Chapter 11: Tumours of the larynx

P. E. Robin and Jan Olofsson

In their broadest sense the terms tumour, swelling or space-occupying lesion have a significance in the larynx beyond that in most other sites, not only because of the early prejudice of the airway, but also because of interference with function in some cases, even when the lesion is minuscule. It is for this latter reason that many lesions are identified which are tumours but not true neoplasms.

Pseudotumours

Cysts

Cysts of the larynx may be congenital or acquired. They may arise in the vocal cords (55%), ventricular bands (25%) or in the epiglottis (20%) (Kleinsasser, 1978). They may be lined by a squamous or columnar epithelium.

Congenital cysts

Congenital cysts are rare and are most often in the ventricular bands or aryepiglottic folds. They may be diagnosed in the neonatal period as a consequence of breathing difficulties directly after birth. They may originate from a sequestration of embryonic cells in the saccule or laryngeal ventricle or arise from the seromucinous glands.

Incision of the cysts may be sufficient or excision can be performed if possible. If the airway is secured the intubation tube may be removed, otherwise it has to be left in place to allow repeat laryngoscopies. However, if the clinical course is prolonged, a tracheostomy is necessary.

Retention cysts

Retention cysts of the larynx are squamous or columnar; both forms may originate from obstructed seromucinous salivary glands. The squamous variant is common on the lingual surface of the epiglottis, the valleculae and on the aryepiglottic folds. These cysts may reach a considerable size before being diagnosed by minor cysts are often incidental findings at a routine otolaryngological examination. If possible these cysts should be excised entirely.

Squamous cysts also present on the squamous-lined portion of the vocal cords. They are most common on the undersurface of the anterior part of the cords. Minor cysts on the vocal cords are filled with clear mucus. Larger cysts contain a yellowish, thick fluid, which sometimes includes cholesterol crystals.

The laryngoscopic appearance of vocal cord cysts and vocal cord polyps may be very similar and it is microscopic examination that reveals the true nature of the lesion. Larger cysts are easier to recognize with their yellow colour and location under a thin translucent epithelium.
The treatment consists of excision of minor vocal cord cysts and marsupialization of larger ones.

Cysts of the ventricular band or cavity may be misinterpreted as neoplasms - differential diagnosis which must be ruled out. Cysts are most common above the age of 60 years and are lined by columnar or sometimes oncocytic cells. Under light microscopy oncocyes are large cells with an abundant pale, dark, or 'colloid' cytoplasm which is more or less acidophilic, and a small dense darkly staining nucleus. Electron microscopic studies show that the cytoplasm of the oncocyes contains large numbers of tightly packed mitochondria accounting for the granular or homogeneous appearance of the cells (Hamperl, 1962). Histochemically the oncocyes are characterized by the abundance of oxidative enzymes (Balogh and Roth, 1965; Johns, Regezi and Batsakis, 1977). The oncocyes tend to appear with increasing frequency in ageing individuals and occasionally form the predominant component of cysts and tumours. Such oncocytic lesions have most commonly been reported in the parotid glands. In the larynx a variety of names such as oncocytic cysts, oncocytic papillary cystadenomata, oncocytic adenomatous hyperplasia, oxyphilic granular cell adenoma, oncocytoma, and oxyphilic adenoma, has been given to these lesions. Nohteri (1946) found oncocyes in eight out of 37 (22%) laryngeal autopsy specimens. De Santo, Devine and Weiland (1970) in an analysis of material at the Mayo Clinic over 20 years found that 11% (33% of the saccular and 4% of the ductal cysts) were lined with oncocyes or contained such cells.

Granulomata

Non-specific granulomata are nearly always caused by trauma. Postoperative granulomata may occur after laryngeal endoscopic procedures or partial laryngectomies. Sometimes a stitch is found in the granuloma. A microlaryngoscopy should be performed to rule out recurrence in patients treated for malignant disease. The more commonly used laser surgery sometimes shows a tendency to excessive granulomatous tissue formation during the healing period.

Intubation granulomata are often caused by long-term intubation with artificial respiration. The granulomata are caused by an ulceration of the mucosa overlying the vocal process. The duration of intubation, as well as the size and type of the tube, and the degree of relaxation of the patients, are all causative factors. Prolonged intubation in adults is frequently discussed in the literature. Most intubation granulomata are diagnosed within a few weeks after extubation. Hoarseness, irritation and sometimes pain may occur. A microlaryngoscopy and excision should be performed, however, recurrences may occur. Intubation ulcerations and granulomata are certainly more common than is realized, but most of these granulomata may be coughed up and the base heals spontaneously.

Contact ulcers and granulomata located over the vocal processes, and often on both sides, probably have a multifactorial aetiology and the patients should be considered from several different aspects. They are nearly exclusively seen in males over the age of 30 years (Kleinsasser, 1978; Öhman et al, 1983). Vocal abuse has been considered to be the most important aetiological factor as suggested by Jackson (1928), who first described this lesion. He recommended a treatment consisting of vocal rest for a long period of time and, in some cases, vocal rest combined with surgical excision (Jackson and Jackson, 19350. Peacher and
Holinger (1947) reported good results with voice therapy, which have been confirmed in many reports. Patients with contact ulcers or granulomata have a low-pitch pressed quality of voice as their most pronounced feature. They often have an irritation and pain localized to the larynx, cough frequently and need to clear the throat. Emotional stress is considered another aetiological factor (Peacher, 1961). Other factors, such as hiatus hernia and gastro-oesophageal reflux have been discussed (Cherry and Margulies, 1968; Goldberg, Noyek and Pritzler, 1978; Ward et al, 1980). In an oesophageal manometric study, 74% of the patients examined with contact ulcers or granulomata, were found to have oesophageal dysfunction as hiatus hernia, gastro-oesophageal reflux, dysmotility, etc. About 30% of the general population of the corresponding age have oesophageal dysfunction (Öhman et al, 1983). It is difficult to know whether oesophageal dysfunction is an aetiological or concomitant factor of contact granulomata. Ward et al (1980) reported good results with antireflux therapy. Biopsy should be performed to rule out cancer which rarely occurs at this site. No difference in healing could be seen when voice therapy combined with surgery was compared to voice therapy alone (Öhman et al, 1983). Excessive granulomata should be excised to facilitate voice therapy.

**Amyloidosis**

The pathogenesis of amyloidosis is unknown but it is characterized by extracellular deposits of a proteinaceous substance. The disease was first described by Rokitansky in 1842, and the term ‘amyloidosis’ was introduced by Virchow in 1851. Burow and Neumann reported the first patient with laryngeal amyloidosis in 1875. Many hundreds of cases of laryngeal amyloidosis have been reported since that time.

Amyloidosis can be either generalized - primary or secondary - or localized. The larynx is rarely involved in generalized primary amyloidosis. It is, however, the usual site for amyloidosis of the respiratory tract. However, the real nature of amyloidosis is still an enigma. Amyloidosis makes up 1% of all benign laryngeal 'tumours'. It is slightly more common in males than in females and usually occurs between the ages of 40 and 60 years (Stark and New, 1949; McAlpine and Fuller, 1964). The sites of occurrence are, in descending order of frequency, the false vocal cords, aryepiglottic folds and the subglottis (Leroux-Robert, 1962; d’Arcy, 1972), but Ryan, Pearson and Weiland (1977) cited the vocal cords as the prime site.

Amyloidosis within the larynx occurs in two forms: one tumour-like and the other displaying diffuse infiltration. The symptomatology will of course, depend on the site of involvement. Hoarseness will occur if the vocal cords are involved, and increasing inspiratory problems are typical of subglottic deposits; patients with supraglottic amyloidosis have uncharacteristic and more diffuse symptoms.

**Histopathology**

Congo red is the most commonly used staining reaction for amyloid and gives a bright red colour. In polarizing light an apple-green birefringence is obtained. Low-angle X-ray diffraction is the third principal method, after light and electron microscopy, for identifying the amyloid substance (Kyle and Bayrd, 1975). The congo red reaction is sensitive, and false
positives and negatives are rare. However, Phorwhite BBU is more sensitive with even fewer false staining reactions (Waldrop, Puchtler and Valentine, 1973).

The following differential diagnoses have to be ruled out: hyalinized myxomatous polyps, benign and malignant tumours beneath an intact overlying mucosa, retention cysts and laryngocoele. Plasmacytoma with amyloid deposits is another differential diagnosis.

**Treatment**

The treatment for laryngeal amyloidosis is surgery, which can be performed microlaryngoscopically. Localized lesions may be removed entirely. In diffuse submucosal deposits repeated excisions may be necessary to restore the airway and to preserve the voice. Extra care should be taken when removing amyloid tissue at the level of the cricoid ring to avoid subglottic stenosis. A laryngofissure approach may be indicated for extensive lesions. The use of the carbon dioxide laser should not be overlooked. In amyloidosis of immunoglobulin origin the use of immunosuppressive or cytostatic agents has been suggested (Jones et al, 1972).

**Benign mesodermal tumours**

**Vascular neoplasms**

Vascular neoplasms arise from blood or lymphatic vessels. The tumours arising solely from lymph vessels are extremely rare within the larynx. Combined lymphangioma and haemangioma may be present. The blood vessel neoplasms may be benign (haemangioma) or malignant (haemangiosarcoma). In addition haemangiopericytoma and Kaposi's sarcoma also occur.

**Haemangioma**

Haemangioma are rare in adults. Vascular but non-neoplastic lesions occur such as the 'telangiectatic' vocal cord polyp, which is filled with thin-walled blood vessels. Some of these vessels may be filled with old or recently formed thrombi. Around such polyps older submucous haemorrhage may be seen at microlaryngoscopy.

Another differential diagnosis is the pyogenic granuloma, often located on the posterior part of the vocal cord and related to a previous intubation.

**Infantile haemangioma**

These are discussed in Volume 6, Chapter 26.

**Chondromata**

Since 1816, when a cartilaginous tumour of the larynx was first described by Travers (van de Catsijne, 1965), more than 200 such tumours have been reported in the literature and approximately 20% of these have been chondrosarcoma (Fombeur et al, 1974; Zismor, Noyek and Lewis, 1975). These tumours tend to occur between the ages of 40 and 70 years
and are more frequent in males than in females, with a ratio of four to one. Most of the
tumours originate in the cricoid cartilage (70%) and most often from the posterior cricoid
plate (van de Catsijne, 1965; Barsocchini and McCoy, 1968).

Symptomatology

The symptomatology of laryngeal cartilaginous tumours is generally non-specific, with
hoarseness and dyspnoea as prominent features, their degree depending on the site and size
of the tumour. Tumours arising from the cricoid cartilage often extend into the subglottic
space and thereby cause progressive inspiratory stridor. Hoarseness may occur if the vocal
cord mobility is impaired. Extension of the tumour posteriorly into the hypopharynx may
result in dysphagia. A swelling may be noted externally if the tumour is located in the cricoid
ring or in the thyroid cartilage.

Clinical findings

Indirect laryngoscopy usually reveals a smooth mass covered by an intact overlying
mucosa. While radiological examination may disclose peripheral or central calcific stippling,
coarse irregular calcification is the rule. This feature is considered to be pathognomonic of
cartilaginous tumours and is found in about 75% (Zismor, Noyek and Lewis, 1975). Because
the tumour may be so hard and difficult to penetrate, biopsy specimens may be
unrepresentative often consisting of the overlying mucosa only.

Histopathology

The histopathological evaluation of cartilaginous tumours often presents considerable
difficulties as regards both classification and grading of malignancy. A difficulty in
distinguishing between chondroma and highly differentiated chondrosarcoma lies in the fact
that pronounced cellularity and polymorphism often occur only in small foci (Lichtenstein,
1965). DNA measurements may assist in a correct diagnosis (Kreicbergs, 1981) but are not
available in all laboratories.

Treatment

Surgery is the treatment of choice, radiotherapy being of little value (van de Catsijne,
1965; Ackerman and del Regato, 1970). The operation of choice has generated much
discussion (Goethals, Dahlin and Devine, 1963; Al-Saleem et al, 1970; Hyams and Rabuzzi,
1970; Lawson, Bryce and Briant, 1972). Conservative surgery, whenever possible, has been
recommended for both chondromata and chondrosarcomata on account of the slow growth rate
of these tumours and the low incidence of metastases of the latter.

Myogenic tumours

Leiomyomata

Leiomyomata comprise three different types - common, vascular and 'bizzare'. The
latter had not been described in the larynx (Kleinsasser and Glanz, 1979). The leiomyoma is
one of the most common benign tumours in the human being.
Leiomyomata have been reported in children but they occur more often in adults of all ages. They seem to be most common in the supraglottic region, have been of pea to pigeon-egg size and have been removed endoscopically or by an external approach.

**Rhabdomyomata**

Rhabdomyomata of the true adult type are extremely rare tumours of the human body. Kleinsasser and Glanz (1979) found only eight descriptions of confirmed cases of rhabdomyomata in the larynx and added one of their own. Most rhabdomyomata in the larynx originate in the vocal cord region and appear as a polypoid mass but may extend above and below the cords.

Microscopic examination shows a tumour composed of round to oval cells with a pale, faintly granular cytoplasm. There are many large vacuoles in the cytoplasm and mainly placed in the periphery. The nuclei are round to oval and vesicular with prominent nucleoli, also located in the periphery. Cross-striations are usually visible in some cells with ordinary haematoxylin-eosin staining, but are accentuated by phosphotungstic acid-haematoxylin (PTAH) staining. Electron microscopic examination may be useful especially in uncertain cases. The differential diagnosis is primarily granular cell tumour.

Fetal rhabdomyoma is extremely rare in the larynx. The precise nature of this tumour is unknown. The lesion may be a hamartoma and not a true neoplasm. It usually presents shortly after birth but may occur in adults and present as a vocal cord polyp (Michaels, 1984).

The treatment for these lesions is surgery and endoscopic measures may be sufficient.

**Granular cell tumours**

In the past, benign granular cell tumours have been considered to be of mesenchymal origin. Abrikossoff (1926) suspected a myogenic origin and suggested the term 'myoblastic myoma'. The exact histogenesis of this tumour, however, still remains uncertain. A Schwann cell origin has been suggested (Azzopardi, 1956). Ackerman and Rosai (1974) concluded that the multiplicity of current aetiological data suggests that a granular cell tumour is the consequence of degradation and that it is not a specific neoplastic entity.

The most common location for granular cell tumours of the larynx is the true vocal cords and they may be managed endoscopically.

**Fibromata**

Fibromata are composed of fibrillar connective tissue. In the large series of benign laryngeal tumours presented by New and Erich (1938) only six of their 722 tumours were fibromata. Eight of the miscellaneous tumours listed in *Table 11.1* are fibromata (Shaw, 1979). The appearance may vary. New and Erich (1938) described them as soft and pedunculated and Shaw (1979) as round, firm, smooth and sessile.

The treatment is endoscopic removal in most cases.
Table 11.1 Benign tumours of the larynx seen at the Institute of Laryngology and Otology, London, 1948-1969 (Shaw, 1979)

<table>
<thead>
<tr>
<th>Non-neoplastic</th>
<th>Neoplastic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocal cord polyps</td>
<td>Papilloma*</td>
</tr>
<tr>
<td>Retention cysts</td>
<td>Adenoma</td>
</tr>
<tr>
<td>Tuberculous granuloma</td>
<td>Chondroma</td>
</tr>
<tr>
<td>Intubation granuloma</td>
<td>Miscellaneous</td>
</tr>
<tr>
<td>Contact ulcer granuloma</td>
<td>(includes fibroma, haemangioma,</td>
</tr>
<tr>
<td>Amyloid deposit</td>
<td>lipoma, and neurofibroma)</td>
</tr>
<tr>
<td>Wegener's granuloma</td>
<td>1122</td>
</tr>
<tr>
<td>Granular cell myoblastoma</td>
<td>44</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td>1300 (86%)</td>
</tr>
<tr>
<td></td>
<td>205 (14%)</td>
</tr>
</tbody>
</table>

* Approximately 25% were multiple juvenile papillomata.

Lipomata

Neoplasms may arise from the adipose tissue present, especially in the false cords. Many of the reported lipomata arose in the hypopharynx and extended into the larynx (Michaels, 1984).

Macroscopically, lipomata are light-coloured, encapsulated and lobulated tumours. Microscopically they are composed of fat cells of varying size and a fibroreticular stroma.

The treatment is endoscopic removal or by an external approach depending on the size and location.

Benign ectodermal tumours

Adenomata

Benign tumours arising from the seromucinous glands of the larynx are rare. The statistics given by Friedman (1975) from the Institute of Laryngology and Otology, London reported 16 cases seen during a 21-year period (see Table 11.1). Sabri and Hajjar (1967) reported on 37 neoplasms of the larynx of which 19 were mixed tumours. Most of these occurred in the subglottic larynx (Som et al, 1979).

Symptoms may be few until the tumour obstructs the breathing. The differential diagnoses should be limited to those lesions that are expansile masses with smooth overlying mucosa - a retention cyst, internal laryngocoele, angioma or adenoid cystic carcinoma.

The treatment is by surgery and the approach depends on the size and location of the adenoma within the larynx.
**Neurogenic tumour**

Along with the other benign tumours, neurilemmoma of the larynx is not common. New and Erich (1938), in their major review of 722 benign laryngeal tumours, reported one neurilemmoma. Holinger and Johnston (1951) reported one in a series of 1197 benign laryngeal tumours. Nanson (1978) found 87 reported in the literature.

Neurilemmoma is a benign tumour arising from the Schwann cells of the axon sheath. The term was coined by Stout (1935). It is usually a well-encapsulated, slowly growing tumour, the size of which can be fairly large. A neurilemmoma with a diameter of a few centimeters is obviously more serious in the larynx than growing subcutaneously. Symptoms develop insidiously but can be prominent if degeneration and haemorrhage occur into the tumour causing a life-threatening situation.

**Treatment**

Treatment is by surgery. Small tumours may be removed endoscopically, others via a laryngo-fissure procedure or a lateral laryngotomy, depending on the size and location of the neurilemmoma.

**Paragangliomata**

More than 30 paragangliomata of the larynx have been reported in the literature with an equal sex incidence and with a peak in the fifth decade of life (Olofsson et al, 1984). Most of these tumours arise from the supraglottic paraganglia and less frequently from the inferior ones. The location of the tumours means that they often do not give symptoms until they have reached an advanced stage. Haemoptysis may occur. Angiography can provide information about the vascularity of these tumours. Computerized tomography or magnetic resonance imaging, if available, are the best radiological methods to determine the extent of these tumours. Paragangliomata arising from the inferior paraganglia may present as thyroid tumours depending on the close relationship to the thyroid capsule. The diagnosis is made entirely on the microscopic examination. Strikingly few of the laryngeal paragangliomata have been diagnosed preoperatively, which to some extent may be the result of too superficial biopsies but also of the rarity of this entity.

**Histopathology**

Important criteria for making the diagnosis of paraganglioma include the typical ‘Zellballen’ pattern in light microscopy, which is best demonstrated by reticulin stain. The presence of argentophilic granules is revealed by Grimelius’ stain. Ultrastructural examination shows neurosecretory granules. The main differential diagnoses are haemangiopericytoma, carcinoid tumour, granular cell tumour, salivary gland tumours, haemangiomata and thyroid carcinomata, which may invade the larynx and trachea. A relatively high percentage of laryngeal paragangliomata show malignant behaviour with regional and distant metastases (Wetmore et al, 1981).
Treatment

The treatment for paragangliomata varies considerably because of the rarity of the tumour and the often incorrect diagnosis. Conservative surgery should be performed whenever possible.

Malignant tumours

Cancer of the larynx is a particularly important malignancy. In the UK it represents approximately 1% of all malignancies (Powell and Robin, 1983) in men, although somewhat less in women (Table 11.2). It has, in common, with many other head and neck cancers, a predominantly squamous pathology as well as early interference with both function and emotion. It shares with only a few other types of cancer (such as of the cervix, skin, lymphoma, perhaps colon) a high rate of cure which, in certain subsites, may reach over 85% (Table 11.3) and overall exceeds 50% (Powell and Robin, 1983). Carcinoma of the larynx, therefore, places upon the clinician a much greater responsibility than usual, for careful evaluation and treatment bring a probability of cure while, in common with a number of other head and neck neoplasms, failure may be followed by a relatively uncomfortable and unsavoury death. Even further demands are made at the present time, for not only the survival of the patient but the rehabilitation of speech is becoming of even greater importance than formerly. Thus the selection of treatment and types of surgery must be made with more insight than previously into the implication of the disease, its behaviour and response. Because of the disparity of the prognosis, not only between laryngeal tumours and those of neighbouring sites, but also of the various sites within the larynx, a greater than usual attention must be paid to the accurate assessment of each tumour, so that the appropriate management may be instituted.

Table 11.2 Incidence of malignancy of head and neck (from Powell and Robin, 1983, courtesy of Castle House Publications)

<table>
<thead>
<tr>
<th></th>
<th>Males (%)</th>
<th>Females (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin</td>
<td>8.2</td>
<td>7.0</td>
</tr>
<tr>
<td>Oral cavity</td>
<td>0.6</td>
<td>0.3</td>
</tr>
<tr>
<td>Oropharynx</td>
<td>0.4</td>
<td>0.1</td>
</tr>
<tr>
<td>Nasopharynx</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Hypopharynx</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>Nasal cavity and sinuses</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Larynx</td>
<td>1.3</td>
<td>0.2</td>
</tr>
<tr>
<td>Thyroid</td>
<td>0.2</td>
<td>0.6</td>
</tr>
<tr>
<td>Lymphoma</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Sarcoma</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>All head and neck</td>
<td>11.7</td>
<td>9.1</td>
</tr>
<tr>
<td>All sites: total number</td>
<td>9177</td>
<td>8585</td>
</tr>
</tbody>
</table>
Incidence

Carcinoma of the larynx is not common, nor is it rare. Incidence world-wide varies (Waterhouse et al, 1982), and a number of areas of relatively high (>10/100,000) incidence can be identified, for example Brazil (Sao Paulo), the black populations in parts of the USA, Honk Kong, India (Bombay, Poona), France (Bas Rhins, Doubs), Italy (Varesa), Poland (Katowice), Spain, and Switzerland (Geneva), while low incidence areas (<3/100,000) include Japan, Norway, Sweden, New Guinea, and Senegal (Dakar). The UK suffers from an intermediate to low incidence (4/100,000). Incidence, it must be remembered, is as reliable as the statistical infrastructure, and a number of less developed countries may suffer from underreporting. It is clear, nevertheless, that significant differences do occur between and within various countries. In Hawaii the Caucasians suffer an incidence (8.1/100,000), more than five times that of the Chinese (1.4), four times the Filipino (2.0) and nearly three times that of the Japanese (3.3), who live in the same place (these figures are for men, those for women are proportionately less). Where the urban population can be identified separately from the rural population the incidence is almost always higher in the former. Where racial groups can be identified, the respective incidence appears to follow that of the country of origin, for example in Hawaii the Japanese incidence is similar to that of the Japanese in Japan, the Caucasians to that in the USA. The racial characteristic extends between countries, for example the incidence in the Chinese in Shanghai and the USA generally is similar. Black populations in the USA have a higher incidence of carcinoma of the larynx than their Caucasian counterparts in the same area. One invariable characteristic of carcinoma of the larynx is its greater predominance in men, compared with women, 6:1 at its lowest in Canada (Mannitoba) and 32:1 at its maximum in Italy (Varesa). Indeed, it is in the higher incidence areas that the male/female disparity is greatest.

Table 11.3 Histological differentiation: 5-year survival, age-adjusted, males only 1957-1976

<table>
<thead>
<tr>
<th>Squamous carcinoma</th>
<th>Supraglottis Total 5-year survival (%)</th>
<th>Glottis Total 5-year survival (%)</th>
<th>Subglottis Total 5-year survival (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>In situ</td>
<td>3 0.0</td>
<td>89 88.5</td>
<td>2 59.2</td>
</tr>
<tr>
<td>Well differentiated</td>
<td>128 38.8</td>
<td>531 71.1</td>
<td>15 29.8</td>
</tr>
<tr>
<td>Moderately differentiated</td>
<td>120 33.8</td>
<td>215 67.2</td>
<td>17 13.6</td>
</tr>
<tr>
<td>Poorly differentiated</td>
<td>197 29.3</td>
<td>195 54.7</td>
<td>26 44.8</td>
</tr>
<tr>
<td>Not specified</td>
<td>99 37.4</td>
<td>276 71.4</td>
<td>11 72.3</td>
</tr>
<tr>
<td>Total number</td>
<td>547 33.8</td>
<td>1306 69.3</td>
<td>71 38.8</td>
</tr>
</tbody>
</table>

Source: Birmingham and West Midlands Regional Cancer Registry, 1986.

It is difficult to draw firm conclusions from observations of incidence beyond remarking that the social and racial differences probably reflect different habits, and in the case of cancer of the larynx along with those of the mouth and pharynx, tend to reflect the already recognized effects of tobacco and alcohol (Newhouse, Gregory and Shannon, 1980). Of interest is the relatively low rate of laryngeal cancer in the UK compared with the definitively high rates of (smoking-related) lung cancer. A small rise in incidence of laryngeal
cancer has been observed in England and Wales 1960-1968 and 1972-1978, a rise proportionately greater in females (McMichael, 1978; Muir, Nectoux and Stukonis, 1983) attributed to the rise in smoking during the 1939-1945 war. This rise is not apparent when only glottic tumours are considered. The already high and increasing levels of mortality from laryngeal cancer in France, Italy and Spain contrast with the rest of Europe, and examination of birth cohorts in France have led to the suggestion (Tuyns and Audigier, 1976) that alcohol plays a promoting role, particularly in the supraglottis.

**Presentation**

The incidence (as opposed to mortality) (Ramadn et al, 1982) of cancer of the larynx, in common with most head and neck cancers, increases with increasing age, but because of the reducing numbers of persons surviving as age progresses, the actual number of cases presenting for treatment falls with age. The peak age of presentation is therefore younger than that of maximum incidence (that of glottis in the UK being approximately 62 years). Supraglottic lesions present at an earlier age than those of the glottis. The trend of increasing incidence with age is not universal and does not apply, for example, in Spain (Zaragosa) (Waterhouse et al, 1982) and Finland (Taskinen, 1969) where the cancer is more often supraglottic. These observations suggest that there may be a significant difference in the aetiology and behaviour of these cancers compared with the glottic tumours which predominate in the UK.

**Classification**

Laryngeal lesions are diverse in their behaviour and prognosis and thus classification is particularly important. Attempts at classification were begun as long ago as 1876 (Isambert). Over a period of years (since 1954) the International Union against Cancer (UICC) has undertaken the task of establishing a classification of a number of cancers, the larynx being one of the first, and now agreement has been reached generally with the American Joint Committee (AJC) and other similar bodies (UICC, 1978) about what may become a definite classification, at least for a decade. The basis of the UICC classification is anatomical.

It is important to understand the purpose of classification. The original intention of classification was to enable different sources to standardize their material in order that numbers and extent of tumours could be compared. The various sites were selected because of both their anatomical ease of identification and also their behavioural homogeneity. The definitions of the original UICC proposals have changed slightly to achieve the original intent. There was never any primary intention to use the classification to promote any treatment, although clinicians have found it useful to use the UICC terminology for this purpose. Classification is fundamental in studies of epidemiology.

Tumours were originally designated 'intrinsic' and 'extrinsic' laryngeal tumours. The latter, and also the term 'laryngopharynx' have been discarded for they represent the present day hypopharynx (sometimes oropharynx). Even now there is some difficulty in definition, and the term 'marginal zone' has been selected to designate the area of difficulty. The TNM (UICC, 1978) classification of larynx (International Classification of Diseases for Oncology, 1977) is given in Appendix 11.1.
There is a lack of precise definition of the 'vocal cord'. Several interpretations are permissible: the free edge; the point where the vestibule meets the upper surface to a point or line 1 cm below; the free edge to 1 cm below; the free edge and the subglottis down to the upper border of the cricoid; that area of the cord beneath which lies Reinke's space, that is the upper surface and free edge of the membranous cord. The lack of definition of the cord may undermine the credibility of the TNM system, yet in practice the use of the last interpretation seems to create little real difficulty. This was the agreed definition at the Centennial Conference on Laryngeal Cancer in Toronto (1974).

Of all the sites of cancer the larynx not only has one of the more detailed and precise TNM classifications, but it is also one of the most well tried and useful. It is for this reason it justifies some degree of study.

**Staging**

Staging is the grouping together of (TNM) features which may share a level of prognosis or a certain treatment. Staging has not been utilized in this and subsequent discussion.

**Aetiology**

The cause of cancer of the larynx is not known. A number of possibly related factors (male predominance, some radial predilection, a greater incidence among urban dwellers) have been designated, and there is an indisputable relationship between tobacco and alcohol (US Surgeon General, 1979; Hinds, Thomas and O'Reilly, 1979). Radiation (Sakamoto, Sakamoto and Sugano, 1979), asbestos (Hinds, Thomas and O'Reilly, 1979), and a number of occupational factors have been cited (Elwood et al, 1984), but none can be regarded as conclusive in the manner of those causing, for instance, lung cancer. Laryngeal keratosis and leucoplakia (Hellquist, Olofsson and Gröntoft, 1981; Crissman, 1982) are related to carcinoma of the larynx, but metaplasia (although smoking-related) has not satisfied the criteria for designation as a clear aetiological factor (Auerbach, Hammond and Garfinkel, 1970). One of the highest alcohol-consuming populations in Europe - the French - also show the highest laryngeal carcinoma incidence in that continent. Contrary to common belief, the perceived consumption of spirits (Scotland, UK) does not have a similarly matching laryngeal cancer incidence (Waterhouse et al, 1982). There is almost invariably an associated social relationship between alcohol and tobacco, and thus a distinction between the two factors is difficult to make, and cohort studies in France (Tuyns and Audigier, 1976) seem to postulate a reduction of laryngeal cancer as a result of deprivation (during World War II) of both alcohol and tobacco (the opposite of the features of the apparent rise in incidence, particularly in women (UK), as a result of their increase in smoking and alcohol consumption during the same war period).

It is reasonable to accept that although no close and irrefutable aetiological factor can be designated, there are several often related environmental factors which are clearly associated with an increased incidence of cancer, that is tobacco, alcohol, environmental (urban) pollution, asbestos, therapeutic radiation (thyroid), as yet unidentified social and possibly genetic factors which affect racial groups, and certain uncommon occupational influences.
Symptoms of carcinoma

The symptoms of carcinoma of the larynx are not greatly different from those of any space-occupying lesion of the larynx, but certain features make a carcinoma more distinguishable.

Progressive and unremitting dysphonia. The feature of a malignant tumour is its relentless advance, although in the early stages, in particular, the dysphonia may be intermittent. A further consideration is the cancer which develops in one who suffers from chronic laryngitis, and these individuals are particularly at risk from delay in diagnosis.

Dyspnoea and stridor are more frequent, and as a sequel to neglected dysphonia, almost invariably indicate an advanced tumour. Subglottic carcinoma may present with these as the only symptoms.

Pain is a relatively uncommon and late symptom and more typical of supraglottic lesions. Pain referred to the ear is particularly sinister and should always promote a high suspicion of cancer.

Dysphagia is relatively rare but carries a worse prognosis because it almost invariably indicates invasion of the pharynx.

Swelling of the neck or larynx may reflect the direct penetration of a tumour outside the larynx and as such its origin, without other symptoms, may initially be difficult to distinguish conclusively. Secondary malignant deposits in the lymph nodes of the neck have few distinctive features other than their predominantly ipsilateral situation, usually in the upper/middle deep cervical chain. A prelaryngeal or tracheal lymph node must be distinguished from thyroid disease.

Cough and irritation of the throat may be early non-descript symptoms; haemoptysis is rare and is most often seen in a lesion of the (margin of the) epiglottis; while anorexia, cachexia or fetor are usually late symptoms.

Examination and diagnosis

Diagnosis will be made after consideration of

(1) history
(2) examination of the larynx
(3) examination of the neck
(4) general examination of the patient
(5) radiology
(6) clinical investigations
(7) histological examination.
History

The history follows from the symptoms already discussed. Of no small importance is the temporal factor, unfortunately not considered in the UICC classification. The rate of advance of a cancer is important in its progress and prognosis - thus a small lesion with a long history of symptoms suggests a slowly growing lesion, whereas a massive cancer with a short history inevitably has a correspondingly poor outlook. Cancer can coexist with or supervene in leucoplakia, chronic laryngitis, tuberculosis, etc, and the symptoms of cancer or of any of the other disorders are not necessarily distinguishable from each other.

Examination of the larynx

This is generally, initially, performed with a mirror (see Chapter 1). Any focal abnormality of the larynx can be a tumour, but typically a vocal cord lesion may appear as a warty enlargement on one cord, but variation from a nodule or thickening of a vocal cord through extensive hyperkeratotic sheets of epithelium to gross ulceration may be seen. In the supraglottis there is focal swelling, redness or ulceration, while a mass may be visible in the subglottis. The subglottis is often difficult to see, but a tumour may appear, most usually an asymmetrical swelling often masked by mucoid debris. A second difficult area may be the posterior surface of the epiglottis hidden by the backward curve of the tip. The laryngeal ventricle is a third area that it is difficult to assess, where the initial or only clue to the presence of cancer may a slight fullness. A feature associated with ulceration of these hidden areas can be pain, referred to the (ipsilateral) ear. It cannot be too strongly emphasized that any focal abnormality may prove to be malignant.

A most important feature to be assessed is the mobility of the larynx. Mobility of any moving part of the larynx can be impaired by invasion of the tumour into muscle layers and it carries a much more sinister prognosis. Mobility may occasionally be impaired by the sheer bulk of a large tumour, but as distinct from deeper invasion, this is uncommon and often uncertain. Subglottic lesions often limit vocal cord movement by invasion of either the muscles or the cricoarytenoid joint, and both indicate an advanced tumour.

Indirect laryngoscopy is satisfactory for most patients, and provides added information about mobility. However, flexible endoscope allow examination of almost every patient without anaesthesia which may prejudice the assessment of mobility. Furthermore, the subglottis can sometimes be examined.

Direct laryngoscopy is necessary for most patients for biopsy purposes; microlaryngoscopy is desirable in many.

Examination of the neck

This must be carried out carefully to identify the possible spread of tumour beyond the larynx either directly or by metastasis to the regional lymph nodes. The most frequent site of secondary deposits is the ipsilateral deep cervical chain, usually in the upper/middle region but confined to this area. Glottic tumours rarely metastasize (Table 11.4), while deposits in the lymph nodes are more frequent from subglottic and particularly supraglottic lesions. Nodes
invaded by subglottic lesions are often found in the upper mediastinum, an added reason for the relatively poor prognosis of these lesions. The frequency of ipsi-, and indeed, bilateral deposits derived from supraglottic cancer is also reflected in the prognosis. Occasionally deposits can be identified in the prelaryngeal nodes and, even more infrequently, beyond the cervical region. Examination must include an assessment of the number, mobility and level of the lymph nodes.

Table 11.4 Incidence of nodal metastases of carcinoma of larynx (males) 1957-1976

<table>
<thead>
<tr>
<th>Node status</th>
<th>Number with known node status</th>
<th>Node positive (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supraglottis</td>
<td>598</td>
<td>38.8</td>
</tr>
<tr>
<td>Glottis</td>
<td>1394</td>
<td>4.8</td>
</tr>
<tr>
<td>Subglottis</td>
<td>77</td>
<td>13.0</td>
</tr>
</tbody>
</table>

Source: Birmingham and West Midlands Regional Cancer Registry, 1986.

Some swelling of the larynx, whether widening or as a result of penetration of tumour through the cricoarytenoid membrane, may be felt. An enlarged thyroid lobe should suggest invasion by tumour.

General examination

A general physical examination is required to identify metastases, for example to the liver, and to assess the overall physical status of the individual who is likely to be subjected to an anaesthetic and biopsy, possibly surgery, radiotherapy or chemotherapy. This examination applies to any case of malignancy and need not be detailed here.

Radiological investigations

Chest

In many respects this is the most important investigation at this stage, for assessment of the chest not only indicates the presence or likely absence of distant metastases (and the chest is undoubtedly the most common site of such metastases in cancer of the larynx); but may also indicate the presence of other disorders. It is indeed, nowadays, an integral part, together with a clinical examination, of the assessment of the general physical status of the older adult.

Larynx

Radiological examination of the larynx is undertaken in order to attempt to delineate the extent of the tumour. It is described in detail in Chapter 2.
Clinical investigation

It is appropriate at an early stage to undertake laboratory investigations, that is a full haematological screen and biochemical profile including liver functions and serum proteins; in the past, serological tests for syphilis were regarded as essential, although in the UK the yield is unrewarding. A (urine) screen for diabetes, and electrocardiography are also indicated.

Histological examination

Currently it is normal to acquire a specimen (biopsy) of the tumour by direct laryngoscopy, and this is usually carried out under general anaesthesia allowing a careful and thorough direct examination of the tumour. Direct examination should include the use of a microscope in most circumstances. Biopsy material should include an adequate amount of tissue both from ulcerated areas and elsewhere if practicable. If the tumour is very small, care must be taken, first to obtain sufficient material, and second, not to damage normal tissue.

It is essential in the climate of medical practice today to obtain a biopsy of all cases, unless by so doing the patient's well-being will be prejudiced - this latter situation is rare (Table 11.5). Biopsy of the primary tumour is most advantageous although on occasions a biopsy of the secondary deposit is enough and occasionally even more appropriate. Sometimes both are required. The general principle should be firmly adopted not to make incisional biopsies in the neck except at definitive surgery unless this is unavoidable.

Table 11.5 Histological confirmation of cancer of larynx 1957-1976

<table>
<thead>
<tr>
<th></th>
<th>Histologically confirmed (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supraglottis</td>
<td>90.9</td>
</tr>
<tr>
<td>Glottis</td>
<td>94.1</td>
</tr>
<tr>
<td>Subglottis</td>
<td>89.0</td>
</tr>
</tbody>
</table>

Source: Birmingham and West Midlands Regional Cancer Registry, 1986.

The biopsy material is important on three grounds:

(1) Definitive diagnosis of malignancy is required. It is not possible in every case either to diagnose or to exclude the presence of malignancy purely by inspection, and all experienced surgeons have found this. Even the most benign-looking polyp or nodule has occasionally been found to be malignant. Conversely, some quite active looking keratoses may not be malignant. Tuberculosis in former times was a diagnostic complication (Hautant, 1937).

(2) Identification of the type of tumour. While squamous carcinoma is undoubtedly the most common, other rare forms of malignancy are found and need individual consideration.

(3) Differentiation, Often neglected, the degree of differentiation may be significant. Biopsy material may, unless representative, be misleading, and thus where possible several
biopsies should be taken. The degree of differentiation may scarcely be worthy of consideration when a prognosis is to be made (see Table 11.3).

**Difficulties in diagnosis**

**Negative biopsy**

If a biopsy of a malignant-looking lesion is found to be negative, the biopsy should be repeated, but on some occasions reliance is placed on clinical diagnosis alone (usually advanced cases).

**Keratosis**

Sometimes a keratosis yields a non-malignant histopathological diagnosis. It is often difficult to decide just when such a lesion becomes malignant.

**Previous radiation**

Previous radiation is a common source of dilemma. A low-grade perichondritis may prevent a larynx from returning to normal. Careful observation is required. If a larynx does return to normal after radiation treatment and changes later, recurrent cancer is the most likely cause.

**Miscellaneous conditions**

Various conditions such as chronic laryngitis, tuberculosis, syphilis and benign tumours may give rise to diagnostic confusion or difficulty (Hautant, 1937).

**Pathology**

The vast majority of malignant tumours arising in the larynx are squamous cell carcinomata. All other types of malignancy arising in the larynx are rare. The histopathological classification can be performed according to Broders (1920, 1932). To determine whether the initial biopsy specimen yielded prognostic information, Jakobssen et al (1973) introduced an eight-factor malignancy grading system and applied it to glottic carcinomata. Nuclear polymorphism, mode of invasion and the total malignancy score were the factors that were most important in predicting the outcome for the patients (Jakobssen, 1973).

A distinct variant of well-differentiated squamous cell carcinoma is the verrucous carcinoma (Ackerman's tumour), which is most frequently reported arising in the oral cavity, but makes up a small proportion of all laryngeal carcinomata (van Nostrand and Olofsson, 1972; Ferlito and Recher, 1980).

**Spread of laryngeal carcinoma**

The growth and spread of laryngeal carcinoma is determined to a great extent by the site of origin of the primary tumour. Important factors in determining the directions and extent
of tumour growth are the anatomic barriers produced by the laryngeal compartments described by Pressman (1956), Tucker and Smith (1962) and Pressman, Simon and Monell (1969). The growth and spread of laryngeal carcinoma is well described by Ogura (1955), Kirchner (1969) and Olofsson and van Nostrand (1973).

**Glottic carcinoma**

Most of the tumours arising in the glottic region originate on the free margins of the vocal cords which are covered by a squamous epithelium. According to the agreements reached at the Centennial Conference on Laryngeal Cancer in Toronto (1974), the glottic region comprises the free margins and the horizontal surfaces of the vocal cords and the commissures. The anterior commissure is defined as a line between the vocal cords measuring a few millimetres in height. The subsurfaces of the vocal cords belong to the subglottic region.

Glottic carcinomata may arise in, or extend to, the anterior commissure area, where there is only a thin layer of submucosa and a fibrous cord, 'the anterior commissure tendon', that separates the mucosa from the underlying cartilage. This explains the increased risk of cartilage invasion in the anterior commissure area compared with that for tumours involving other parts of the vocal cords where muscle and perichondrium intervene.

The anterior midline is the most frequent location for invasion of the laryngeal framework (Ogura, 1955; Olofsson and van Nostrand, 1973). When the framework is invaded this occurs most frequently in the ossified parts of the cartilage. Local bone destruction by osteoclasts active at the margins of the tumour precedes the tumour invasion (Carter and Tanner, 1979). The vascularization of the cartilage is of great importance too. Unvascularized cartilage has a great resistance to tumour invasion (Olszewski, 1976; Guerrier and Andrea, 1977).

Tumours involving or crossing the anterior commissure often extend below the cords and may then escape outside the larynx through the cricothyroid membrane anteriorly, sometimes using the preformed vascular channels. Tumours may also extend laterally to the conus elasticus and can then escape through the cricothyroid triangle - bounded by the cricothyroid membrane, the thyroid cartilage and the medial edge of the cricothyroid muscle.

When the vocal cord muscles are invaded the tumour may extend along the muscle bundles anteriorly or posteriorly and may then reach lateral to the arytenoid cartilage where the tumour comes close to the mucosa of the pyriform sinus. Invasion of the posterior cricoarytenoid muscle may occur. Tumour extension lateral to the arytenoid cartilage is difficult to assess by conventional laryngoscopical and radiological means, but may be assessed by computerized tomography. A widening of the thyroarytenoid space indicates such tumour spread. The mucosa of the pyriform sinus on the affected side should be included in the laryngectomy specimen in these cases to avoid a recurrence above the stoma.

Vertical extension of glottic carcinomata to the subglottis and/or supraglottis seems to occur more frequently than extension to the opposite side (Pressman, Simon and Monell, 1969; Olofsson and van Nostrand, 1973).
Fixation of the vocal cord indicates deep invasion with involvement at least of the thyroarytenoid muscle. When the posterior part of the vocal cord is involved, fixation of the cord may be the result of invasion of the arytenoid or cricoid cartilages or the crico-arytenoid joint. Perineural invasion may be another aetiological factor but is seen mainly in major carcinomata. Fixation of the vocal cord indicates that the laryngeal framework is invaded and/or that the tumours have spread outside the larynx through cartilage and/or through the cricothyroid membrane or spaces as in about 50% of the cases (Olofsson and van Nostrand, 1973; Olofsson, Lord and van Nostrand, 1973). This means that fixation in most cases is a contraindication to partial surgery. Impaired mobility indicates a more superficial invasion of the thyroarytenoid muscle and is often not a contraindication to conservative surgery.

With previously used diagnostic methods, more than 50% of patients with vocal cord fixation in glottic carcinoma were under-assessed, as methods were lacking to determine cartilage invasion and spread outside the laryngeal framework. Computerized tomography has become a valuable complement in the radiological diagnosis of laryngeal carcinoma and adds important information about deep tumour invasion, cartilage destruction and extension of tumour outside the larynx (Archer et al, 1978; Archer and Yeager, 1979; Gregor, Lloyd and Michaels, 1981; Mancusa, Calcaterra and Hanafee, 1978; Sökjer and Olofsson, 1981).

Several reports have stressed the risk of cartilage invasion for tumours which traverse the laryngeal ventricle to occupy at least the glottic and supraglottic regions and often also the subglottis causing a fixed hemilarynx. These tumours extend within the paraglottic space and spread outside the larynx through the cartilage and the cricothyroid space.

Supraglottic carcinoma

The growth and spread of supraglottic carcinoma is well studied by the use of whole organ (specimen) serial sections (Kirchner and Som, 1971; Olofsson and van Nostrand, 1973; McDonald, de Santo and Weiland, 19760. McGavran, Bauer and Ogura 91961) noted that supraglottic carcinomata often had 'pushing margins'. They often involve both sides of the supraglottic larynx. Bocca, Pignataro and Masciario (1968) stressed that supraglottic carcinomata seldom extend to the glottic region because 'the larynx consists of two distinct parts, an upper and a lower part, whose line of demarcation runs at the level of the vocal cords'. The different embryological derivations and the various lymphatic supplies were also stressed. Supraglottic carcinomata do not always respect the glottic region, but the various opinions in reported series depend to a certain extent on the selection of the material examined (Szlezak, 1966; Olofsson and van Nostrand, 1973). Exophytic supraglottic lesions do not often extend to the glottic region and seldom invade the thyroid cartilage. Ulcerative lesions may extend down below the anterior commissure, and when doing so they have a great tendency to invade the thyroid cartilage (Kirchner and Som, 1971). Invasion of the cartilage does not seem to occur unless the tumours can be seen macroscopically extending below the anterior commissure. This observation is certainly important in selecting the patients for horizontal supraglottic laryngectomies.

Invasion of the pre-epiglottic space is a prominent feature of supraglottic carcinomata and especially for those that involve the posterior (laryngeal) surface of the epiglottis. The tumours may extend into the pre-epiglottic space through the fenestration in the epiglottic
cartilage or by destruction of the cartilage. The lateral parts of this space are in direct continuity with the paraglottic space (Tucker and Smith, 1962) and this is another, but not so common, pathway for the tumours to reach the pre-epiglottic space. Nearly all tumours that invade the pre-epiglottic space involve the laryngeal surface of the epiglottis, which in most cases can be assessed at laryngoscopy (Olofsson and van Nostrand, 1973). Invasion of the pre-epiglottic space occurs in 40% of all supraglottic carcinomata and in 70% of all epiglottic tumours (Ogura, 1955; Szlezak, 1966; Kirchner, 1969; Olofsson and van Nostrand, 1973; McDonald, de Santo and Weiland, 1976).

Supraglottic carcinomata may extend cranially to the valleculae and to the base of the tongue. Posteriorly, the tumours may extend to the arytenoid cartilage, invasion of which seems to occur only when the arytenoids are grossly involved by tumour (Kirchner and Som, 1971). The pyriform sinus can be involved by tumours riding over the aryepiglottic folds. The pyriform sinus may also be reached by deep invasion.

**Subglottic carcinoma**

Primary subglottic carcinomata are rare and are characterized by a tendency to grow circumferentially and to be extensive before symptoms, such as inspiratory stridor, occur. Invasion of the vocal cords may cause impairment of their mobility and thereby hoarseness for which the patient may seek medical advice.

Subglottic carcinomata can spread through the cricothyroid membrane anteriorly or through the cricotracheal space, for example posteriorly, or invade the trachea caudally.

**Lymph node involvement**

The lymphatics within the larynx can be divided into a supraglottic and a subglottic network, separated by the free margin of the vocal cords, which has a minimal lymphatic drainage (Rouvière, 1931). This explains the low incidence of lymph node metastases for tumours confined to the vocal cords.

The supraglottis is rich in lymphatics, which accounts for the high incidence of lymph node metastases for supraglottic carcinomata, 32% as reported by Som (1970) and 73% as reported by Baclesse (1949). Sand Hansen (1975) found that 44% of the patients with supraglottic carcinomata, but only 5% of those with primary glottic carcinomata and 6% of those with subglottic carcinomata, had palpable cervical lymph nodes at the time of initial diagnosis. In total 18% of patients with laryngeal cancer had lymph node metastases at the time of referral.

The incidence of palpable lymph nodes increases with the extent of the primary tumour. Of patients with T1 supraglottic carcinomata 17% had lymph node metastases compared with 47% for the T2-T4 tumours. For glottic carcinomata the highest incidence of lymph node metastases was found when the sub- and supraglottic regions were involved (17%) (Sand Hansen, 1975).
Distant metastases

Few patients present with distant metastases at the time of diagnosis of their laryngeal carcinoma. Secondary distant metastases are more common. Sand Hansen (1975) reported 11% with distant metastases, most of which occurred in the lung (6.8%). The occurrence of pulmonary metastases seemed to some extent to be influenced by the presence of lymph node metastases, the macroscopic appearance and histology of the tumour. Poorly differentiated, necrotic tumours and tumours with lymph node metastases had the highest incidence of pulmonary metastases.

Multiple primary tumours

A number of papers stress the occurrence of synchronous and metachronous second and third primary tumours in patients with head and neck cancer. Wagenfeld et al (1980, 1981) found 6.5% of second primary carcinomata within the respiratory tract in patients with glottic carcinoma and 12.3% in those with supraglottic carcinoma; more than half of these tumours were located in the lungs and have to be separated from metastases.

Prospective panendoscopic examinations in patients with neoplasms arising in the upper respiratory tract have yielded a high percentage of synchronous multiple primary carcinomata (McGuirt, Matthews and Kourman, 1982) and introduce interesting aspects in the clinical management of patients with upper aerodigestive tract malignancies.

Treatment

Almost all carcinomata of the larynx are treated. Like most head and neck tumours, the therapeutic problem is local, not merely because in the majority of cases there is no evidence of spread beyond the local tissue or regional nodes, but also because even in those cases where dissemination is evident, the local lesion is the one causing symptoms that require some form of management. Even temporary control of the local and regional disease may require energetic treatment.

Most cancers of the head and neck show a reduced or uncertain response to second treatments (the separate treatment of regional nodes which appear after the treatment of the primary tumour is excepted from this statement), but the larynx is in this respect rather different. The so-called 'salvage' surgery of the primary lesion is thus a legitimate approach and must be considered in the treatment planning (Lederman and Dalley, 1965; Bryce, 1972; Stell et al, 1982).

Treatment may fall into the following categories:

(1) no treatment
(2) palliation
   (a) pain relief
   (b) tracheostomy
   (c) other surgery
   (d) radiotherapy
   (e) chemotherapy
(3) curative (radical)
  (a) radiotherapy
      radioactive implants
      megavoltage
      neutron
  (b) surgery
  (c) (chemotherapy)

(4) rehabilitation.

Since squamous carcinoma makes up the overwhelming proportion of malignancy of the larynx, the discussion will refer almost exclusively to this disorder. Rare forms of malignancy of the larynx will be dealt with separately.

**No treatment**

A few patients require no treatment, including those presenting *in extremis*, who are no longer conscious of pain or distress, or in whom disseminated tumours cause their death without the primary tumour or regional disease causing symptoms. In a retrospective sense this category also includes those who do have cancer of the larynx but who die of other disorders, the laryngeal cancer unrecognized. The fact that cancer of the glottis, especially the small lesion of the vocal cord, has a relatively long natural history may occasionally raise the question of the necessity of any treatment in those who have another debilitating or lethal disorder, and a careful judgement is required before instituting treatment at all. Approximately 7-8% of patients presenting clinically with carcinoma of larynx receive no treatment (Stell, Morton and Singh, 1983).

**Palliation**

It is appropriate to consider palliation of cancer of the larynx at an early stage, not because of its importance numerically, but because it is necessary to consider carefully the purpose of the treatment and the means used. Palliation indicates the attempt to suppress the carcinoma and its symptoms but without expectation or intent to cure. It may be of little value if the result is short-term, and allows the disease to recur in a more distressing or painful form. Palliation which, for instance, suppressed the disseminated disease but not the troublesome primary lesion could be unwelcome. Palliation is commonly used in the later stages of disease.

**Pain relief**

Pain is not particularly common in laryngeal cancer. Paradoxically it is the slowly growing, sometimes underestimated and thus undertreated, lesion which can be the most intractable. A carcinoma with a long previous history, often of recurrences, is likely to take a long time to destroy the sufferer, and once pain develops a long period of control may be required. such patients need the benefit of pain control specialists and the various adjuvant psychological, electrical and pharmaceutical methods. Such patients, too, may be subjects for treatment by a combination of methods including radiation, surgery and chemicals.


**Tracheostomy**

The relief of airway obstruction in a patient with incurable cancer often provides a dilemma. Dyspnoea is indeed distressing and its relief in such patients may merely delay for a very short period the inevitable death and on some occasions preserve a life temporarily only for other suffering and pain. These patients often provide problems, not only because a decision may be required rapidly, but also because the individual may be unable to indicate his/her wishes. Discussion with relatives is important, and often the time gained by tracheostomy is required for the relatives and the patient to come to terms with the unpleasant reality. It is this situation which requires the most informed and sympathetic management by the surgeon.

Tracheostomy may well be required as a preliminary before the possibility or practicability of treatment has been assessed. Tracheostomy in these cases also requires considerable thought and judgement, but is more appropriately discussed in relation to curative management.

The third instance where tracheostomy may be considered as a palliative procedure is in conjunction with other palliative procedures. Certain lesions are incurable - examples are all those with disseminated metastases, or those already treated where the airway becomes prejudiced and recurrence(s) are identified which may be temporarily controlled by chemotherapeutic agents, allowing a period of relative well-being. Each case must be considered upon its own merits.

**Other surgery**

Too often surgery, otherwise regarded as 'radical', is neglected as a palliative procedure. On occasions a total laryngectomy is the most reliable method of pain control, and a radical neck dissection, even in those with disseminated metastases, may remove a fungating or painful local lesion which is otherwise difficult to control and which is the source of the current symptoms. Such treatment, permitting sometimes months of relative well-being, may be a simple substitute for debilitating and time-consuming radiotherapy or chemotherapy, the modes of treatment usually invoked for palliation but which often impose more discomfort than the cancer itself.

**Radiotherapy** *(see Volume 1, Chapter 20)*

Radiation therapy is commonly used for palliation. Radiation is of particular value under these circumstances because it can be applied locally and selectively, focusing on the area or cause of symptoms; thus cases in which the primary lesion is obtrusive, or those where local (or even distant) metastatic lesions are the major problem, may be treated sufficiently to suppress those symptoms.

Usually the approach to palliation is simpler than for curative therapy. A complicating factor may be larger volumes requiring treatment (the larger the volume the less radiation per unit volume can be given) and less likelihood of complete control - often the original reason for the palliative nature of treatment. Sometimes the detailed planning and preparation is waived since these exercises are designed to promote maximum dosage to an accurately
limited volume, the need for accuracy being heightened by the desire to treat to tolerance, while tolerance is not sought when palliation is required. Radioactive implants of gold are useful for local treatment, especially of secondary deposits. Palliative courses of radiation can be delivered in fractions, but over a shorter period, since extension of the period is desirable only where treatment to tolerance is sought. Even so, there are limitations to the value of palliative radiotherapy and, as a general rule, one course to a particular area is offered, the patient, like any other, being at risk from the destructive effects of radiation if the appropriate dosage is exceeded.

**Chemotherapy** (see Volume 1, Chapters 21 and 22)

As yet (with a few anecdotal exceptions) no carcinoma of the larynx has been cured by drugs. Nevertheless, chemotherapy has become an integral component of the armamentarium used to manage cancer, although in realistic terms it is predominantly a palliative therapy. Its use as an adjuvant will be discussed in the section on radical treatment. For some 40 years single drug regimens, for example, nitrogen mustards, have been used in a variety of cancers particularly in the field of lymphomata. Intra-arterial perfusion was intended to maximize the effect in the tumour-bearing area, minimizing the toxic effects with a systemic antidote. The larynx was not suitable for this type of regimen. More recently, again following the lead from the lymphoreticular tumour, where protocols were based on biologically-observed cell kinetics, the trend has been towards (usually) the intravenous use of a multiple drug course of therapy, timed strictly over a prescribed period and repeated after an interval (Price and Hill, 1977; O'Connor et al, 1977). A variety of drugs has now been used including methotrexate, cyclophosphamide, 5-fluorouracil, bleomycin, hydroxyurea, vincristine, and cisplatin. In those cases where some response can be recorded, the inconvenience and, indeed, the risk of complications and side-effects, may be worthwhile and there are numerous reports describing the results of treatment with one or a variety of these agents (for example Perry et al, 1982).

Response to chemotherapy may be measured by partial or complete regression of tumours (as in phase II trials) or by the survival of the patient (phase III). Complete regression is rare while partial response, even then in only one patient in five, can demonstrate the effect of the chemical treatment, but is, in effect, a complete failure. Chemotherapy can in no way be compared with radiation or surgery, for survival has not yet been shown to be improved; rather it is an alternative to analgesics.

Chemotherapy has two other major disadvantages. First it is a 'blunt instrument' influencing cancer wherever it may be, that is both local and distant (where the local lesion is the one causing symptoms); indeed it may be negatively selective, being more effective against the metastases (perhaps better perfused) than the local lesion. The second objection is the tendency towards significant side-effects and the associated malaise, rather than a promotion of well-being, in a significant proportion of patients. It is as well to consider that suffering induced by non-curative treatment is hard to justify.

**Curative treatment**

Curative or radical treatment may involve radiotherapy, surgery, or chemotherapy, of which the last is not used alone. The first two, may be used either separately or together.
Radiotherapy

At the present time a radiotherapist is a specialist in his own right skilled in the application of all forms of radiation treatment, trained in medical physics and internal medicine at least to the extent of appreciating the interaction of disease with the treatment proposed and the variety of complications both early and late. The radiotherapist is also, essentially, an oncologist with experience of a very wide range of cancers, and until relatively recently the main author of chemical treatment. It is thus that the radiotherapist has a major role in the assessment and selection of treatment for most cancers, as well as cancer of the larynx. Joint clinics are now regarded as almost indispensable in the management of cancer of the larynx, particularly because most patients are treated by radiation. Radiotherapy is described in detail in Volume 1, Chapter 20.

Radiation is biologically most effective where the tissues are well oxygenated. This would seem to imply that it is most valuable in small lesions and where the vascular supply is undamaged, for example, where it has not been preceded by surgery. (There is no real evidence to suggest that surgery is actually prejudicial.) Attempts to use hyperbaric oxygen have not borne fruit (Hurley, Richter and Torrens, 19720. Conversely, the less attractive cases for radiotherapy are those where the tumour is large or widespread, not only because the volume is large and a tumoricidal dose more difficult to achieve without unacceptable side-effects, but also because the centre of larger tumours is often avascular and tends to be necrotic. In addition, the characteristics, even of megavoltage radiation, are such that tumours in bone are less responsive, and the cure of lymph nodes is uncertain. Radiation is thus theoretically more applicable on the oxygenated periphery of the tumour, while surgery could deal with the mass.

Selection of cases

Radiation is chosen in those cases where cure is likely with preservation of function. It may be used in a few circumstances where surgery is contraindicated or refused. Preliminary radiation of unresectable tumour is only rarely helpful. Radiation may be chosen, even if cure is uncertain, but with surgery in reserve. Radiation may be used for a majority of cases of cancer of the larynx.

The combination of radiation with chemotherapy may be considered, although the results of such treatments are not yet fully validated (Coker et al, 1981). Chemotherapy before radiation may increase the response but not survival.

Few circumstances contraindicate radiotherapy: active perichondritis, where cartilage is invaded; and where radiation has been used previously.

Interstitial radiation

Historically, radium-226 needles were implanted (Finzi and Harmer, 1928) by surgically removing part of the thyroid ala, with good results. This has now been superseded by external radiation.
Radioactive gold-198 grains can be inserted using a special gun in a pattern which can give a very high dose (100 Gy) localized to nodes or nodules in the neck, with little damage to normal structures.

**Radiation reactions**

Radiation reactions are frequent but usually not severe. They may be minimized by the avoidance of smoking, alcohol and careful attention to the skin and to nutrition. It is usual for the patients to develop mucositis, or painful erythematous reactions in the larynx and pharynx. In many cases, it is sufficient to require hospitalization for a week or so towards and after the end of treatment. Local and systemic analgesic mixtures are generally sufficient to control the symptoms. Rarely antibiotics and steroids are required. Similarly, erythema or moist desquamation of the skin may develop, and patients are discouraged from washing or abrading the skin until a little time after treatment is complete. Severe reactions may progress to necrosis of the skin, although this is very rare except where the tumour originally involved the skin.

Perichondritis is a deeper inflammatory reaction of the laryngeal skeleton. Whether true necrosis of cartilage occurs is uncertain. The symptoms are persistent pain, earache, more severe dysphagia and, where sepsis supervenes, severe illness. Perichondritis may require the suspension of radiation treatment. Mild symptoms during or after the treatment usually respond to steroids and antibiotics. If perichondritis is severe, urgent removal of the larynx is required. Mild symptoms may occur some years after radiation, provoked usually by a respiratory tract infection. When laryngeal oedema follows radiation, it can be hard to establish whether perichondritis or local residual disease is the cause, and it can be immensely difficult to reach a decision. It is essential, however, to monitor such patients carefully, for if residual tumour is present but allowed to extend beyond the larynx, the prognosis is poor.

Generally, a patient who undergoes radiotherapy for carcinoma of the larynx must undergo a relatively strenuous treatment, because of hospitalization or travelling and the almost invariable interference with nutrition, together with general side-effects of malaise, weakness, anorexia, insomnia, followed by dryness of the mouth and throat, loss of taste, and sometimes pigmentation of the skin and telangiectasia with some subcutaneous fibrosis.

Radiation is not an easy course or 'soft option', and many patients who have been subjected to both surgery and radiation will readily volunteer that radiation was by far the most miserable form of treatment. On the other hand, treatment for many small glottic tumours is relatively easy.

Most patients who have undergone successful radiation therapy retain a good or useful voice. A number are subject to dysphonic episodes with respiratory tract infections. Treatment of larger tumours, particularly if the reaction was severe, may be followed by some change in the voice, but this is preferable to its loss by surgery.
Neutrons

Fast neutron radiotherapy (Catterall, 1977) has shown a capacity for local control of malignancy apparently in excess of the success of photons in some sites. Its value has yet to be the subject of closely supervised trials and it is not generally available.

Surgery

Microendolaryngeal and laser surgery

The advent of the carbon dioxide laser used with the surgical microscope has added further impetus to the treatment of the smaller cancers of the larynx. Carcinoma \textit{in situ} can be treated by microsurgical excision (Kleinsasser, 1978; Hellquist, Olofsson and Gröntoft, 1981) and laser surgery makes this even easier. Ideal cases are uncommon and require long and careful follow-up. There is an attraction to avoid radiation in younger persons where a sufficient length of life remains during which the risk of radiation-induced or other cancers is significant. Certain localized supraglottic lesions may be excised using a laser (Schlechter and El Mahdi, 1984). The real value of this method is still not fully evaluated.

Lasers can be used for biopsy, for tumour reduction (Vaughan, Strong and Jako, 1978) and staging (Fried, 1984), cordectomy (Davis et al, 1982), treatment of local tumours (Strong, 1975) and, of course, many benign tumours, especially vascular ones (Strong et al, 1976, 1979).

Excision surgery

Surgical treatment of carcinoma of the larynx historically precedes radiation treatment (Gussenbauer, 1874). Almost invariably there is some risk, if not some prejudice to, or loss of, the voice - and in supraglottic laryngectomy risk to the protection of the airway. In contrast with this, radiation generally preserves function. Today surgery is not associated with the major risks of former years, and physical fitness or age are not often the limiting factors. Most patients are fit for treatment and all may generally be offered surgery or radiation, the choice being made according to the likely effective control of the cancer and the relative consequences of the treatment.

Surgery is effective in almost all cases where the lesion can be encompassed. As a primary or sole treatment it is more effective than radiation in larger tumours and where there are secondary deposits of carcinoma in the lymph nodes of the neck. Rehabilitative procedures do much to minimize the disability after surgery. Surgery, however, may be used in combination with, or as a sequel to radiation therapy, especially in its role as 'salvage' or secondary surgery for recurrence, in many cases without detriment to the expectation of cure (Bryce, 1972; Stell et al, 1982). Partial resection of the larynx may also maintain near normal function with high rates of cure (Ogura, Sessions and Spector, 1975). After radiation failure, surgery is the appropriate course for most potentially curable cases.
**Selection of treatment**

With the principles outlined above, the selection of treatment of cancer of the larynx can be outlined.

Those cases of doubtful malignancy, keratosis and those with carcinoma *in situ* in the glottis and supraglottis may be treated by microendoscopic removal (Kleinsasser, 1978) and with the help of lasers (Strong, 1974, 1975). Small tumours of the marginal zones (suprahyoid epiglottis, aryepiglottic fold, sometimes false cord) may also be candidates for such surgery. Once the need arises to remove tissue which may interfere with function (for example, the vocal cord), alternatives should be considered.

Smaller tumours of the supraglottis and glottis (especially T1a and T1b lesions) are usually treated by radiation with good results, although some regard many such lesions of the supraglottis, especially those arising from the base of the epiglottis and the false cords, as most appropriately treated by conservative (horizontal partial) laryngectomy (Schechter and El Mahdi, 1984) with good results (Ogura and Mallen, 1967; Bocca, Pignataro and Masciaro, 1968). The relative values of radiation versus surgery are not clear. T2 lesions are treated by radiation - the alternative being total laryngectomy. Larger T3,4 lesions may best be excised if surgery is the only mode of treatment to be used. T3 glottic lesions may be treated by radiation (Hunter and Palmer, 1980) with salvage surgery without a reduction in cure (Bryce, 1972; Stell et al, 1982). Subglottic lesions too may be irradiated (Lederman, 1970) with possible secondary surgery if required, but follow-up with endoscopy, is a necessary part of management. Where there are secondary nodal deposits the use of primary surgery is much more appropriate, particularly if conservative surgery is possible for, although small or subclinical nodes are effectively controlled by radiation (Fletcher, 1972), the expansion of the field may make cure more difficult, and conservative surgery after radiation is less attractive (Radcliffe and Shaw, 1978).

Other less common forms of malignancy of the larynx are almost invariably treated by laryngectomy; these include adenocarcinoma (Whicker et al, 1974), verrucous carcinoma (van Nostrand and Olofsson, 1972), salivary adenocarcinoma (Spiro et al, 1976), fibrosarcoma (Flanagan, Cross and Libcke, 1965), melanoma (Moore and Martin, 1955), chondrosarcoma (Swerdlow, Som and Biller, 1974) and chemodectoma (Adlington and Woodhouse, 1972).

**Emergency laryngectomy**

This controversial issue was proposed by Kiem, Shapiro and Rosin (1965) as a result of their studies of 116 laryngectomy patients of whom 17 developed peristomal recurrence. Peristomal recurrence occurred without particular reference to the original site (supra/subglottic) but more frequently in those who had tracheostomy as a preliminary procedure at the time of laryngectomy (13.9%) and even more frequently (40.9%) in those whose tracheostomy preceded laryngectomy by 2 days or more. Peristomal recurrence was uniformly fatal. Baluyot, Shumrick and everts (1971) described the policy, and also the role of radiotherapy.

The difficulties in achieving the proposed ideal management are, naturally, the possible lack of availability of frozen section histology, and the doubt whether a patient with a
compromised airway can give rational consent to a laryngectomy. Nor has the effectiveness of the policy been demonstrated either in terms of reduced peristomal recurrence or mortality.

**Surgical techniques**

Many different techniques for treatment of laryngeal cancer have been devised since Buck in 1853 first performed a successful partial laryngectomy by laryngofissure in the USA, and Billroth of Vienna carried out the first total laryngectomy for cancer in 1873 (Gussenbauer, 1874). All the subsequent techniques have derived from the work of these early pioneers, and later modifications have concerned mainly such details as anaesthesia, skin incisions, succession of stages and methods of closure.

In the early years of the present century, although these operations were increasingly used, serious complications were the rule and operative mortality caused by haemorrhage, wound infection and bronchopneumonia was at times as high as 25% for the smaller procedures and 50% or more after complete removal of the larynx.

From about 1910 onwards this toll was gradually reduced through the work of pioneers such as Gluck (1922), and Thomson and Colledge (1930). Their achievements were obtained not merely by technical skill, but by a realization of the importance of adequate preparation of the patient before surgery and careful postoperative nursing to combat the dangers of infection.

After 1940, with the advent of surgical aids such as antibiotics, safer anaesthetics and blood transfusion, the whole scene changed. There are now few definite contraindications to laryngeal surgery and serious complications are rare. Operative mortality for major laryngeal operations is no more than about 1%.

The following types of procedure are now used:

1. **Vertical partial resection**
   - (a) cordectomy
   - (b) frontal partial laryngectomy
   - (c) lateral partial laryngectomy
   - (d) frontolateral partial laryngectomy
   - (e) extended frontolateral partial laryngectomy

2. **Horizontal partial resection**
   - (a) epiglottectomy
   - (b) supraglottic partial laryngectomy
   - (c) extended supraglottic partial laryngectomy

3. **Total resection**
   - (a) total laryngectomy alone
   - (b) total laryngectomy with partial pharyngectomy or partial glossectomy.

The operation of radical block dissection of cervical lymphatics on one or both sides may need to be combined with any of these procedures. It is seldom required in the first group owing to the paucity of lymphatics in the true cords and therefore the improbability of
metastatic spread. In addition, partial or total thyroidectomy may be obligatory in the major resections.

Lateral or vertical partial laryngectomy, often termed 'laryngofissure', is today performed less frequently owing to the equally effective results achieved by radiation in suitable cases. However, it still has a very definite place in situations where good radiation is not available, in some cases of radiation failure, possibly for limited cordal tumours in young adults, where radiation may provoke future neoplastic changes, and perhaps also in a few older patients unsuitable for prolonged radiation. Primarily it is indicated for T1a lesions of one vocal cord which should not extend into the anterior commissure or on to the arytenoid cartilage. It is also a suitable operation for the removal of many large benign laryngeal tumours.

Frontolateral partial laryngectomy may be useful where a glottic tumour crosses the anterior commissure to involve the anterior third of the opposite cord and without any reduction of mobility ('horseshoe tumour') (Som and Silver, 1968).

The older more anatomical hemilaryngectomy is no longer employed, but provided that there is no evidence of deep infiltration, an extension of the lateral partial laryngectomy technique to include the whole ventricular band and arytenoid cartilage may on occasion be used in highly selected cases (Ogura and Mallen, 1967), and is often termed 'hemilaryngectomy'. This term is also rather loosely applied to other types of partial resection.

Pharyngotomy, either by the anterior transverse approach or by the lateral route (Trotter, 1926), provides a satisfactory access to limited T1 or T2 supraglottic tumours. The anterior pharyngotomy approach is also useful in excising small tumours of the tip of the epiglottis and marginal aryepiglottic folds (Martin, 1957). The larger operation of supraglottic horizontal partial laryngectomy for T1a and T1b lesions of the epiglottis and laryngeal vestibule is more modern in concept. Although popular in Europe and centres in the USA (Bocca, Pignataro and Masciaro, 1968; Ogura et al, 1969; Some, 1970; Cachin, 1974), it is still not widely practised in the UK partly because of the relative rarity of suitable cases. However, it deserves greater acceptance in view of the consistently good results published compared with those of radiation. Primarily it is indicated for T1a or T1b lesions confined to the supraglottis. Transglottic extension or involvement of the tongue base usually contraindicates the procedure. It is also inadvisable in poorly differentiated lesions, in patient much over 65 years and those with reduced pulmonary function (Som, 1970), for these accommodate relatively poorly to the changed swallowing and compromised laryngeal sphincters.

Consent for total laryngectomy must always be obtained before attempting any type of partial resection and prudence indicates that the operation should start with a direct endoscopy. Previous full-dosage radiation is certainly no bar to lateral partial laryngectomy but greatly increases the hazards of the horizontal supraglottic operations. Nor should surgery be performed without a precise knowledge of the extent of the lesion before radiation (Radcliffe and Shaw, 1978; Stell and Ranger, 1974).

Preparation for surgery. It is a most important preoperative measure in this type of surgery to ensure the health of the mouth as far as possible. Unhealthy teeth should be treated
and particular attention must be paid to the periodontal tissues. Operation ought not to be undertaken until the mouth has healed. Nasal sepsis should be eliminated as far as is practicable. Attention must be given to general health, haemoglobin level, chest, and the control of other medical conditions. A systemic antibiotic should be given commencing at the beginning of operation (for example, ampicillin).

From a psychological point of view the surgeon will naturally assess each case individually. It is highly desirable that the patient is informed in some detail as to what the procedure is and what to expect, for thus is obtained not only the necessary informed consent but the better cooperation of the patient during the postoperative period.

**Anaesthesia.** The operations can be performed under local anaesthesia, but general anaesthesia is preferable, and essential for the more exacting supraglottic (horizontal) partial laryngectomy.

Where the resting airway is seriously reduced by the tumour, there should be no hesitation in carrying out a preliminary tracheostomy under local anaesthesia with insertion of an angled cuffed anaesthetic tube. As soon as the trachea is exposed, the cuffed tube is inserted and general anaesthesia is induced.

**Position of the patient.** This should be similar to that used for tracheostomy; the head is extended by placing a roll or a sandbag beneath the shoulders. It is important that the pillow or sandbag be evenly placed in order to ensure that the larynx and trachea are strictly in the midline.

**Lateral (vertical) partial laryngectomy**

Using this technique it is possible to remove completely many tumours confined to the vocal cord, with an adequate margin of healthy tissue and without removal of the arytenoid cartilage. The principles of operative surgery for malignant disease elsewhere apply, with the exception that it is unnecessary to remove the associated cervical lymph nodes for reasons already given.

The tumour must be removed in one piece with as wide a margin of apparently healthy tissue as is practicable. It has been suggested that this margin should be at least 0.5 cm and, although this suggestion is of some practical value, the tissue removed must be as much as is possible and prudent. Even in the earliest case it should consist of the whole of the side of the larynx anterior to the arytenoid cartilage, including its tip, and from the upper border of the cricoid cartilage below to the upper border of the thyroid ala above. It may be more than 1 cm above, but may be less anteriorly if the tumour approaches the commissure, or less posteriorly if it approaches the tip of the arytenoid cartilage.

Naturally, the smaller margin of healthy tissue removed, the less satisfactory are the results likely to be.

If, on histological examination of the specimen removed at operation, any doubt exists as to the complete removal of the lesion with an adequate margin of healthy tissue, a full course of radiation should at once be given if the larynx has not previously been irradiated.
However, in the latter event, vigilant follow-up alone is permissible with recourse to total laryngectomy at the first sign of recurrent disease.

**Incision.** A transverse incision over the upper border of the cricoid cartilage gives adequate exposure with a separate lower one for the tracheostomy.

The strap muscles are separated and retained for later use. The thyroid isthmus is divided. The tracheostomy is prepared by excising a disc of the anterior tracheal wall or by a midline incision only.

Excision of the thyroid ala is achieved by first separating the outer perichondrium as far as the oblique line, and sectioning the cartilage (with a saw) in the midline and laterally.

**Excision of tumour.** The midline (or just to the contralateral side if the tumour reaches the commissure) is incised, and the growth excised, above through the ventricular band, below just above the cricoid, and posteriorly including the tip of the vocal process of the arytenoid.

**Closure.** After haemostasis, and using the sternohyoid muscle placed inside the preserved outer perichondrium to reduce the dead space, the perichondrium is sutured in the midline and the wound closed in layers. A nasogastric tube is inserted.

**Postoperative care.** The main complications of haemorrhage and chest infections are avoidable, the former by meticulous haemostasis, the latter by care of the tracheostomy (see Chapter 9). Early activity should be encouraged. Swallowing is painful at first, and nutrition is by nasogastric tube for a few days. The tracheostomy may be closed when the airway is demonstrably adequate. Antibiotics should be continued for some weeks, especially if there has been previous radiation. Granulations may form over unepithelialized cartilage and will need to be removed.

**Late results of operation.** The larynx heals by slow fibrosis and epithelialization, and this rarely results in stenosis, especially if the thyroid ala has been removed. Usually, however, a fibrous replica of the cord is produced which, after a year, may become a very passable substitute for the true cord. Conley (1961) claims better healing and an improved voice by fashioning a new cord from an inturned flap of cervical skin used to line the raw side of the larynx. Other reconstructive techniques have been tried.

There is no satisfactory movement of this band of scar tissues and, although the voice will be useful, it is husky, variable in strength and usually cannot be said to approach the normal. Singing is impossible. There is often some stenosis of the anterior part of if the opposite cord has been removed as in the frontolateral operation. Marked stenosis may limit the airway, and in these cases the tracheostomy is retained using a valve to permit phonation.

Local recurrence either in the scar or in adjacent tissue is uncommon. If a growth later occurs on the opposite cord it is difficult to decide whether it is a recurrence or a second primary growth. Metastasis is rare but may become evident in the cervical or mediastinal lymph nodes months or years after operation and with no evidence of local recurrence in the larynx.
Supraglottic partial laryngectomy

**Incision.** The T-shaped incision described by Som (1970) or a simple transverse incision is adequate. A tracheostomy is performed.

**Approach to supraglottis.** After elevation of skin flaps, the strap muscles are divided from the hyoid bone and the superior laryngeal vascular bundles ligated, defining the hyoid, superior cornua, and posterior borders of the thyroid cartilage. If a neck dissection is required, or is indicated, it is performed at this stage. The external perichondrium is dissected and the cartilage sectioned horizontally.

**Exposure of the tumour.** The pharynx is entered laterally just below the greater cornu of the hyoid. The hyoid bone is removed. The incision is carried across the base of the tongue, maintaining an adequate margin until the tumour can be viewed from above.

**Excision of the tumour.** Working from above, the tumour is excised with scissors with a blade each side of the aryepiglottic fold, preserving the arytenoid. Extended operations (Ogura, Sessions and Spector, 1974) are described.

**Cricopharyngeal myotomy.** A myotomy is performed, and a nasogastric tube inserted.

**Closure.** After haemostasis, closure is of the raw surfaces first by suturing the cut edges of mucosa and then of the pharynx in layers by approximating the base of the tongue to the cut edge of the thyroid cartilage, and the infrahyoid muscles to the cut suprahyoid muscles, and finally of the skin.

**Postoperative care.** A routine similar to that for partial laryngectomy and tracheostomy is followed, but even with particular care, spillover and aspiration are almost invariable.

**Rehabilitation.** Gradual use of the voice is begun after about 7-10 days. Once spillover is reduced, oral food, initially semisolids, is begun. This aspect of care is paramount for patients after horizontal partial laryngectomy, and it is because of this difficulty that the operation may not be appropriate in those with reduced pulmonary function and who are aged much over 65 years; previous radiation may also be a contraindication (Radcliffe and Shaw, 1978).

Total laryngectomy

Billroth of Vienna first removed the larynx as a treatment for cancer in 1873 (Gussenbauer, 1874).

At first, the results of operation were bad and not a single patient survived for one year in the first 25 cases recorded. Postoperative complications were frequent and severe, the most common causes of death being general septicaemia, spreading cellulitis or mediastinitis, septic pulmonary complications, haemorrhage and shock.
An attempt to improve on these poor results was made by performing the operation in two stages, the first consisting of the establishment of a tracheostomy, the larynx being removed a few weeks later.

Single-stage laryngectomy was suggested in 1921 by Moure and Portmann and, since that time, most surgeons have practised a one-stage operation with increasing safety.

**Incisions.** A commonly used incision was first recommended by Gluck (1922) and modified by Soerenson (1930). The incision commences on the anterior border of the sternomastoid muscle about the level of the hyoid bone, passes down along the anterior border of the muscle for about 6-7 cm and then curves across the midline at the level of the second or third ring of the trachea.

Other incisions are used, especially for combined total laryngectomy and radical neck dissection, and all have advantages. Jackson's single vertical incision is not now used. A single horizontal incision midway between the hyoid bone and the sternum with a separate one for the tracheostomy, is adequate and can be adapted for neck dissection.

**Exposure of larynx.** The larynx is dissected from the sternomastoid and carotid sheaths on each side, tying the vascular bundles. The strap muscles are section low in the neck, and usually the contralateral lobe of the thyroid freed from the specimen. The infrahyoid muscles are section from the bone.

**Tracheostomy.** The trachea is divided below the tumour and a tracheostome fashioned now or later.

**Removal of the larynx.** This is easier from above downwards, sectioning the constrictor muscles from the thyroid cartilage, and preserving mucosa as far as appropriate. Care should be taken to ensure adequate margins, especially over the cricoarytenoid joints.

**Closure.** Closure of the pharynx is in layers in the shape of either I or Y, ideally with a Connell suture. A long posterior myotomy (Singer and Blom, 1981) may avoid segments of spasm. The skin is closed in layers over suction drains.

**Postoperative care.** This is as before, and much as for tracheostomy (see Chapter 9). Feeding is by nasogastric tube. Antibiotic cover (for example ampicillin) may be continued for a few days.

**Complications.** The most frequent complication (apart from those associated with any surgery) is pharyngocutaneous fistula. This may develop at 4-10 days with a collection under the skin which requires drainage. Most fistulae close spontaneously after some days or weeks, assisted by frequent dressing, adequate nutrition and maintenance of the haemoglobin level. They are prevented by good technique, haemostasis, antisepsis, and a well-prepared patient. Rarely, extensive sloughing and large fistulae need repair by full thickness distant flaps.
Other complications include haemorrhage, wound infection, pulmonary and cerebral embolism, cardiac infarction, tracheal crusting and stomal recurrence, and the chest complications associated with any laryngeal operation and tracheostomy.

Thyroid insufficiency. In some cases a total thyroidectomy is necessary as part of the surgical procedure. In such cases, thyroid replacement in the form of L-thyroxine is required, 0.1-0.3 mg daily. Replacement therapy is not necessary immediately but can await the resumption of swallowing in 1-2 weeks.

Rather more insidious is the hypothyroidism which may follow surgery and radiotherapy. While the patient may have retained one lobe of the thyroid, previous or later radiotherapy may on occasions impair the function, and hypothyroidism may supervene even after several years. Treatment is straightforward once the condition is recognized.

Parathyroid insufficiency. This usually, but not invariably, follows total thyroidectomy. The problem may be acute in the immediate postoperative period. It may be delayed, or it may be temporary and may occur even after partial thyroidectomy.

In cases where it is anticipated, pretreatment with a vitamin D preparation may reduce the postoperative problem; otherwise intravenous calcium maintenance is necessary until either control is achieved by vitamin D medication or the condition resolves.

Respiration. Most surgical procedures on the larynx require a tracheostomy to maintain the airway during and often after the surgical procedures. Total laryngectomy requires a permanent end-tracheostomy, and the maintenance of respiration depends on a good formation of the tracheostome and good healing without crusting. Most patients require no special care afterwards but, not infrequently, a respiratory tract infection is followed by tracheitis and crusting, and a short period of treatment may be required to control it.

A partial laryngectomy ideally does not require a permanent tracheostomy, and the tube may be withdrawn once the natural airway can be shown, by occluding the tube, to be adequate. However, the benefits of retaining part of the natural larynx in respect of phonation are so great that the retention of the temporary tracheostomy should not be regarded as of overriding concern and should be infinitely preferable to a total laryngectomy if the control of the cancer permits it. However, the retention of a tracheostomy in a horizontal partial laryngectomy may in itself be prejudicial to the recovery of the effective protective function of the glottic sphincter. Fine judgement may be required.

Swallowing after total laryngectomy. As a rule this presents no difficulty. Even while a nasal feeding tube is in position a patient can swallow his saliva and drink fluids quite satisfactorily, although the act of swallowing is painful for the first few days. If healing has proceeded well and a fistula is not anticipated, it should be possible to remove the feeding tube after about 6 days, but if there has been previous radiation it would be much wiser to leave the tube in position for about 10 days since it is often not until the tenth day or later that the pharyngeal wound tends to break down. If the wound does break down, the tube should be left in position until the full extent and size of the fistula is revealed.
**Functional rehabilitation of voice.** Because the voice is impaired by operations on the larynx, the cooperation of a speech therapist is essential in maximizing its recovery.

Partial vertical and horizontal laryngectomy are operations designed to retain at least part of the glottis. The benefit of this is quite clear in that it utilizes the remains of the glottic vibrator in order to phonate, and the pulmonary reservoir to permit the production of a flow which can be modulated, and sufficient to produce sentences rather than a few words. The cords are often intact after horizontal partial laryngectomy and the voice is relatively little impaired, while vertical partial laryngectomy rarely allows a normal voice. In both cases a speech therapist can improve the production and efficiency in voice production.

**Oesophageal voice.** Many patients who have undergone a total laryngectomy have been able to develop abnormal but functionally satisfactory oesophageal speech. This mechanism relies upon the subject charging the oesophagus with air and utilizing the vibrations, at either the cricopharyngeal sphincter level or another level, to phonate (Dworkin and Banton, 1982). The preoperative and postoperative assistance of a speech therapist is essential in most cases, not only to teach the mechanism of voice production, but also to improve and teach other normally subsidiary communication methods. While it is optimistically said that 60% of laryngectomees develop satisfactory phonation, it is evident that a significant minority does not. Often the elderly do not have the capacity or even the will to phonate adequately, and even those who do so are restricted, because of the limitation of the oesophageal air reservoir, in the length of word sequences they can achieve. It is not surprising therefore that much ingenuity has been applied to assist laryngectomees to improve upon the relatively poor outlook (for speech) after total laryngectomy. Conservative surgery has developed because of its capacity to preserve speech (Bocca, Pignataro and Masciario, 1968; Ogura et al, 1960; Som, 1970) and has been applied in vertical partial laryngectomy since inception.

An early method of improving speech or voice production has been to develop a small tracheo-oesophageal fistula (Conley, de Amnesti and Pierce, 1958) which allows the oesophagus to be charged with air more continuously from the trachea (that is the pulmonary 'bellows' is brought back into play). Such a procedure relies upon the development of the oesophageal or pharyngeal vibrator, which is not developed by all patients.

**Neoglottis.** More definite attempts at laryngeal voice replacements are represented by the method of Staffieri (1974). This procedure also develops a tracheo-oesophageal fistula. One method uses the fistularized redundant mucosa derived from the postcricoid region positioned over the cut end of the trachea, and the second prepares a fistula through the posterior wall of the trachea. In each case the tracheostomy is made through the anterior wall of the trachea lower down and no end-tracheostomy is fashioned. Both these methods are intended to provide a form of neoglottis which itself generates a voice, but the second method, particularly, may act as a recharging mechanism for the oesophagus, utilizing a phonatory vibration in the pharynx.

The construction of such a neoglottis is as follows. A total laryngectomy is carried out without prejudicing the lower margin of the tumour, that is an adequate margin of the subglottis must be removed with the tumour. A tracheostome is constructed at a lower level in the anterior wall of the trachea. The mucosa of the postcricoid/anterior oesophageal wall
is preserved and positioned using the index finger over the cut end of the trachea. A vertical incision is made through the fasciomuscular layer and the mucosa drawn through, incised, and sutured to line the fistula. A filament is passed through the nose, fistula and tracheostomy to mark the fistula, the pharyngeal wall is sutured to the end of the tracheal and then closed as is usual after laryngectomy and the skin closed. Drains should not be placed too close to the reconstruction. Phonation is achieved by temporarily closing the tracheostomie and directing air into the pharynx.

The Asai technique (Asai, 1965) is an ingenious method using a tube of skin from the upper end of the trachea to recurved under the based of the tongue, using, for example, a medially-based (deltopectoral) chest flap.

All these techniques are attractive but have the same problems. Their attraction is that, in the majority of cases, speech at least as good as the oesophageal speech is obtained, and often better because the reservoir (the lungs) of air is large. In addition, it is easy to ensure that phonation is achieved rapidly just as a patient with a tracheostomy but retaining the larynx is quickly returned to speaking normally. However, the disadvantages are those associated with a tracheo-oesophageal fistula, and no method has so far been described where aspiration has not been experienced - if the neoglottis is too wide, aspiration may occur; if too narrow, phonation is impaired.

Valves. In order to improve upon the achievements associated with the construction of a neoglottis, Singer and Blom (1980) and Panje (1981) devised replaceable valves which, when inserted, behave in a manner which is an advance on the quality of phonation usually produced by a neoglottis. Since they are one-way valves, aspiration may be reduced. Their disadvantage is the need to replace the valve regularly and the associated cost; nor are these methods entirely free of the risk of aspiration. However, both the Blom-Singer and the Panje valves can be inserted as a secondary procedure (Singer and Blom, 1980) after a standard laryngectomy and end-tracheostomy have been performed. An essential part of the procedure is the prevention of muscular spasm of segments of the pharynx, and Singer and Blom (1981) emphasized the need for a (posterior) myotomy of the pharyngeal wall at laryngectomy or as a secondary procedure. Hamaker et al (1985) have summarized the results.

A reasonable approach to voice rehabilitation may be as follows. A total laryngectomy with an end-tracheostomy is carried out and healing allowed to be completed. A myotomy of the pharyngeal musculature from the level of the tongue to the upper oesophagus is performed. This minimizes the operative risk and allows any adjuvant radiotherapy and chemotherapy to take place. Voice rehabilitation should be pursued and will be achieved by a proportion of patients. A later reassessment will permit the identification of those whose rehabilitation is inadequate, and a neoglottis or valve preparation can be provided as a secondary procedure. A practical compromise may be to construct a tracheostomy in the anterior wall of the trachea, leaving the end prepared with a pharyngeal wall cover, but not fistularized, in order to be able to construct the neoglottis more satisfactorily at a second stage if a Staffieri type is preferred to a replaceable valve.

Disability after total laryngectomy. The main disability from which the patient will suffer after operation is naturally the loss of the normal voice. The sense of smell is also
impaired because there is no regular air current through the nose, and taste and the appreciation of flavours are reduced.

The patient must take care that water does not enter the tracheostome when bathing or washing, and swimming must be prohibited.

Heavy lifting or strenuous digging are not possible as these actions entail fixation of the chest wall by closure of the larynx, but light physical work is possible and, occasionally, the patient can partially close the tracheostome by contracting any muscle remnants surrounding it. Some young women who have undergone this operation have subsequently married and borne children without difficulty (Shaw, 1965).

If radical neck dissection has been necessary, some reduction in the usefulness of the arm at the shoulder level may be expected, especially in the older age groups, together with a variable amount of persistent discomfort more evident in those whose range of movement is most impaired (Ewing and Martin, 1952).

Apart from these disadvantages, patients generally come to terms with their disabilities, adaptation being usually good in age groups up to 65 years. Unfortunately, many patients are older and less adaptable but with instruction and encouragement from surgeons, speech therapists, laryngectomee clubs and associations, the majority lead happy and useful lives although they are often socially limited.

**Other malignant ectodermal tumours**

**Verrucous carcinoma**

This rare carcinoma (approximately 1% of laryngeal malignancies) (Ryan et al, 1977) has a male predominance, causes the usual laryngeal symptoms, frequently has an extensive warty papillomatous appearance, and its site is glottic more often than supraglottic. Lymphatic spread is rare (Biller, Ogura and Bauer, 1971). Traditionally treatment is surgical (Burns, van Nostrand and Bryce, 1976) by partial or total laryngectomy. Radiotherapy has been employed, but anaplastic change and death have been reported after this (Burns, van Nostrand and Bryce, 1976), while uniformly good results follow surgery (and this may include local or biopsy excision) (Maw, Cullen and Bradfield, 1982).

**Carcinosarcoma**

An equally rare lesion (less than 1% of laryngeal malignancies) (Goellner, Devine and Weiland, 1973), carcinosarcoma presents with typical symptoms and usually a polypoid or pedunculated appearance (Brodsky, 1984). Treatment is by excision, with either partial or total laryngectomy. Radiation has rarely been used and is difficult to evaluate (Hyams and Rabuzzi, 1970).

**Adenoid cystic carcinoma**

Adenoid cystic carcinoma of the larynx is also very rare (Olofsson and van Nostrand, 1977) with the typical rather long history of laryngeal symptoms. The subglottis, in contrast
with other laryngeal malignancies, is the commoner site. Local or wide-field surgery is the generally favoured treatment, although radiotherapy is used on some occasions. The slow and relentless course of this tumour makes 5-year 'cures' meaningless and the vast majority eventually succumb.

Other rarities include anaplastic small cell carcinoma (Olofsson and van Nostrand, 1972). These tumours are treated with primary radiotherapy and adjuvant chemotherapy (Baugh et al, 1986).

**Malignant mesodermal tumours**

*Chondrosarcoma* is exceedingly rare, and usually occurs in the posterior segment of the cricoid. Surgery, inevitably in the form of total laryngectomy, is the only useful treatment in most cases, although tumours in certain locations could be excised conservatively (Hellquist, Olofsson and Grontöft, 1979).

*Non-Hodgkin's lymphoma* is rare, but once diagnosed is treated, as other extranodal lymphomata, by radiotherapy and/or chemotherapy. *Melanoma* (Conley, 1967) and *fibrosarcoma* are equally rare and are treated by excision.

**Summary and selection of treatment**

Assessment of the relative value of differing treatment methods for laryngeal cancer is not easy. Despite the gradual international adoption of the TNM classification system, confirmed in 1978 for the larynx, and greater uniformity in end-result reporting, most accounts are still based on retrospective studies. Adequate conclusions by randomized controlled prospective studies are still lacking, in part as a consequence of difficulty of application in cancer therapy. Despite this, much knowledge has been gained in recent years by extensive clinical experience using increasingly refined methods of surgery and radiation; also by the histological study of serially-sectioned laryngeal specimens (Kirchner, 1969; McDonald, de Santo and Weiland, 1976; Olofsson and van Nostrand, 1973). Important knowledge of lymphatic pathways within the larynx (Pressman and Simon, 1961) and patterns of local spread and cervical lymph node involvement has also been gained (Kirchner, 1974; Olofsson and van Nostrand, 1973).

Forty years ago radiotherapy was condemned for limited cordal cancer (Colledge, 1940). Today it is established as the treatment of choice in such lesions. In early glottic cancer (T1 and T2), modern radiation techniques still allow the surgeon to perform partial or total laryngectomy for failures with good salvage rates (Lederman, 1970; Bryce, 1972). In support of radiation for early glottic lesions, Lederman (1970) reported 5-year survival rates of at least 77% in his large series. Recurrence of glottic cancer after radiation and still treatable by lateral partial laryngectomy, can give a salvage for 3-year survivals of about 60% with preservation of voice and natural airway (Radcliffe and Shaw, 1978). In more advanced recurrent glottic or transglottic cancer after radiation, a 5-year survival rate of 47% by total laryngectomy can still be obtained (Stell et al, 1982).

On the other hand, 5-year survival results for initial treatment by radiation of smaller supraglottic and epilaryngeal cancer without nodal spread are very satisfactory (Lederman,
1970; Fletcher et al, 1970; Fletcher and Goepfert, 1977), but salvage for failures will generally require total laryngectomy. Such cases treated by supraglottic partial laryngectomy may give a 5-year survival of 70% with voice preservation and equally good chances of salvage by total laryngectomy for the failures (Som, 1970; Shumrick, 1971; Leroux-Robert, 1975; Ogura, Marks and Freeman, 1980). Primary conservation surgery therefore compares favourably with primary radiation treatment (de Santo, Willie and Devine, 1976). Supraglottic laryngectomy may be preferable in those cancers which include the false cord and base of epiglottis and those with metastatic nodes (Ogura, Sessions and Spector, 1975).

T3 glottic lesions, once automatically recommended for primary surgery or planned combined radiotherapy and surgery (Lederman, 1970; Sissons, 1974), should now be considered for primary radiation treatment with 'salvage' surgery if there is recurrence (Bryce, 1972; Stell et al, 1982). Larger T4 lesions are still much more appropriately treated by surgery, although some clinicians would challenge this.

The rare cases of true subglottic cancer are generally advanced when diagnosed and planned combined treatment by radical surgery with postoperative radiation to the lower neck and mediastinum probably gives the best chance of cure (Harrison, 1971; Bryce, 1972). However, Lederman (1970) has shown that where the disease is limited to the anterior half of the subglottic space with no palpable neck nodes and no vocal cord fixation, a 5-year survival rate of 60% can be obtained by radiation, particularly in women.

A more recently emerging treatment, apparently of value when used as an adjuvant method in advanced lesions (T3 and T4), is cytotoxic chemotherapy. Since 1974, the use of a kinetically based multidrug protocol has been on trial either before or after conventional therapy (Price and Hill, 1977) or integrated with radiation (O'Connor et al, 1977). Results are beginning to emerge from both techniques with minimal side-effects (O'Connor et al, 1979).

These results illustrate certain definite trends in the management of laryngeal cancer. First, that radiation gives excellent results in the early glottic lesions with absolute preservation of function. Second, that the balance of judgement between conservative and radical surgery of the larynx is becoming more refined, with the results of the former approximating to the latter for supraglottic tumours and at least equalling the results of radiation. Third, that the attack on cancer at the molecular level through cytotoxic drugs is now being applied to the larynx as an aid to conventional methods or combined treatment, again with cure and functional conservation as the objectives.

Perhaps in contrast with the foregoing has been the development of endolaryngeal procedures with the laser, permitting more accurate excision and, combined with careful follow-up, an even more conservative approach to non-malignant lesions, to carcinoma in situ and to a few very small invasive malignancies. The development of a more positive attitude to rehabilitation, including the neoglottis and valve techniques, should encourage a more definitive and constructive approach to laryngeal cancer in general. Whether still further advances can be made by prevention (that is alcohol reduction and a non-smoking generation) and by further therapeutic developments, remains to be seen.
Appendix 11.1 Larynx (ICD-0 161) (classified 1972, confirmed 1978)

Rules for classification

The classification applies only to carcinoma. There should be histological verification of the disease. Any unconfirmed cases must be reported separately. The minimum requirements for assessment are:

- **T (site):** clinical examination, laryngoscopy and radiography
- **N (node):** clinical examination
- **M (metastases):** clinical examination and radiography
- **X** indicates that minimum requirements for assessment cannot be met.

Anatomical regions and sites

(1) Supraglottis (161.1)

*Epilarynx including marginal zone*

(i) Posterior surface of suprahoid epiglottis (including the tip)
(ii) Aryepiglottic fold
(iii) Arytenoid

*Supraglottic excluding epilarynx*

(iv) Infrahoid epiglottis
(v) Ventricular bands (false cords)
(vi) Ventricular cavities

(2) Glottis (161.0)

(i) Vocal cords
(ii) Anterior commissure
(iii) Posterior commissure

(3) Subglottis (161.2)

*Regional lymph nodes*

The regional lymph nodes are the cervical nodes.
TNM pretreatment classification

T - primary tumours

Supraglottis

Tis  Preinvasive carcinoma (carcinoma in situ)
T0  No evidence of primary tumour
T1  Tumour confined to the region with normal mobility
T1a Tumour confined to the laryngeal surface of the epiglottis or to an aryepiglottic fold or to a ventricular cavity or to a ventricular band
T1b Tumour involving the epiglottis and extending to the ventricular cavities or bands
T2  Tumour confined to the larynx with extension to adjacent site or sites or to the glottis without fixation
T3  Tumour confined to the larynx with fixation and/or other evidence of deep infiltration
T4  Tumour with direct extension beyond the larynx
Tx  The minimum requirements to assess the primary tumour cannot be met.

Glottis

Tis  Preinvasive carcinoma (carcinoma in situ)
T0  No evidence of primary tumour
T1  Tumour confined to the region with normal mobility
T1a Tumour confined to one cord
T1b Tumour involving both cords
T2  Tumour confined to the larynx with extension to either the supraglottis or the subglottis regions with normal or impaired mobility
T3  Tumour confined to the larynx with fixation of one or both cords
T4  Tumour with direct extension beyond the larynx
Tx  The minimum requirements to assess the primary tumour cannot be met.

Subglottis

Tis  Preinvasive carcinoma (carcinoma in situ)
T0  No evidence of primary tumour
T1  Tumour confined to the region
T1a Tumour confined to one side of the region
T1b Tumour with extension to both sides of the region
T2  Tumour confined to the larynx with extension to one or both cords with normal or impaired mobility
T3  Tumour confined to the larynx with fixation of one or both cords
T4  Tumour with destruction of cartilage and/or with direct extension beyond the larynx
Tx  The minimum requirements to assess the primary tumour cannot be met.
\textit{N - regional lymph nodes}

N0 No evidence of regional lymph node involvement
N1 Evidence of involvement of movable homolateral regional lymph nodes
N2 Evidence of involvement of movable contralateral or bilateral regional lymph nodes
N3 Evidence of involvement of fixed regional lymph nodes
Nx The minimum requirements to assess the regional lymph nodes cannot be met.

\textit{M - distant metastases}

M0 No evidence of distant metastases
M1 Evidence of distant metastases
Mx The minimum requirements to assess the presence of distant metastases cannot be met.

(Note: The TNM system, with particular reference to N (nodes) is due for revision in 1987.)