequent upon progressive destruction of the zona reticularis, the zona fasciculata, the zona glomerulosa, and the medulla of the adrenal glands, in that order. Until recently all cases of Addison's disease were thought to be due to adrenal tuberculosis. It is now evident that tuberculosis accounts for only 50 per cent. of cases, the remainder being due to atrophy, amyloidosis, and other lesions that destroy the cortex. The medulla, which may or may not be implicated, appears to play no part in the production of the clinical disturbance.

FIG. 358.—Addison's disease in a spinster aged twenty. Scattered pigmented areas are shown, especially in relation to a pressure point of her girdle. *(Dr. Leonard Simpson, London.)*

Clinical Features.—Addison's disease usually commences in the third or fourth decade, although it is not very rare at an earlier age ; sometimes it is the terminal event in cases of adrenogenital hyperplasia. The sex distribution is about equal. The leading features are muscular weakness and a low blood pressure. Irregular dusky pigmentation of the skin, especially at points of pressure (e.g. garter, belt) (fig. 358) and in the flexion creases, and pigmentation of mucous membranes, particularly of the mouth, is often striking and is due to deposits of melanin. When fully established, the course of the disease is punctuated by crises of acute adrenocortical insufficiency, the symptoms and signs of which are identical with those of shock (see p. 14).

Confirmatory Diagnostic Tests :

1. *The Water Test.*—If, after an overnight fast, a normal individual is given 9 ml. of water per pound of body weight (20 ml. per kilo), 80 per cent. of it will be excreted in four hours, whereas a patient suffering from Addison's disease shows impaired diuresis.

2. *The urinary 17-ketosteroids* excreted by a patient with Addison's disease is usually less than 5 mg. if the patient is a man, and less than 1 mg. in the case of a woman. The ketogenic steroids are also low, and fail to increase after ACTH administration.

3. Especially during a crisis, the plasma sodium is decreased, the chlorides low, and the potassium elevated above 20 mg. per 100 ml.

Treatment is medical.

Prognosis.—By newer hormone treatment, the expectation of life of a patient suffering from Addison's disease has been extended from about three years to (in 50 per cent. of cases) at least seven years.

HYPERCORTICALISM

Usually the various forms of adrenal cortical hyperfunction are, by convention, classified according to syndromes :

Thomas Addison, 1793–1860. Physician, Guy's Hospital, London.

1. Cushing's syndrome.
2. The adrenogenital syndrome.
3. ' Mixed ' syndrome—intergrades between 1 and 2.

CUSHING'S SYNDROME

Cushing's syndrome is due to an excessive production of glucocorticoids, mainly hydrocortisone (compound F).

In 35 per cent. of cases an adrenal neoplasm is present ; in half of these the tumour is malignant.

In 60 per cent. of cases the patient has bilateral adrenal hyperplasia ; in one-third of these a basophilic tumour of the anterior pituitary gland—often microscopic in size—is present.

In 5 per cent. of cases there is no discernible structural alteration in the adrenal glands, but in a small proportion of these there is a tumour of the pineal gland or the thymus.

In its purest form, Cushing's syndrome is seen in patients treated with large doses of cortisone over long periods for non-endocrine diseases, particularly rheumatoid arthritis.

Clinical Features.—The female : male ratio is at least 3 : 1. The great majority of cases (excluding those induced by cortisone therapy) occur in females between fifteen and thirty years of age, in whom it produces highly characteristic features. Although the patient's weight is not necessarily increased, there is a deposition of fat in certain situations. The face becomes rubicund, rounded like a full moon, and the lips are pursed. The abdomen becomes protuberant, the neck thick, the supraclavicular fossæ obliterated, and a roll of fat appears over the region of the vertebra prominens (buffalo hump). The arms, and especially the legs, are relatively thin, and muscular development is poor, and the patient complains of increasing weakness. As the disease progresses, so the general contour becomes more and more that of a lemon on match-sticks.→ Consequent upon the inhibitory effect of the hypercorticalism on fibrous tissue, the skin becomes of tissue-paper consistency, and inelastic. Exceedingly characteristic are purple-red striæ distentiæ, mostly on the abdomen (fig. 359), of a texture that can be likened to an over-stretched

FIG. 359.—Cushing's syndrome in a woman aged twenty-three years. Adrenal hyperplasia. (*Dr. Leonard Simpson, London.*)

Harvey Cushing, 1869–1939. Professor of Surgery, Harvard University, U.S.A.

garter. Ecchymoses are frequent and bruising occurs on the slightest trauma. Acne is common, and there is a low resistance to skin infections. Often there is increased growth of lanugo hair, but hirsutism is usually absent. Amenorrhœa is usual or, in the male, impotence. Again, because of interference with the deposition of connective tissue, the matrix of bone becomes thin, and severe osteoporosis results. Pathological fractures, particularly compression fracture of a vertebra, are common, and this is sometimes the first reason for the patient seeking advice. Mild glycosuria is often present. Hypertension is frequent, and eventually congestive heart failure supervenes. In about 60 per cent. of cases various psychoses occur.

Cushing's syndrome is rare in children; when it occurs, the patient is nearly always a female and an adrenal tumour is usually the cause.

Laboratory Findings.—Polycythæmia, lymphopænia, and eosinopænia are common. A fasting eosinophil count over 30 per cu.mm. of blood is good evidence against the diagnosis. Usually the basal metabolic rate is low and the serum cholesterol elevated. The dextrose tolerance is impaired, and the insulin tolerance test reveals a resistance to the action of insulin. Urinary 17-ketosteroids are somewhat high, and urinary ketogenic steroids are above normal levels.

Radiography of the skeleton reveals osteoporosis, most marked in the spine and pelvis.

Treatment.—In cases of cortical hyperplasia total adrenalectomy on one side and resection of seven-eighths of the adrenal gland on the other side (usually after an interval) is the best course. Obviously the only treatment for neoplastic cases is excision of the adrenal gland bearing the tumour.

The older treatment for cortical hyperplasia was removal of the ACTH stimulus by implants of radio-active gold seeds into the pituitary fossa, or by other methods of pituitary ablation, including deep radiotherapy.

Although sometimes followed by a long remission, this form of treatment is falling, or has fallen, into disuse because, (*a*) deep X-ray therapy excepted, it is far more hazardous; (*b*) there is always the danger of overlooking an adrenal neoplasm. Treatment by deep X-rays to the pituitary fossa has proved inadequate in a high percentage of cases.

THE ADRENO-GENITAL SYNDROME

(*a*) **Congenital.**—It is likely that androgenic excess during intrauterine life causes pseudo-hermaphrodism to occur in the female child. The condition is present at birth; sometimes the enlarged clitoris and a varying degree of hypospadias make it difficult to determine the infant's sex. Not infrequently the 17-ketosteroid content of the urine is sufficiently elevated to substantiate a diagnosis of a female with adrenal hyperfunction. If this is not the case, it is justifiable to perform laparotomy[1] before the age of one year to determine the sex of the patient. Female pseudo-hermaphrodism with virilism is invariably associated with disease of the adrenal cortex, usually bilateral hyperplasia of the cortex. Hormonal studies have shown

[1] Sex determination by skin biopsy often obviates the necessity of performing laparotomy for this purpose.

that there is a congenital failure of the adrenal glands to synthesise glucocorticoids, mainly compound F. Due to this lack, these infants are liable to pass into acute phases of adrenal insufficiency during stress or infection, or to suffer from periodic hypoglycæmic attacks. These patients have been treated successfully with cortisone, not only in the emergencies described above, but as a long-term therapy, thereby inhibiting the secretion of excessive androgens. In the absence of such treatment the epiphyses join early, the patients are dwarfed, menstruation does not occur, and the breasts do not develop. All these tendencies are corrected by cortisone given by mouth, 25 mg. or more daily, the dose being determined by 17-ketosteroid estimations (Leonard Simpson). Hirsutism is moderated, but not necessarily abolished. It is important that the treatment should be commenced early if good results are to be obtained.

Pre-pubertal.—There is never any doubt as to the sex of the infant at birth, for during the very early years of life the child is normal. The symptoms commence about the age of five or six years.

In the Female.—Pubic and axillary hair appear, but there is no gross enlargement of the clitoris. The child is short in stature, the legs being especially stunted, but she looks much older than she is. Puberty is often precocious, menstruation, if it occurs, being scanty. There is a deepening of the voice at this time.

In the Male.—The child Hercules is descriptive. He is extremely short, muscular, and hirsute. The genitalia assume adult proportions, and spermatazoa are often present in the seminal fluid.

In both sexes, 17-ketosteroid content of the urine is increased. A very high reading supports the diagnosis of an adrenocortical tumour, which must always be excluded.

Treatment.—In the case of a female an appropriate operation on the adrenal glands (see p. 263) gives excellent results (L. R. Broster) provided, of course, if the cause be a tumour, it is removed early. In the male, if a tumour can be eliminated, it is doubtful if operation is required.

Post-pubertal.—There are two varieties—the fat and the muscular. Modern evidence suggests that in the fat group there is an excessive secretion of adrenal glucocorticoids, and in the muscular group an excessive secretion of adrenal androgens. The fat group, which is the more common, has been dealt with under the heading of Cushing's syndrome; the muscular group commences between the ages of fifteen and twenty-five and is confined to females. One of the first indications of its onset is amenorrhœa or oligo-menorrhœa. There follows an excessive growth of hair on the face (fig. 360), acne, atrophy of the breasts, alteration in bodily contour and muscular development, deepening of the voice, and enlargement of the clitoris.

FIG. 360.—Adrenogenital syndrome in a woman of twenty-eight. (*Dr. Leonard Simpson, London.*)

Samuel Leonard Simpson, Contemporary. Endocrinologist, St. Mary's Hospital, London.
Lennox Ross Broster, Contemporary. Consulting Surgeon, Charing Cross Hospital, London.

Jewish and Spanish women are more prone to this affection than those of other races.

Very rarely, the adreno-genital syndrome appears in youths and men. Owing to excessive production of œstrogenic hormones by the adrenal cortex, corporal and psychic signs of effeminacy appear.

Investigation and treatment are similar to those described for Cushing's syndrome.

Post-menopausal is usually characterised by the growth of a beard (the bearded woman of the circus), and is often accompanied by mental aberration.

Operative treatment can be tried, but is usually disappointing.

ADRENALECTOMY FOR HYPERCORTICALISM

It is essential that all patients who are to be subjected to extirpation of adrenal cortical tissue be prepared adequately for the operation, and supported post-operatively by adrenocortical hormone replacement therapy, irrespective of the extent of adrenal resection.

CORTISONE THERAPY

Pre-operative	Cortisone acetate, 100 mg. intramuscularly twelve and two hours before operation.
During the Operation and Immediate Post-operative Period	Hydrocortisone, 100 mg. slowly by intravenous drip during the operation, and a similar quantity during the subsequent twelve hours, to be followed by cortisone 50 mg. intramuscularly six-hourly.
Post-operative	**Day 1.**—Cortisone 50 mg. intramuscularly six-hourly. **Days 2 and 3.**—Cortisone 50 mg. intramuscularly eight-hourly. **Days 4 and 5.**—Cortisone 50 mg. intramuscularly every twelve hours. **Days 6 and 7.**—Cortisone 25 mg. by mouth every eight hours.

Thenceforward cortisone by mouth should be reduced slowly to maintenance level in cases of total adrenalectomy, or to zero in subtotal adrenalectomy.

N.B.—If hydrocortisone is not available, 200 mg. of cortisone instead of 100 mg. should be administered intramuscularly twelve hours before operation.

Operation :

(*a*) When an adrenal tumour has been demonstrated pre-operatively, excision of that adrenal gland alone is carried out.

(*b*) If a tumour has not been demonstrated, the patient is prepared for bilateral exploration.

Because the difficulties are usually less on the left than on the right side, exploration of the left adrenal gland is undertaken first. If a tumour is found, adrenalectomy is carried out. If the left gland is found to be atrophic it is highly probable that there is a tumour on the right side, which should be explored forthwith. Should the gland be hyperplastic or normal, subtotal (90 per cent.) adrenalectomy is indicated. If, after this has been performed, it is apparent that the patient will not tolerate a bilateral operation well, exploration of the contralateral side should be postponed until an appropriate future date.

Technique.—An ample postero-lateral incision, such as is used for exploration of the kidney (see Chapter 32), is commonly employed. After subperiosteal resection of the twelfth rib the lower border of the pleura is defined and protected. The incision is extended through the bed of the twelfth rib to reveal the perinephric fat, within which the adrenal gland is identified, as described below.

On the right side the suprarenal vein is short and is torn easily from the vena cava if it is not identified and ligated at an early stage of the dissection. By finger and gauze dissection, keeping close to the gland, the gland is freed from below and behind, upwards, ligating and dividing bleeding vessels as they are encountered, until it is suspended only by its main vascular pedicle near its apex. If subtotal adrenalectomy is to be performed, the gland is cut across with scissors so as to leave a small triangular fragment of the apex well supplied with blood-vessels. Bleeding should be controlled by swab pressure, as diathermy coagulation leads to necrosis. The incision is closed, if necessary with drainage.

The Excised Specimen.—When the adrenal cortex is the seat of hyperplasia or a neoplasm that is physiologically active, it takes ponceau-fuchsin stain readily, and assumes a vivid red colour (H. W. Vines).

BILATERAL TOTAL ADRENALECTOMY FOR INOPERABLE CARCINOMA OF THE BREAST OR PROSTATE, OR THEIR METASTASES

In somewhat more than 50 per cent. of patients, total adrenalectomy results in a surprising degree of reduction of pain, a feeling of well-being, occasional radiographic evidence of recalcification of osseous metastases, and apparent resorption of metastases in other situations. In the case of carcinoma of the breast, the operation is combined with that of removal of both ovaries (see Chapter 42). While hormone therapy before, during, and after adrenalectomy is the same as that described previously, the hazards of the operation are fewer than those connected with hypercorticalism. Indeed, the majority of patients tolerate a single-stage bilateral adrenalectomy exceedingly well.

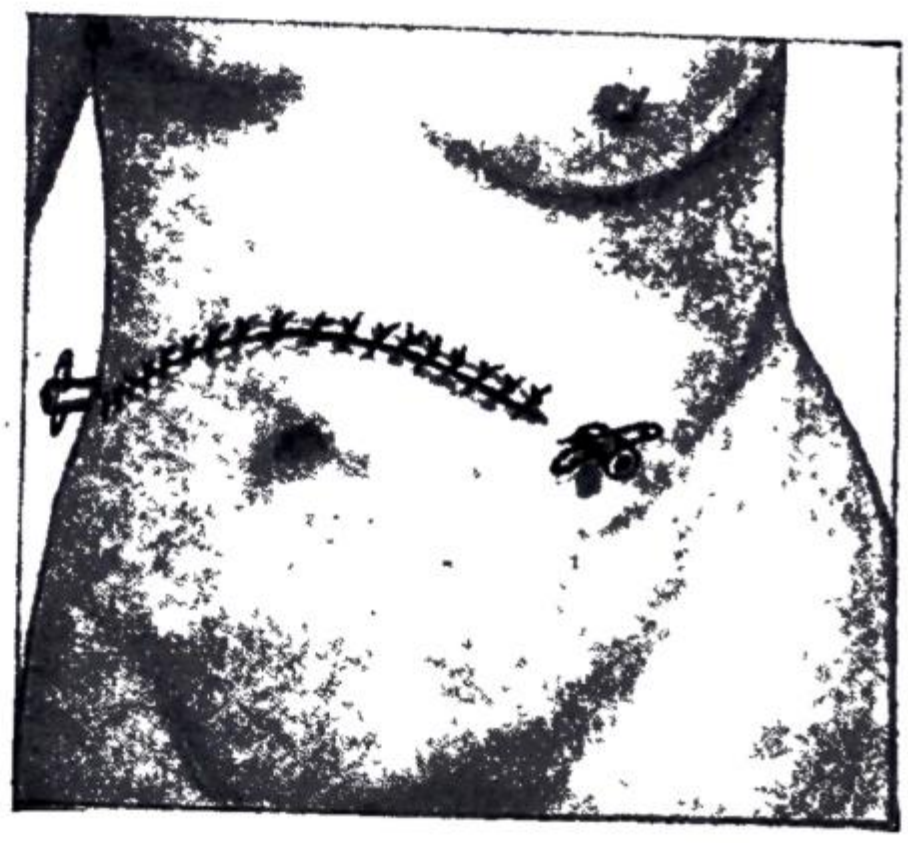


FIG. 361. — Incision for bilateral adrenalectomy via the anterior route. Operation completed.

Operation.—The anterior route is to be preferred in these cases, and the adrenal glands are approached through a curved transverse incision with its concavity upwards (fig. 361). The left adrenal gland is approached first by cutting along the lateral leaf of the lieno-renal ligament and then curving downwards and medially, so as to enable a wide peritoneal flap to be reflected. By retracting the spleen downwards and medially, the adrenal gland comes into view. The fascia over its lateral border is incised, and by gauze dissection the blood-vessels of the gland are defined, ligated, and divided, thus freeing the gland, which is removed. The right adrenal gland is more deeply situated. The peritoneum is incised lateral to the duodenum and above the upper pole of the kidney. The flap of peritoneum is raised to expose the anterior surface of the adrenal gland as it lies against the bare surface of the liver. The fascia covering the lateral surface of the gland is

Howard William Copland Vines, Contemporary. Formerly Professor of Pathology, University of London.

incised. A finger can then be inserted above the upper pole of the gland into the space between the two layers of fascia enclosing the gland (fig. 362). This prevents the gland from becoming displaced upwards, which otherwise it is prone to do. The anterior fascial layer is then incised transversely and the gland can be dissected under vision, as on the left side. After removal, each gland should be inspected to check its completeness, and each adrenal bed must be searched for the presence of accessory adrenal tissue, which is present in 32 per cent. of cases. If this important step is omitted, failure of the operation is not unlikely. The abdomen is closed with small drainage tubes passing to the adrenal fossæ on either side.

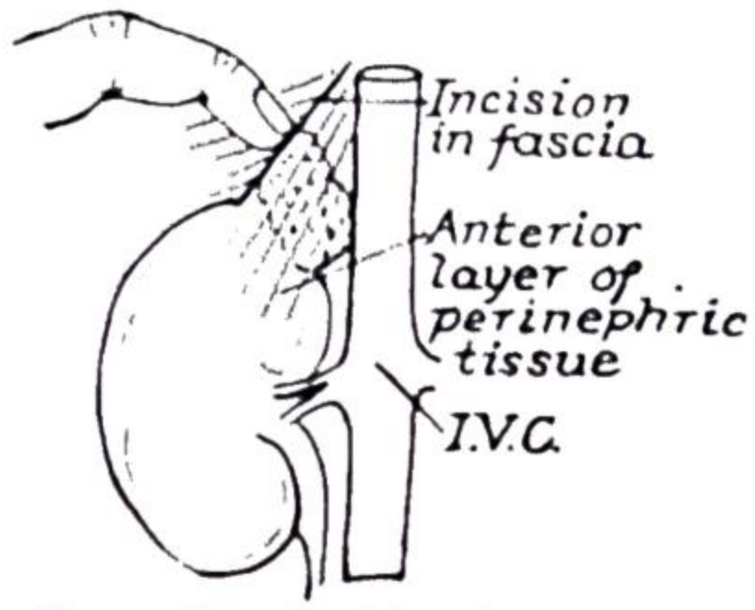


FIG. 362.—Incision in the fascia lateral to the right adrenal gland. Insertion of the finger into the space above the gland prevents its upward displacement. *(After J. C. McKenzie and A. Ganguli.)*

THE ADRENAL MEDULLA

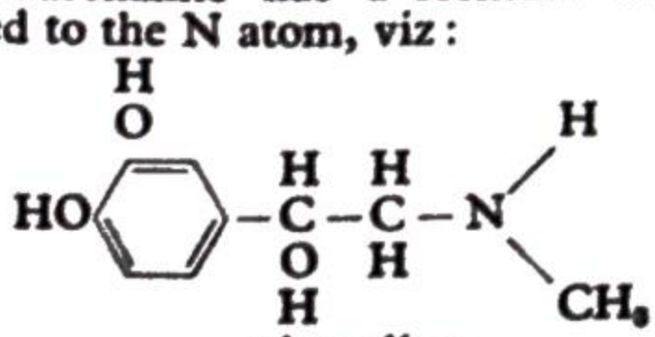
The medulla of the adrenal glands (chromaffin tissue), which is developed, together with sympathetic nerves, from ectoderm, is grey in colour and connected intimately, both anatomically and functionally, with splanchnic nerves. Chromaffin tissue is so-called because the large polyhedral cells of which it is composed contain granules that stain yellow with chromic acid. There is every reason to believe that these granules are the internal secretion of the adrenal medulla itself, for they can be observed being extruded *in toto* into radicles of the adrenal vein. This internal secretion, which is not absolutely essential to life, is released continuously in varying amounts. Fear, anger, pain, and effort give rise to an increased output in response to the stimuli received via the splanchnic nerves. The secretion consists of adrenaline and noradrenaline.[1] In health, 80 per cent. of the output is adrenaline, and 20 per cent. is noradrenaline. However, in hyperfunctioning medullary tumour (phæochromocytoma) this ratio is reversed completely.

It would appear that one of the principal functions of chromaffin tissue is to liberate quickly hormones that permit a more rapid response of the body to noxious stimuli. Noradrenaline causes an over-all vasoconstriction, thereby raising the blood pressure, whereas adrenaline in small or moderate doses decreases it. The action of noradrenaline is short-lived, but it is more suitable than adrenaline for the treatment of circulatory failure. The method of administration is to give very slowly indeed (30 drops per minute, gradually reduced to 7 drops) dextrose-saline solution intravenously,[2] to which has been added 4 ml. of noradrenaline to each 1,000-ml. flask of the solution, the aim being to adjust the drip to maintain the diastolic blood pressure between 70–80 mm.Hg.

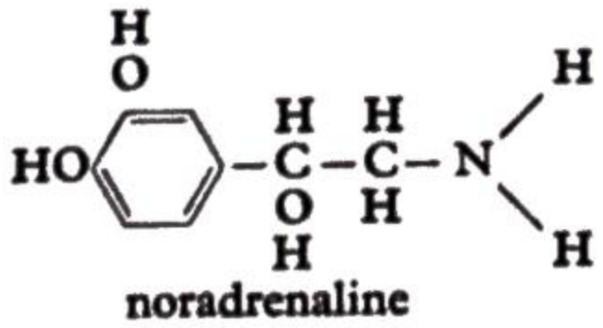
TUMOURS OF THE ADRENAL MEDULLA

- Medullary
  - Neoplasms of the sympathetic neurones
    - Ganglioneuroma
    - Neuroblastomata
  - Neoplasm of chromaffin cells = Phæochromocytomata

[1] Noradrenaline has a formula similar to adrenaline, but without the methyl group attached to the N atom, viz:



adrenaline



noradrenaline

[2] The saphenous vein should not be used, as the vasoconstriction may cause skin necrosis.

Those occurring at any age :

A ganglioneuroma is relatively benign. This neoplasm is symptomless, grows to a large size, and constitutes one of the varieties of retroperitoneal 'sarcoma' (see p. 510). If removed completely at a comparatively early stage, a cure can be expected.

Those occurring in infants and children :

Neuroblastoma of the adrenal medulla is a reddish-grey tumour that is highly malignant. It soon breaks its confines and invades neighbouring organs, e.g. the kidney and the pancreas, and metastasises by lymphatics, and especially by the blood-stream.

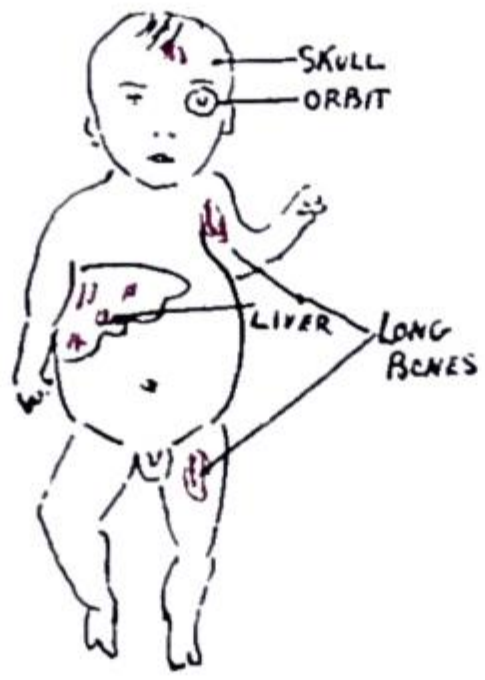


FIG. 363.—The common sites for metastases from neuroblastoma of the adrenal. Bones are involved more frequently than the liver.

Clinical Features.—Distributed equally between the sexes, 80 per cent. of these comparatively rare tumours occur below the age of five years. Usually the child is brought on account of an abdominal swelling. Pallor and loss of appetite are frequent accompaniments. The knobbly contour of an adrenal neuroblastoma helps to differentiate it from a Wilms' tumour (see Chap. 32), which remains smooth even after it has attained a great size. Although unilateral, the growth, as it enlarges, extends across the middle line. About 60 per cent. of patients have metastases by the time they are brought for advice (fig. 363).

Investigations should include a complete radiographic examination of the skeleton.

Treatment.—Unless there are secondary deposits, exploration (before or after radiotherapy) should be undertaken ; in comparatively early cases the tumour can be removed completely. When total removal is not feasible, as much as possible of the neoplasm should be excised, followed later by a course of deep radiotherapy.

Of course, if complete excision is possible, the prognosis is enhanced, but an extraordinary feature of these cases is that from time to time a patient survives when the tumour is found to be so advanced that only a piece is removed for section, and no treatment of any kind is given ; sometimes even secondary deposits disappear. With operation, followed by X-ray therapy, about 25 per cent. of the patients recover, and if they are free from recurrence by the end of one year, it is almost certain that they are cured permanently (R. E. Gross)—an exception to every other highly malignant tumour.

Those occurring in adults (and but rarely in children) :

Phæochromocytoma is a yellowish-brown benign tumour, usually less than 2 inches (5 cm.) in diameter (fig. 364), composed of large differentiated sympathetic ganglion cells, and a few fibres enclosed in a delicate capsule. It owes its name to the presence of chromaffin granules. In a little less than one-fifth of the cases the tumour is bilateral. This tumour, which occurs in both sexes, usually during early adult life or middle-age, produces, either intermittently or continuously, an excess of adrenaline, and especially of noradrenaline : the ratio of the latter to the former often being as high as 20 : 1. In so far as the secretion of these hormones is concerned, phæochromocytomata fall into two groups—the paroxysmal and the persistent : the latter predominate statistically and

FIG. 364.—Phæochromocytoma excised successfully. *(Collection of Brady Urological Institute, Johns Hopkins Hospital, Baltimore.)*

Robert E. Gross, Contemporary. *Professor of Children's Surgery, University of Harvard, Boston, Mass., U.S.A.*

are probably late stages of the former. Consequently all patients under sixty years of age who suffer from sustained arterial hypertension deserve routine tests to confirm or exclude a phæochromocytoma. In all probability not more than 0·5 per cent. of cases of hypertension are caused by a phæochromocytoma ; notwithstanding, at the Mayo Clinic, where routine diagnostic procedures are undertaken to confirm or exclude the presence of this tumour in all cases of hypertension, the percentage was nearly 3 per cent. Untreated, it progresses to a fatal termination.

Clinical Features.—The most common symptoms, in order of frequency, are: headache (55 per cent.), palpitation, vomiting, sweating, dyspnœa, weakness, pallor—i.e. the symptoms of adrenaline overdosage. A typical attack is associated with hypertension. Ten per cent. of the patients have diabetes mellitus.

Radiography.—Pyelographic examinations sometimes reveal displacement of the upper pole of the kidney. Other radiographic investigations are those described on p. 255.

Laboratory Tests

1. *Colorimetric examination of the urine* for noradrenaline, or, even better, fluorimetric determination of the catecholamines, can be relied upon to exclude the diagnosis of phæochromocytoma.

2. *Biological assay* (injection of an extract of the urine into a spinal animal, usually a cat) determines accurately if there is a pressor substance excreted in the patient's urine.

3. *Direct Blood Examination.*—Another test is to pass a polythene tube into the inferior vena cava and test samples of blood for their concentration of noradrenaline.

The response to a diagnostic dose of rogitine[1] is also confirmatory evidence of hypersecretion of chromaffin tissue.

Operation.—Twenty to 40 mg. (for an adult) of rogitine (1 to 2 tablets) should be given after meals t.d.s., while the patient is being prepared for operation. The hazardous phases in the operation are during the induction of anæsthesia, positioning of the patient on the operating table, when the tumour is manipulated, and immediately after removal of the tumour. Five mg. of rogitine is given intravenously, prior to commencing the anæsthetic. With an intravenous drip infusion of dextrose-saline running, the operation is commenced. The blood pressure rises sharply when the adrenal gland is handled, and to counteract this rise another 5 mg. of rogitine is given into the tube of the intravenous drip. Should it be necessary, yet another dose is given. As soon as the adrenal gland has been extirpated, a considerable fall in the blood pressure is to be expected, and is combated by giving an injection of noradrenaline (see p. 265), which, during the first week following the operation, should always be at hand for immediate intravenous injection in case of need. With these precautions, the earlier operative mortality has been lowered. The operation is curative, except in very rare instances where the tumour proves to be malignant. In cases where the symptoms persist after unilateral adrenalectomy, a tumour in the contralateral gland is highly probable. In this instance the second tumour, which is usually well-defined, must be dissected from the healthy portion of the gland. Some consider this to be the better technique for all cases, particularly because these tumours are benign.

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[1] Rogitine (Ciba) (phentolamine B.P.), a substance that suppresses temporarily the pressor activity of the secretion of chromaffin tissue.

The excised specimen, when fixed in bichromate solution, stains brown.

Hyperplasia of the adrenal medulla, although often more in evidence on one side than the other, is usually bilateral. Paroxysmal hypertension,[1] clinically identical with that produced by a phæochromocytoma, is present. Unilateral adrenalectomy brings about amelioration, but for a cure of the condition, after an interval, the remaining adrenal should be removed.

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[1] Adrenalectomy is being practised as a more radical alternative to sympathectomy in cases of severe essential hypertension. Concrete reports with five-year follow-ups are not yet available.

CHAPTER XV

THE PHARYNX

HAMILTON BAILEY

TONSILS AND ADENOIDS

Surgical Anatomy.—The conception that the lymphadenoid tissue of the naso-pharynx is Nature's barrier to bacterial invasion can be fostered, and the ætiology of certain cervical inflammations can be visualised and better understood, if Waldeyer's inner and outer rings (fig. 365) are studied. *The faucial tonsils* are the largest and most important moieties of the inner ring. Tonsillar tissue normally contains crypts, usually tortuous, that extend right through the tonsillar substance to the external capsule. These crypts can, and often do, harbour pus and micro-organisms. Clothing the lateral two-thirds of the circumference of each tonsil is the capsule, a well-defined structure composed of fibrous and elastic tissue, and muscle fibres. The medial third of the circumference lies between the pillars of the fauces and, being bereft of covering, is readily accessible to clinical examination.

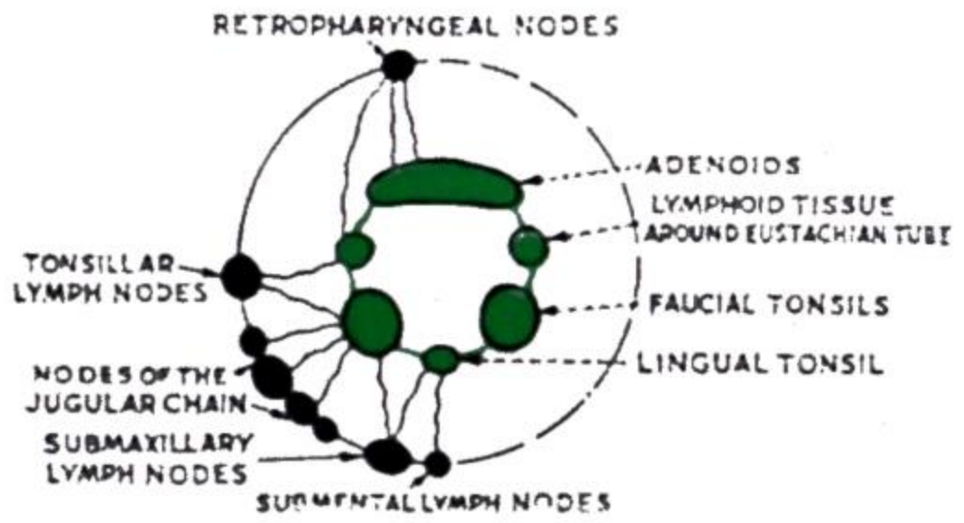

FIG. 365.—Waldeyer's rings. Inner ring—first barrier to infection; outer ring—second barrier.

The tonsil has an exceptionally good blood supply (fig. 366). It is well to bear in mind the vulnerable but infrequent anomaly of the internal carotid artery forming a complete circular coil (fig. 366, inset), but it is reassuring for those who enucleate tonsils with a guillotine to know that they drag the tonsil away from this dangerous zone (Brown Kelly).

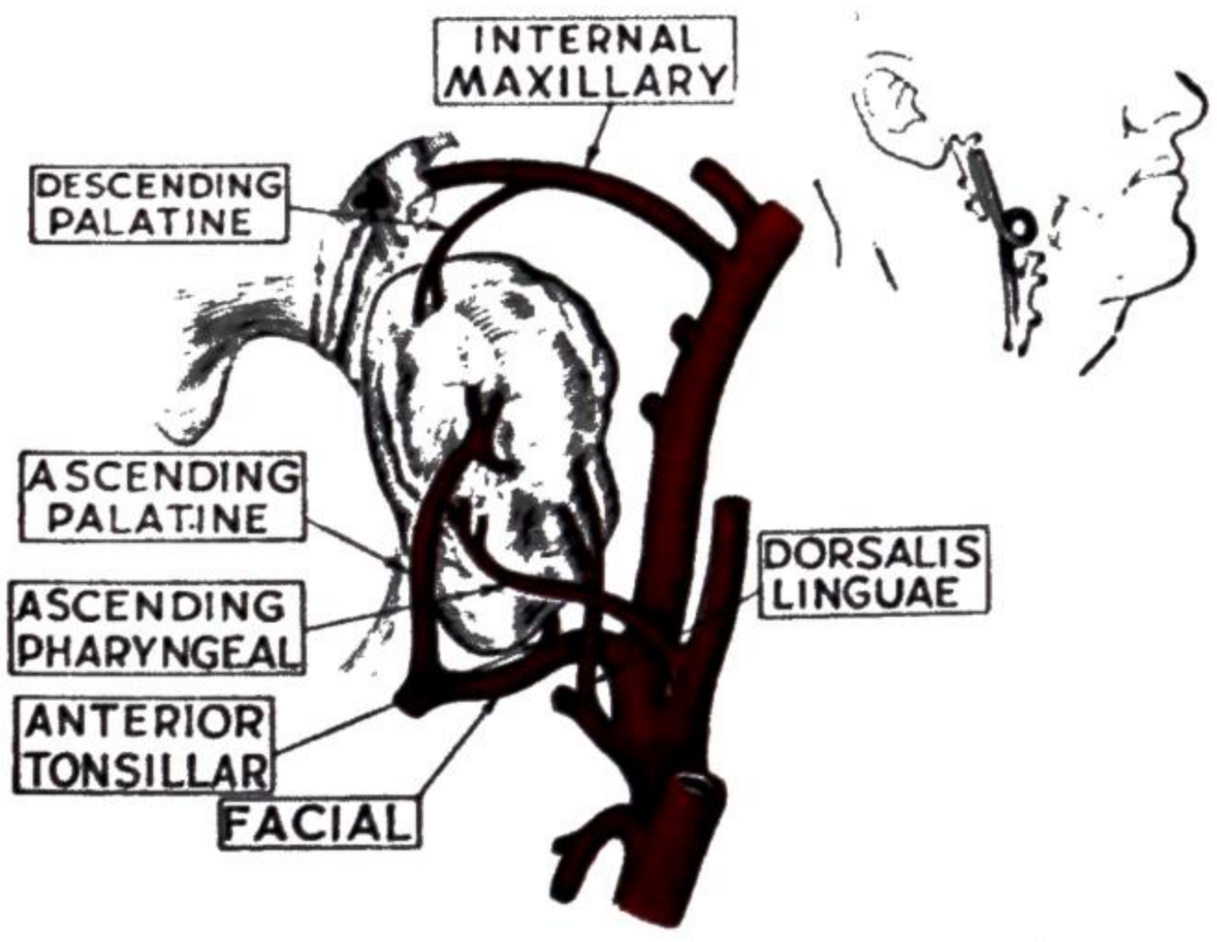

FIG. 366.—The arterial supply of the tonsil. (*After R. H. Fowler.*) (Inset) Internal carotid artery forming a complete circular coil. (*After A. Brown Kelly.*)

ENLARGEMENT OF THE TONSILS AND ADENOIDS

Enlarged tonsils are not necessarily infected; a certain amount of hypertrophy is common in early childhood. As adult life approaches, the tonsils, together with other lymphoid tissues, tend to atrophy. Excessive hypertrophy is often bilateral. Occasionally, the tonsils are so large that they almost meet in the middle line.

Wilhelm von Waldeyer, 1836–1921. Professor of Pathology, Berlin.
Adam Brown Kelly, 1866–1941. Surgeon to Ear, Nose, and Throat Department, Victoria Infirmary, Glasgow.