Chapter 35

The Larynx

Foreign Body in the Larynx

Impaction of foreign bodies is more likely to occur in children than in adults. Cardiac arrest and death may occur.

Treatment.- If the foreign body cannot be dislodged by hooking it out with a finger, or by inverting the child and slapping its back, immediate tracheostomy is necessary in urgent cases with obstructive symptoms. In less urgent cases radiography is useful when the foreign body is radio-opaque. By the aid of direct laryngoscopy the object can be seized and removed.

Acute Oedema of the Glottis (Epiglottis)

Pathology.- Strictly speaking, the oedema is not of the glottis (the chink between the vocal cords) but of the aryepiglottic folds and the epiglottis, but this ancient and inaccurate term is difficult to displace.

Aetiology.- 1. Extension of acute inflammation, especially acute streptococcal and haemophilus influenza laryngitis or tonsillitis, diphtheria, acute parenchymatous glossitis, and Ludwig's angina. (Wilhelm von Ludwig, 1790-1865. Professor of Surgery and Midwifery, University of Tübingen, Germany.)

2. Angioneurotic oedema.

3. Irradiation either with or without perichondritis.

4. Trauma (*eg*, car accidents).

5. Indirect irritants such as corrosives, scalds or noxious gases.

6. Extension of an adjacent carcinoma.

7. Local dropsy (renal or heart failure).

The patient's voice is reduced to a hoarse whisper and some dysphagia may be present. Increasing dyspnoea occurs and frequently the oedema is sufficient to cause urgent stridor. If laryngoscopic examination is possible, the entrance to the larynx can be seen resembling the appearance of the cervix uteri.

Treatment.- Inhalation of steam and spraying with a dilute solution of adrenaline afford relief in early and mild cases. Systemic antihistamines (*eg,* Phenergan) or cortisone are valuable. (In cases of laryngeal obstruction, never give morphine. A patient under the influence of morphine stops fighting for breath, seems peaceful, and not infrequently the nurse returns to find him dead (Chevalier Jackson).) When dyspnoea is urgent, intubation or tracheostomy must be performed forthwith. (Chevalier L Jackson, 1900-1961. Professor of

Laryngology and Broncho-Oesophagoscopy, Temple University, Philadelphia, Pennsylvania, USA.)

Tracheostomy

The indications are as follows:

(a) **To relieve obstruction of the upper air passages due to:**

1. Impaction of a foreign body.

2. Acute infections such as: acute laryngo-tracheo-bronchitis of children, acute epiglottis of influenza or virus origin. Laryngeal diphtheria.

3. Oedema of the glottis.

4. Bilateral abductor paralysis of the vocal cords following injury to the recurrent laryngeal nerves during thyroidectomy.

5. Tumours, particularly carcinoma of the larynx.

6. Chronic stenosis following tuberculosis or scalding.

7. Congenital webs or atresias.

8. Cut throat.

(b) **To improve respiratory function,** by reducing the anatomical dead space, and also enabling effective aspiration of bronchial secretions to be done in:

1. Fulminating bronchopneumonia.

2. Chronic bronchitis with severe emphysema.

3. Chest injuries, particularly 'flail' chest.

(c) **Respiratory Paralysis.-** It allows assisted or positive pressure respiration to be performed. Also secretions or inhaled foreign material (*eg,* vomitus) can be aspirated. Causes:

1. Unconsciousness associated with head or facio-maxillary injuries.

2. Coma from other causes persisting for more than a few hours where there is difficulty in maintaining a free airway, *eg,* barbiturate poisoning.

3. Bulbar type of poliomyelitis.

4. Tetanus. Many of these patients are, of necessity, heavily sedated, have trismus, and are in mortal danger because of inability to expectorate.

(d) **As a preliminary to certain operations on the upper airway.**

In cases of dire emergency the operation has been performed successfully with nothing available except a penknife. If at all possible, intubation even with a small intratracheal tube, should be attempted. If successful, a general anaesthetic can be administered and a hurried procedure transformed into a deliberate, calm operation. Intubation brings the abnormally low intrapleural tension to normal and prevents the occurrence of surgical emphysema and possibly pneumothorax, especially in children (see Mediastinal emphysema). Insertion of an intratracheal tube also permits aspiration of secretions which have accumulated below the laryngeal obstruction. Intubation will also prevent spasm of the glottis.

Operation.- If a skilled anaesthetist is unavailable, local anaesthesia is employed, but in desperate cases none is required. The patient may be pinned in a blanket so that a sudden movement of the arms may not embarrass the surgeon. When preparations are complete, a rolled towel or a small sandbag is inserted beneath the shoulders, and an assistant keeps the head extended strictly in the midline.

The surgeon, standing at the right side of the patient, places his left index finger on the upper border of the cricoid cartilage, with the thumb and the second finger on either side of the trachea, and makes an incision vertically downwards for 2.5 to 3.75 cm, dividing skin, fascia, platysma, pretracheal fascia, and passing between the infrahyoid muscles. (When circumstances permit, a horizontal skin incision midway between the cricoid the suprasternal notch should be used, as subsequent healing is far more satisfactory.) If seen, the isthmus of the thyroid gland is divided between haemostasis. In an emergency, haemorrhage is ignored. A cricoid hook is then inserted under the cricoid cartilage and grasped into the left hand. The hook steadies the trachea and brings it to the surface of the wound. The trachea is incised with a scalpel, the second, third, and often the fourth rings being divided: the lower the tracheostomy, the less will be the liability to laryngeal stenosis. A tracheal dilator is inserted through the tracheostoma, the cricoid hook removed, and the edges of the tracheal wound are separated gently. In the case of diphtheria the surgeon places a swab over the wound so that the violent expiratory efforts which follow do not spray membrane, infected mucus, and blood over himself and his assistants. When respiratory efforts have become less violent, a tracheostomy tube on a pilot is inserted into the trachea, the dilator is removed, and the surgeon keeps his finger on the tube while the assistant ties the attached tapes around the patient's neck. The inner tube is then fixed in position, and one or two nylon or silk stitches are introduced if necessary. The inner tube is longer than the outer tube, so that the latter cannot remain obstructed when the inner tube is removed for cleaning. To carry out suction effectively, the inner tube must be of such a diameter that it will not be occluded by the passage of a No 3 or 4 rubber catheter.

In the case of a less urgent tracheostomy all bleeding is stopped before the trachea is opened. The injection of a few drops of 2% Xylocaine before the trachea is incised prevents the bout of coughing that follows the insertion of the tube. When the operation is performed on an adolescent or an adult, the isthmus of the thyroid gland is divided. The tracheostomy opening should be circular in shape (not just a vertical slit), by excising the edges of the incision with a scalpel strong enough to cut cartilage. A circular stoma facilitates the introduction and later changing of the tracheostomy tube, and heals well after eventual removal of the tube.

If a patient is unable to breathe unaided, an *inflatable rubber or polyethylene cuff tube* is introduced through the tracheostomy opening in order to seal off the air passage. The airway must be kept clear by frequent aspiration, assisted by postural drainage.

After-treatment.- Beside the bed is placed a trolley containing a tracheal dilator, duplicate cannulae and introducer, retractors, and dressings. Oxygen is at hand. For the first few days a special nurse must be in constant attendance. A mechanical humidifier is essential in order to render the secretion less viscid. A sucker with a catheter attached should be at hand to keep the tracheo-bronchial tree free from secretions. The catheter must be kept sterile on a special tray covered by a sterile towel. The introduction of the catheter must be carried out under aseptic precautions by all concerned (nurses and physiotherapists). Unless these precautions are observed, secondary broncho-pneumonial infection is inevitable. When mucus is very tenacious, and consequently difficult to aspirate, isotonic saline or a detergent such as Alevaire (Bayer Products Ltd) is administered through the tracheostomy by a fine nebuliser.

The inner tube is removed and washed in sodium bicarbonate solution every four hours, more if necessary. Before removal the patient should be able to sleep with the tube occluded.

Complications:

1. *Crusting in the trachea* or main bronchi can seriously embarrass the airway; it can be cleaned by the aid of a bronchoscope passed through the tracheostoma.

2. *Surgical emphysema* in the neck is a complication and may occur if the skin is too tightly sutured around the tube, or if the tube slips into the tissues of the neck.

3. *Mediastinal Emphysema.*- The cause is an abnormally low intrapleural tension - air is sucked into the tissue planes during the operation before the trachea is opened, causing subsequent dyspnoea and cyanosis. In severe examples the air in the mediastinum causes the mediastinal pleura to rupture, and a pneumothorax results. The diagnosis can be confirmed by radiography. Apart from oxygen therapy in high concentration, there is no specific treatment. The extravasated air is slowly absorbed.

4. *Tracheal Stenosis* is described later.

Endotracheal catheterisation is a substitute for tracheostomy (mainly cases in group (c) **Respiratory Paralysis.-),** but is usually less desirable, for two reasons:

(a) Repeated bronchial tree toilet is performed more easily by a nurse through a tracheostomy. (b) Intubation granuloma of the vocal cords and subsequent stricture may occur.

Laryngeal Paralysis

The muscles of the larynx are innervated by the recurrent laryngeal nerves, with the exception of the crico-thyroid muscle which is supplied by the superior laryngeal nerve. Lesions of the recurrent laryngeal nerve cause the vocal cord on the affected side to lie in the

paramedial position: this is due to the unopposed tensing and adducting action of the crico-thyroid. Lesions of the vagus nerve above the origin of the superior laryngeal nerve will cause complete vocal cord paralysis on the affected side. The cord will be flaccid and lie midway between abduction and adduction, which is the state and position of the vocal cords soon after death.

Aetiology.- The lesion may be central, cervical, or mediastinal. Of over-riding importance is the relation of a goitre, and especially of thyroidectomy, to recurrent laryngeal paralysis. Routine laryngoscopic examination must be made before thyroidectomy, as 3 to 5% of patients are found to have paresis or paralysis of one vocal cord, possibly due to neuritis following exanthemata during childhood, although no symptoms point to such a lesion. Pre-operative laryngoscopy is especially necessary when operating on a case of recurrent goitre. If pre-operative paralysis of a vocal cord is found, this fact *must* be recorded in the patient's notes in order to protect the surgeon from possible litigation. Pre-operative paralysis of a vocal cord with symptoms, *eg,* a recent husky voice, is highly suggestive that the goitre is carcinomatous. Other causes of recurrent laryngeal paralysis are a central lesion (*eg,* tabes), carcinoma of the upper oesophagus, carcinoma of the bronchus, malignant disease of the mediastinal lymph nodes, aneurysm of the arch of the aorta (always left-sided), and peripheral neuritis. Thirty per cent of cases are idiopathic.

Clinical Features.- Unilateral recurrent laryngeal palsy of sudden onset produces a whispering voice and occasionally some slight difficulty in swallowing fluids, due to paralysis of the crico-pharyngeus on the affected side. These symptoms are short-lived and the voice may return to normal within a few weeks as the muscles in the opposite cord compensate and move it across the midline to meet the paralysed cord. Owing to this efficient compensation, in slowly progressive lesions, the patient may only experience slight weakness of the voice towards the end of the day.

Bilateral recurrent laryngeal nerve palsy is an occasional and very serious complication of thyroidectomy. Acute dyspnoea occurs due to the paramedian position of the cords which tend to get sucked together on inspiration. Unless tracheostomy or intubation is carried out forthwith, death from asphyxia is probable.

Unilateral complete laryngeal paralysis causes a hoarse voice in which compensation does not readily occur owing to the flaccid state of the vocal cord and its lateral position. The healthy vocal cord has difficulty in meeting it.

Bilateral complete laryngeal palsy is an uncommon condition which occurs in lesions of the brain stem. It is usually associated with other cranial nerve lesions.

Treatment.- Tracheostomy should be performed in all cases of bilateral lesions, even when the paralysis is flaccid, for it is far better to provide the patient with a free airway than to permit him to suffer from chronic dyspnoea and its attendant evils, chief of which is the risk of asphyxia. The use of a tracheostomy tube with a speaking valve allows the patient to speak: the delicate valve opens on inspiration and closes on expiration. The expired air passes through the vocal cords so that the patient has an audible voice. With an ordinary tracheostomy tube the inspired and expired air by-passes the larynx and the patient's voice amounts only to whisper. In cases following thyroidectomy where the patient is otherwise in

good health, the next step is to wait up to a year in the hope that one or both of the nerves will recover, otherwise arytenoidectomy either by endoscopic laser resection or by an external approach may be considered. It gives permanent relief of stridor at the expense of a good voice.

Simple Swellings of the Larynx

1. Vocal Cord Polypus.- This is the most common of the simple swellings in the larynx and must be distinguished from true benign neoplasms. It originates in the subepithelial space within the vocal cord. Initial congestion is followed by localised areas of oedema and hyalinisation; a soft, pearly grey often pedunculated mass is formed. It is easily removed endoscopically with cupped forceps or by laser.

2. Intubation granuloma may arise as a rare complication following the use of endotracheal anaesthetic tubes.

3. Laryngocele.- A laryngocele is a unilateral (occasionally bilateral) narrow-necked, air-containing diverticulum resulting from a herniation of laryngeal mucosa. It originates in the laryngeal sacculus, situated in the anterior third of the laryngeal ventricle, and ascending between the false cords and the ala of the thyroid cartilage, and it herniates through the thyrohyoid membrane, and when distended forms a visible, often resonant, swelling in the neck. (Cervical air-pouches are present in many mammals, and can be inflated voluntarily; they are exceptionally well developed in South American monkeys that utilise them for howling (howling pouches). The condition, therefore, can be looked upon as partly atavistic but mainly acquired, for it occurs in professional trumpet-players, glass-blowers, and in persons with chronic cough.)

The symptoms, due to a recrudescence of infection, come in attacks when the swelling, which often appears when the patient blows his nose, does not abate completely for hours or days; the explanation being that the neck of the sac becomes obstructed by mucopus. The attack often terminates with a gurgling noise and discharge of mucus into the pharynx. The sac should be excised and the neck, which is crushed, ligated, and divided, is invaginated like the stump of a vermiform appendix.

Tumours of the Larynx

Benign.- Papilloma is the commonest benign tumour of the larynx.

In an adult a papilloma is usually single, and its pedicle is attached to one of the true or false vocal cords. The symptoms to which it gives rise are similar to those of carcinoma of the larynx, from which it must be distinguished. The diagnosis is made by laryngoscopic examination. Rarely, a papilloma becomes malignant; therefore the papilloma should be removed and submitted to microscopical examination.

In a child the growth is relatively common: it is usually more vascular and softer than a papilloma appearing during adult life. Moreover, implantation growths soon appear in the vicinity and may obstruct the glottis. There is a marked tendency to recurrence after removal, and the papillomas may spread to almost any site in the larynx, pharynx, or trachea.

Treatment.- Chevalier Jackson's warning was not to be too radical in the treatment of multiple papillomas for fear of damaging the vocal cords. 'Laryngeal papilloma', he said, 'is a self-limiting disease and disappears spontaneously in early adult life provided the patient can be carried through until that time'.

Endoscopic removal with cupped forceps is the usual method of treatment but if a laser is available the long-term results are better.

Micro-surgery of the Larynx.- This is a technique whereby the vocal cords can be inspected under magnification and benign lesions more carefully and accurately removed (Kleinsasser). The operating microscope is used with a special laryngoscope which is inserted and fixed to a clamp for stability. Healing of the cords and the post-operative voice are generally much better than after ordinary laryngoscopy. (Oskar Kleinsasser, Contemporary. Associate Professor, Ear, Nose and Throat Clinic, Cologne, Germany.)

Angiofibroma is always single, and is distinguished from a papilloma by its smooth contour. Except that occasionally it gives rise to haemoptysis, it resembles a papilloma in symptomatology. In appropriate cases the condition must be distinguished from *singer's nodules*, which are nearly always bilateral. The latter condition, which produces a pearly-white nodule on the free edge of the vocal cord, is not a neoplasm, but an epithelial hypertrophy, and should, if possible, always be treated by prolonged voice rest (which is sometimes successful) before resorting to operation. On the other hand, an angiofibroma should be removed endoscopically with cupped forceps or cryosurgery. Great precision is necessary, because if normal tissue is removed the speaking voice will be impaired and the singing voice ruined.

Malignant.- Squamous-cell carcinoma is more common than an innocent tumour of the larynx. It usually occurs between forty and sixty years of age, and men are ten times more often attacked than women. Smoking is by far the most important aetiological factor.

There are three varieties of laryngeal carcinoma:

1. *Glottic* (70% of growth), arising from the true vocal cord, which is relatively common and the most favourable type.

2. *Subglottic* (10%), below the vocal cords, with a worse prognosis.

3. *Supraglottic* (20%), originating from the ventricular bands (false vocal cords), laryngeal ventricles or the root of the epiglottis. This group has the worst prognosis.

1. Carcinoma of a vocal cord (glottic) usually arises from the anterior half of one of the true vocal cords. Most frequently it is of the papillary variety, occasionally it is flattened, rarely it is ulcerative. Due to the paucity or absence of lymphatic vessels of the vocal cords, this type of carcinoma of the larynx remains locally malignant for a long period.

The first symptom is huskiness of the voice. The huskiness is progressive, and the patient can speak only in a low whisper, which finally gives place to aphonia. About this time

the growth breaks through its confines, and metastases occur in the cervical lymph nodes and elsewhere.

The diagnosis is made by laryngoscopy examination and biopsy, and every patient with hoarseness persisting for more than three weeks should be submitted to this form of examination. According to the length of time the growth has been present, *four stages* of the disease are recognised:

i. The growth is confined to a *still mobile* vocal cord,

ii. Infiltration impairing mobility of the cord. Extension to other cord.

iii. Fixation of the cord. The growth has entered adjoining part of the larynx. Isolated involved lymph nodes.

iv. Extension to the pharynx or skin. Lymph node metastases with fixation.

2. Subglottic carcinoma is a less common variety that occurs beneath the vocal cords. In this site the neoplasm grows steadily and silently, until dyspnoea develops. The paratracheal and lower deep cervical nodes, and even the thyroid gland may be involved.

3. Supraglottic Carcinoma.- The initial symptom is often a sense of discomfort in the larynx. Pain and hoarseness come relatively late. In 60% of cases there is cervical lymph node involvement at the time of presentation.

Tomograms are very helpful to determine the extent of the growth.

Treatment.- Supraglottic tumours metastasise early into the cervical lymph nodes, whereas tumours of the true vocal cords remain locally malignant for many months. For early (stage 1 and 2) carcinoma of the true vocal cord, the results of irradiation are as good as those of surgery and the voice is better. Therefore, where adequate facilities exist, irradiation (supra voltage x-ray therapy, or telecobalt) is preferable to surgery. Although in the stage 1 growths there is an 80% five years' survival rate, every effort should be made to have a careful follow up. If recurrence occur, or where the cervical lymph nodes are involved by metastatic deposits of squamous-celled carcinoma, laryngectomy, with block dissection of the lymph nodes in continuity, gives results superior to irradiation.

Laryngo-fissure and Excision of the Growth.- The vocal cord must be still mobile. After preliminary tracheostomy, the thyroid cartilage is bisected and the whole vocal cord is removed. The tracheostomy tube is removed after a few days. As the vocal cord becomes replaced by fibrous tissue, the patient tends to have a gruff voice.

Total laryngectomy is performed for carcinoma of the vocal cord which is already *fixed* by infiltration, when radiotherapy fails to destroy the growth or where the growth recurs after radiotherapy.

Anaesthesia.- General anaesthesia is given through an endotracheal tube inserted via the nose. This is changed by the surgeon during the later stages of the operation after delivery of the larynx.

Incision.- A variety of incisions is used. This may be modified if a block dissection is necessary.

Dissection.- The laryngeal cartilages and trachea are exposed by division of the thyroid isthmus. The strap muscles are divided and the inferior constrictor is carefully dissected off the thyroid cartilage. The hyoid is freed. The pharynx is opened by incisions above the hyoid bone. After changing the anaesthetic tube, the hyoid is drawn forward and the mucous membrane incised down each pyriform fossa, to meet along the back of the arytenoids. A nasal feeding tube is passed into the oesophagus and the defect in the pharynx is closed by interrupted sutures, and reinforced by suturing the inferior constrictors together anteriorly.

The trachea is divided between the second and third rings. A laryngectomy stoma is fashioned by suturing the trachea to the cut edges of the wound in the suprasternal notch.

For supraglottic carcinoma, subglottic tumours, and in cases where cervical lymph nodes are obviously the sites of secondary deposits, block dissection of the lymph nodes must be combined with the laryngectomy. If the carcinoma extends into a lobe of the thyroid gland, this lobe is also removed.

Speech after laryngectomy. Prior to operation the patient should have already met and been assessed by a speech therapist so that as soon as the neck and pharynx have healed the therapist can commence teaching oesophageal voice. In many cases the patient becomes quite proficient in its use and should at least communicate to some extent. However, should the patient not acquire a reasonable competence, one of the following methods can be used to create communication:

1. *Surgical rehabilitation of the voice* is now possible by means of a valve placed in a small fistula which is formed between the upper part of the trachea near the tracheostome and the pharynx. During expiration the patient occludes the tracheostome with his thumb so that the column of air is diverted through the valve into the pharynx. as the column of air passes up the irregular contours of the pharynx it creates a primary vibration which is then modified by the tongue and lips to create a very credible and satisfactory voice. The shape of the valve prevents ingested material passing from the pharynx into the trachea.

2. *The use of an electrically operated vibrator sound* (so called artificial larynx) which is applied to the side of the neck creating a primary sound while the patient articulates to produce the words.