Radiological evaluation of the mucosal surfaces of the upper aerodigestive tract has always been secondary to clinical examination, but can be useful for showing foreign bodies or the lower limits of a tumour when this cannot be assessed endoscopically. Traditionally the radiographic techniques used have been (a) plain films to show the air/soft tissue interface and surrounding bony structures, (b) intraluminal contrast examinations. High kilovolt techniques, tomography and xeroradiography, singly or in combination, are used to give a better demonstration of the outlines of these air-filled cavities; the first two techniques by partially eliminating the overlying bony structures from the image, and xeroradiography by the edge enhancement effect. However, interpretation is fraught with difficulty because of variations in airway contour, poor radiographic contrast and superimposition of areas of interest. The barium swallow remains the most important radiological examination for the oro- and hypopharynx, especially when combined with cineradiography. It is a simple and easy means of examination, although obviously of more value for lesions below the cricopharyngeus which cannot be assessed with a laryngeal mirror.

High resolution computerized tomography (CT) has greatly improved and extended the imaging capabilities in this region. Not only is the clearest demonstration of the air/soft tissue interface given in axial sections, but also the surrounding fascial planes, muscles and vessels in the parapharyngeal region, are shown. Thus anatomy which formerly could not be assessed, except by invasive contrast examinations such as angiography or sialography, can be seen and CT has proved capable of showing deep pathology that is undetectable by physical examination and sometimes even by biopsy.

The radiographic anatomy and a brief account of some features of disease of the mucosal surface of the nasopharynx are considered in Volume 4, Chapter 2. It is stressed there that demonstration of infiltration by carcinomata into the deep tissue planes of the parapharyngeal region was the most significant advance made by the latest sectional soft tissue imaging techniques. The parapharyngeal space bridges the nasopharynx and oropharynx and so a discussion of the CT anatomy and the fascial spaces and compartments below the skull will be considered, together with a brief account of the relations of the salivary glands to these spaces.

Magnetic resonance (MR) promises to give even better demonstration of these soft tissue structures. Differentiation between mucosal and lymphoid tissue is possible, and there is clear delineation of tumours from surrounding soft tissues. The relationship of a mass to major blood vessels is also shown better with MR than by enhanced CT (Lloyd and Phelps, 1986). Above all, direct three-plane imaging is a major advantage especially in the demonstration of the limits of the tumour.
Imaging techniques

Plain radiography

The best plain film view of nasopharynx, larynx and pharynx is given by the lateral projection with the pharynx and larynx clear of the cervical spine. The film is placed against the shoulder and the incident beam is centred on the angle of the jaw if the nasopharynx is the region of interest, or the thyroid cartilage if the larynx is being examined. Xerograms give a clearer demonstration. Alternatively, a high kilovolt technique may be used utilizing 'low dose' film with screens, or a wedge filter to allow visualization of the range of densities from the neck to the thoracic inlet.

To show the structures low in the neck and upper mediastinum, the central ray is directed to a point below the middle of the clavicle at the level of the thoracic inlet and to the centre of the film, placed in the Bucky tray.

Even with xerography or high kilovolt technique the anteroposterior projection is usually less informative as the air-filled structures of the nasopharynx and larynx are largely obscured by the cervical spine, but it may show tracheal displacement or compression, or a fluid level in a pouch or abscess. To demonstrate a laryngocoele the exposure is made during the Valsalva manoeuvre, but tomography may be necessary. Long ossified styloid processes are best shown on an anteroposterior film taken through the open mouth. All examinations should be performed erect if possible to show fluid levels if present.

Structures demonstrated

On the lateral projection, air in the upper respiratory passages outlines the valleculae and cavities of the larynx and trachea. Soft tissue structures such as the soft palate, base of tongue, epiglottis and aryepiglottic folds are silhouetted against this air background. Occasionally enlarged tonsils may be seen as oval densities, and the cartilaginous eustachian tube may present as a narrow dark slit when filled with air having a rim around it due to the eustachian cushion. The hyoid bone and, if ossified, the thyroid and cricoid cartilages, can usually be clearly seen. Careful note should be made of the thickness of the soft tissues in the nasopharynx and of the prevertebral soft tissues. These are important, as a bulge or increase in thickness may indicate oedema, abscess, haematoma, cyst or tumour. Loss of the normal spinal curvature should also be noted. Surgical emphysema shows as linear streaks of air in the prevertebral plane. In adults the soft tissues in the roof of the nasopharynx should measure not more than 1 cm; they should be regular in outline and thickness. In children, hypertrophy of adenoids may be so pronounced as to obliterate the air space between the posterosuperior wall and the soft palate, and enlarged adenoids may be visible into early adult life. Imaging of the adenoids is considered in Volume 6, Chapter 24.

In infants, particularly in the first weeks of life, the prevertebral soft tissues normally look thick, especially on full expiration, and this should not be mistaken for a retropharyngeal infection. Films should always be taken on inspiration and, if there is any doubt, the film should be repeated on expiration, or a cine run taken with the infant held in an erect lateral position.
The depth of the cervical prevertebral soft tissues normally increases slightly from the level of the anterior arch of the atlas down to the lower border of the fifth and sixth cervical vertebrae, where it blends with the thicker soft tissue shadow of the cricopharyngeus and upper oesophagus. After the age of 2 or 3 years it should not measure more than 4 mm in depth. Below the cricoid the soft tissue thickness between the air-filled trachea and the spine should not normally exceed three-quarters of the diameter of the corresponding cervical vertebra, and should it do so a tumour or inflammation in the postcricoid region or upper oesophagus should be suspected.

Foreign bodies and growths in the larynx or trachea may be silhouetted against intraluminal air. At the thoracic inlet the trachea usually lies centrally in the anteroposterior projection. On the lateral view, it normally lies equidistant between the anterior vertebral border and the posterior profile of the upper manubrium. These relationships may be disturbed by scoliosis or kyphosis, the trachea being displaced towards the concavity of the scoliosis, and forwards with kyphosis. With a straight cervical spine, displacement of the air-filled trachea (or barium-filled oesophagus) indicates extrinsic pressure.

Ossification commonly occurs in one or more of the laryngeal cartilages, although there is considerable individual variation both in age of onset and extent. It is uncommon before the third decade. Ossification occurs most commonly in the thyroid cartilage in which it starts posteriorly and slowly extends forwards and upwards. The cricoid tends to ossify from behind forwards. The stylophoid ligament not infrequently ossifies in its upper part, and occasionally throughout its whole extent. The styloid processes are best shown on an anteroposterior film taken through the open mouth. Rarely, ossification occurs in the epiglottis and occasionally the cricothyroid ligament is ossified. Compression of the trachea is usually obvious.

The arytenoids may ossify in the absence of ossification in other laryngeal cartilages and present as dense triangular opacities. If superimposed they should not be mistaken for a swallowed foreign body when the examination has been performed to try to demonstrate one. The same applies to ossified triticeous cartilages. The corniculate and cuneiform cartilages are unlikely to be so mistaken because they lie more anteriorly.

The region of the anterior commissure is often difficult to assess endoscopically and lesions of this part of the larynx may be shown best by lateral xerography or by CT which can also demonstrate extension of a tumour into the pre-epiglottic space.

**Tomography**

Conventional tomography still has an important place in the examination of the larynx especially in the frontal projection, although a similar demonstration may be obtained by high-kilovolt techniques. Anteroposterior tomographic studies of the larynx demonstrate the true and false vocal cords and the laryngeal ventricle between them. The cords should be demonstrated in full adduction by obtaining a picture with the patient phonating ‘ee’ and as near as possible in full abduction in the phase of quiet respiration. Linear tomography is preferred because of the short exposure time and good radiographic contrast. Further views may be obtained in inspiratory phonation to distend the laryngeal ventricles, or with the
patient performing a Valsalva manoeuvre which produces distension of the supraglottic larynx and hypopharynx.

Immobility of one vocal cord due to paralysis or fixation shows loss of the normal acute angle between the undersurface of the cord and the subglottis when the patient phonates 'ee', but such immobility is of course normally assessed clinically. Tomography is of more value for lesions below the cords, especially when there is narrowing as by a tumour or previous intubation.

**Computerized tomography**

Computerized tomography of the larynx is now a valuable addition to available imaging techniques although it has not replaced the traditional ones, especially linear tomography. The axial CT sections produce an image similar to the one seen by the surgeon. Respiratory movement is less of a problem with the new fast scanners, but acceptable images can be obtained in quiet respiration with long scanning times. Scanning is begun at the level of the hyoid bone and sequential scans are viewed. Above the rounded hypopharynx it is bisected by the crescentic epiglottis. Further down the median and lateral glosso-epiglottic folds delineate the valleculae. Below this the airway assumes a triangular shape and the pyriform fossae are seen as two lateral appendages separated by the aryepiglottic folds. At the level of the cords the shape changes to the characteristic glottic chink or boat shape with the sharp anterior commissure extending right up to the thyroid cartilage in the midline. In the subglottic area there is an even symmetrical oval shape which gives way at the level of the first tracheal ring to an oval flattened posteriorly, which may be likened to the shape of a horseshoe. Further sections may be taken with the patient holding his breath or performing a modified Valsalva manoeuvre. A good demonstration of distended pyriform fossae and the supraglottic structures may be obtained.

Computerized tomography provides a non-invasive, quick and effective radiological investigation of the larynx, and is not uncomfortable for the patient. It can be carried out without risk in the face of respiratory obstruction or after suspected laryngeal injury. It gives an accurate assessment of laryngeal anatomy and involvement by tumour, particularly at the glottic level. The value of such an assessment is greatly increased if partial laryngectomy is contemplated, but this is an unusual operation in the UK where carcinoma of the larynx is treated by radiotherapy and/or total laryngectomy. Because CT and conventional tomography present images in different planes, the two are complementary. Whereas CT is better for showing the laryngeal cartilages and structures at the glottic level, conventional tomography is superior for showing subglottic extension of growths, and gives a more satisfactory demonstration than reformatted CT images in the coronal plane.

Fractures of the larynx, as from direct contact with the steering wheel of a motor vehicle, are difficult to demonstrate radiologically and even harder to assess clinically. Xerography may be useful but CT is now the optimum method for showing fractures of the thyroid cartilage, displacement of the arytenoids and the size and state of the airway.

Computerized tomography can assist the endoscopic assessment of tumours both benign and malignant, although it is not required routinely. Some rare benign tumours may show characteristic features. Chondromata arise from one of the laryngeal cartilages and show
a typical appearance on CT with speckled calcification. Plasmacytoma appears radiologically as a smooth rounded tumour, homogeneous in consistency and often indistinguishable from carcinoma of the larynx. Lipoma is a very rare tumour which may be suspected preoperatively because of low attenuation of the fat.

Malignant tumours are nearly always squamous cell carcinomata, and CT may help to evaluate deep laryngeal and paralaryngeal soft tissue invasion, thereby altering the staging of the disease. The paraglottic space, that is the space between the mucosa and the cartilage, is well demonstrated and is seen as a translucent line just deep to the thyroid lamina. When this line is absent on one side, it contrasts with the normal side and indicates tumour infiltration of the thyroarytenoid muscle, up to the thyroid cartilage. The most important role for CT is for showing invasion of the cartilaginous skeleton of the larynx by the tumour. Such involvement is a strong indication for total laryngectomy. Gross involvement of the thyroid laminae is usually obvious on CT, but minor degrees of destruction by tumour invasion may be difficult to evaluate, since the thyroid laminae may show considerable unevenness of density in the normal. This may give rise to both false positives and false negatives in interpretation (Lloyd, Michaels and Phelps, 1981). Another feature which has been associated with invasion of the cartilages, confirmed after surgical excision of the larynx, has been the presence of increased density and ossification. This may involve the arytenoid, cricoid and thyroid lamina. In the author's series of 26 cases, increase in the density of the cartilage was shown to be due to increased ossification and was most often seen in the arytenoid. Previous radiotherapy appeared to be an important factor in most but not all cases.

**Magnetic resonance**

Magnetic resonance images can be obtained in three planes, but this modality has not been fully evaluated at present.

**Soft tissue imaging in the parapharyngeal region**

An axial CT scan with 5-mm contiguous sections forms the basis of the examination. Contrast enhancement, by bolus injection or infusion, is usual to show the position of the major vessels or the presence of a vascular tumour. There is normally clear delineation of the parotid gland from the muscles and from fat in the parapharyngeal space, but sialography may help to define the limits of the deep lobe of the parotid. Magnetic resonance shows the position of the vessels more clearly.

**Infratemporal and pterygopalatine fossae**

The infratemporal fossa is an irregularly shaped space behind the maxilla and medial to the ramus of the mandible. It is situated below the zygoma, the greater wing of the sphenoid and part of the squamous temporal bone. The medial wall of the fossa is the lateral pterygoid plate. The anterior and medial walls meet below, but are separated above by the pterygomaxillary fissure through which the infratemporal fossa communicates with the pterygopalatine fossa. The upper end of the pterygomaxillary fissure is continuous with the inferior orbital fissure. The pterygopalatine fossa is well shown by axial CT and the sphenopalatine foramen, which is an opening in its medial wall, that is the lateral wall of the nasal cavity, can sometimes be seen. The normal fossa contains fat.
Spread of tumours along the axis of the pterygomaxillary fissure with expansion of the walls is an important concept, particularly in the natural history of juvenile angiofibroma. This tumour arises in the region of the sphenopalatine foramen and spreads through the fissure into the infratemporal fossa (Lloyd and Phelps, 1986). This is a much more important sign than the traditional 'bowing' of the posterior wall of the antrum, but erosion of bone in the region of the sphenopalatine foramen appears to be pathognomonic.

The infratemporal fossa contains all muscles of mastication except the laterally placed masseter and the small depressors of the mandible. Most laterally and superiorly is the head of the temporalis muscle which inserts on the coronoid process of the mandible. The pterygoid muscles are protractors of the mandible and fill the bulk of the infratemporal fossa. A significant portion of the maxillary artery also lies within the infratemporal fossa.

The 'spaces' that have been considered so far have some bony boundaries, although inferiorly they are continuous with other described potential spaces whose boundaries are not bony but the deep fascial planes of the neck. Unfortunately these fascial boundaries are not demonstrated by imaging techniques; neither do they interfere with the spread of malignant neoplasms. Nevertheless they must be considered, as expansion of benign tumours and the resultant CT appearances depend very much on the site of origin of the tumour. The two most important of these spaces will be referred to as the parapharyngeal space and the carotid space.

The parapharyngeal space

This is the most anterior space and extends from the base of the skull to the hyoid bone. The fat in the space is a prominent feature of axial CT scans at this level. The lateral wall of the parapharyngeal space is formed by the pterygoid muscles. The medial wall is made up of the swallowing muscles. At the level of the nasopharynx, these are principally the tensor and levator palati, but below this the medial wall is formed by the constrictor muscles of the pharynx. The muscles arising from the styloid process form the posterior wall.

As described in the account of the nasopharynx in Volume 4, Chapter 2, carcinomata of the nasopharynx have a marked tendency to spread into and obliterate the parapharyngeal fat space, but this space is also encroached upon by benign tumours arising laterally in the deep lobe of the parotid gland, or medially in the wall of the nasopharynx. When the tumour becomes large the fat planes are obliterated, but before this stage is reached the position of the fat in the parapharyngeal space in relation to the mass is an important indication of whether this mass arose in the pharynx or in the deep lobe of the parotid gland.

The carotid space

The carotid space or sheath is a potential fascial space containing the internal jugular vein, the carotid arteries, and the lower four cranial nerves, as well as the sympathetic chain and various lymph nodes. Benign tumours arising in this space are usually vagal neuromata or rarely glomus tumours. These tumours tend to respect the fascial margins of the carotid space and to separate the major blood vessels. The relationship of the blood vessels to the mass is better shown by MR. Lower down at the hyoid level, a densely enhancing but smoothly outlined mass shown by CT is almost certain to be a carotid body tumour.
Rarely a mass may arise more posteriorly in the so-called 'paraspinal space' and displace all the vessels as well as the anterior scalene muscle anteriorly.

**Regimen for investigating parapharyngeal masses**

At the present time CT in the axial plane with 5-mm contiguous sections and contrast enhancement, preferably by infusion, appears to be the optimum means of investigating these lesions. In selected cases, further sections in the coronal plane may be an advantage. At least one series (Schaefer et al, 1985) has demonstrated better definition of these tumours by MR than by CT, and another series (Lloyd and Phelps, 1986) has shown a better demonstration of the relationship of the major vessels. Angiography is clearly indicated if the lesion appears to be vascular, but seems to have little to offer if there is no contrast enhancement on the CT scan.

Dynamic CT scanning is discussed in Volume 1, Chapter 17 but there has been little experience or success in differentiating neck masses by use of this technique. Som et al (1984) described a protocol based on differentiating a deep lobe parotid mass and an extraparotid lesion. The best way of making this distinction is by demonstrating a fat plane between the deep lobe and the posterolateral aspect of the mass. This fat plane represents the compressed fibrofatty supporting matrix of the parapharyngeal space and, when it is seen, the mass is extraparotid in origin. When the fat plane is not seen between the mass and the parotid gland, the lesion is probably a parotid tumour.

Further discrimination can be made by the degree and timing of the contrast enhancement by plotting attenuation against time curves. Immediate enhancement followed by rapid washout is a feature of vascular anomalies and vascular tumours with little stroma such as glomus tumours, whereas meningiomas show a less rapid but more persistent degree of enhancement. Neuromata almost always enhance less but the degree of enhancement is very variable and difficulty may be encountered in distinguishing between extraparotid benign mixed tumours and the neuromata that do not show enhancement. Their similar appearances on CT scans and the dynamic scan findings do not, in most cases, allow a confident distinction to be made. The internal carotid artery is usually, but not always, displaced anteromedially by neuromata and posteriorly by minor salivary gland tumours. Som et al also found that most extraparotid benign pleomorphic salivary adenomata arise within salivary cell rests in the parapharyngeal space and, therefore, are separate from both parotid and the pharyngeal muscular wall. This has also been the experience of the author.

Few authorities in the UK use CT for assessment of cervical lymph nodes, but at least one series from the USA (Stevens et al, 1985) has shown that CT has greater accuracy than the clinical examination of the neck for the staging of patients with nodal metastases. Their criteria on the CT scan were:

(1) if there was a lymph node greater than 1.5 cm in size;

(2) if the node had central necrosis regardless of size, in the absence of clinical infection, or
(3) if a group of three or more nodes, each smaller than 1.5 cm, was seen in the primary drainage station of the primary tumour, as sometimes enlarged nodes may be demonstrated replacing the parotid gland or within the carotid sheath obscured by the overlying sternomastoid muscle.

It appears that magnetic resonance is inferior to CT for this demonstration, and is unable to show any nodes that cannot be palpated.

**Barium swallow examination**

Assessment of the mucosal surfaces of the oro- and hypopharynx is, as with the nasopharynx, almost entirely by inspection. Barium swallow is of more value for showing lesions of the oesophagus, pharyngeal pouches, fistulae, and for neurological swallowing problems especially when cine is used.

Normally barium flows rapidly through the pharynx and down the oesophagus. It may coat the sides of the pharynx for a short time and, after the first swallow, a little may remain in the valleculae and pyriform fossae only to be quickly cleared by a subsequent swallow. Any degree of stasis beyond this should be suspect. The normal larynx will appear as a 'filling defect' in the frontal projection with contrast in the pyriform fossa on either side. This is well shown on the oblique projection, obtained with the patient swallowing while his head is turned to one side. Tumours of the pharynx will be well outlined by a coating of barium and masses demonstrated in the pyriform fossae, which are sometimes difficult to see with a mirror.

When the larynx fails in its primary function as a protective sphincter for the lungs, 'spillover' will occur to give a 'barium laryngogram'. This problem is seen more and more in an ageing population when dysphagia is often the result of a mild stroke. Cineradiography at four frames per second gives a good demonstration of deglutition. Passage of the bolus across the back of the tongue, with elevation of the larynx and tilting of the epiglottis down over the closer larynx, is shown. Contrast then passes through the open cricopharyngeus into the oesophagus. Minor functional disorders of swallowing can only be shown by this technique, but it is wasteful of film and should probably only be used to try to solve a particular swallowing problem. A good account of pharyngeal deglutition in patients with functional disorders of the act of swallowing, compared with a group of volunteers with no complaint of dysphagia, is contained in two papers from Malmo, Sweden (Ekberg and Nylander, 1982a, b). These authors, using cineradiography at 50-100 frames per second, found a high incidence of epiglottic dysmotility and cricopharyngeal incoordination in the patients with dysphagia. Although only a small percentage had severe disturbance, such as complete paralysis of the pharyngeal constrictors or aspiration into the trachea, nevertheless contrast was frequently seen to enter the vestibule of the larynx.

**Oesophagus**

This is a tubular organ the diameter of which varies from a potential space to the size needed to accommodate whatever can be swallowed. It normally contains no air, although occasionally a small triangular air shadow can be seen on a lateral film just below the level
of the cricopharyngeus. Air is almost always visible in this region when there is a foreign body present in the pharynx or upper oesophagus.

The conventional radiological examination is the barium swallow. It is often stated that barium should never be used if it is thought that spillover into the trachea may occur, but provided small amounts only are used, there seems to be little danger, especially if postural drainage is used afterwards.

Barium is insert and less irritating than most water-soluble contrast media, and usually provides better radiographic detail. In infants, if atresia or a fistula is suspected, it is better to pass a soft rubber tube and to inject a water-soluble opaque fluid, of the kind used for bronchography, only if necessary. Communication between the oesophagus and trachea involves the anterior wall of the oesophagus so that injection of opaque fluid should be made in prone and prone oblique positions under X-ray screen control and films taken as required.

When undertaking a screen examination of the oesophagus, the patient is usually given barium fluid to swallow, although occasionally barium paste is used. The radiologist follows the passage of a mouthful of barium from the mouth to the stomach. The situation, extent, and form of physiological and pathological constrictions or filling defects, or any hesitation, hold-up or diversion of the normal flow are noted. Attention is paid to the form and amplitude of peristaltic waves. Some authorities test the lower oesophageal sphincter for competence by watching the patient swallowing prone while abdominal compression is applied. However, such an unphysiological manoeuvre has little relevance as a test for reflux. Reflux of barium into the oesophagus when the patient swallows water in the supine position is probably a better test.

Zaino and colleagues (1970) have demonstrated that there is a sphincter 1-2 cm long at the upper end of the oesophagus, below the cricopharyngeus, in which increased pressure can be measured manometrically, and stated that this provides the true sphincter mechanism for the upper oesophagus and not the circular fibres of the cricopharyngeus. At times the cricopharyngeus muscle may produce a pronounced indentation of the posterior outline of the filled oesophagus as barium passes through, and this is often especially marked when there is neuromuscular incoordination present, as with bulbar lesions.

Foreign bodies in the upper aerodigestive tract are usually fish or meat bones lodged in the upper oesophagus. It may be difficult to differentiate the foreign body from ossification in the laryngeal cartilages. Air in the soft tissues or in the oesophagus, held open by a non-opaque foreign body, is an important sign. Less often objects such as pins, coins, dentures, buttons, etc may lodge in the pyriform fossa, the nasopharynx or between the cords. Stridor is the presenting feature in such cases. Perforation, either by the foreign body or by instrumentation, can lead to inflammatory changes in the para- and retropharyngeal tissue planes. Widening of the retropharyngeal soft tissue space is seen in such cases, sometimes with surgical emphysema or an abscess cavity.

When one attempts to demonstrate or localize a non-opaque swallowed foreign body such as a fish bone, success can sometimes be achieved by persuading the patient to swallow a sandwich of teased-out dry cotton wool with a centre of cotton wool soaked in barium. The
patient should try and swallow this without mouthing it and saturating it with saliva and, should it be impaled on the fish bone, the site is immediately shown.

The upper oesophagus normally deviates a little to the left at the level of the thoracic inlet. It may be indented, compressed or displaced by an enlarged thyroid, or parathyroid gland, or enlarged lymph nodes, as well as by mediastinal tumours or aneurysms of the aortic arch. It is indented anteriorly, and on its left side, by the normal aortic arch and left main bronchus and, when present, the oblique indentation of an anomalous right subclavian artery above the level of the aortic impression is diagnostic. Malformations of the aortic arch, such as right-sided aorta or double aorta, may be suspected or diagnosed by the different impressions they produce on the barium-filled oesophagus.

The oesophagus is usually loosely attached to the descending aorta and tends to maintain this relationship throughout life, so that when the aorta becomes elongated and unfolded with atheroma, the oesophagus tends to be displaced with it. An atheromatous aorta may compress the oesophagus at its lower end where they cross, and this is particularly liable to happen when the thoracic aorta is tortuous and heavily calcified.

Barium swallow is complementary to oesophagoscopy in the diagnosis of obstructive lesions at the lower end of the oesophagus and is the principal means of identifying achalasia of the cardia.

**Subsidiary imaging techniques**

Other imaging techniques which have a minor or obsolete role in the examination of pharynx, larynx and oesophagus have been briefly considered in Volume 1, Chapter 17. Laryngography is time consuming, uncomfortable for the patient and contraindicated in airway obstruction and stridor. It has not been almost entirely replaced by newer imaging methods for showing the mucosal surfaces of the larynx.

**Sinography**

Cysts of congenital origin in the neck arise laterally from branchial cleft remnants or in the midline along the course of the thyroglossal duct. On CT scans they will appear as well circumscribed low density lesions with normal fascial planes around them unless the cyst has become infected. When a cyst breaks through to the skin it produces a fistula. Valuable information about the situation and extent of fistulae, sinuses and tracts in the neck can be obtained by injecting an oily contrast medium (Lipiodol Ultra Fluid) through a small catheter.

**Sialography**

Pathological changes in the salivary glands are traditionally investigated by plain radiography, or after injection of a contrast medium into the parotid or submandibular ducts. The technique of sialography and its importance for showing abnormalities of the duct systems are discussed in Volume 1, Chapter 17.

Mass lesions within or around the salivary glands are now best demonstrated by CT. The precise location of a mass within the parotid gland can be shown, and the position of the
facial nerve inferred. CT demonstrates whether a mass is circumscribed or invasive and suggests the histological nature of a cyst or lipoma. It can differentiate masseter muscle hypertrophy from diffuse non-inflammatory enlargement of the parotid gland. It is not, however, reliable for differentiating benign from malignant neoplasms. Most intraparotid masses, even those differing little in density from the surrounding gland, are detectable by CT, but intravenous or intraductal contrast injection may be helpful to delineate the tumour more clearly and confirm that the deep lobe is not involved. Adenolymphoma (Warthin's tumour) tends to have multiple lobules and is often wholly or partially outside the gland. Isotope studies with technetium-99m ($^{99m}$Tc) may be diagnostic as Warthin's tumour accumulates the radionuclide intensely. This differs from other tumours which show as areas of decreased activity in the concentration of isotope which occurs in normal salivary glands. Malignant tumours may be well defined, or they may have indistinct margins at their interface with the parotid tissue and may infiltrate outside the gland into the surrounding fat if they are invasive.

**Angiography**

Angiography, by means of transfemoral catheterization, is now largely replaced for the study of neck masses by enhanced CT, MR and digital vascular imaging. There seems to be little point in performing angiography unless the lesion shows significant contrast enhancement on CT scanning. A sparsely vascularized mass, such as a neurofibroma, will show some 'puddling' of contrast on the angiogram, and characteristically there is anteromedial displacement of the internal carotid artery. The paragangliomata or glomus tumours make up the next most common group of enhancing extraparotid parapharyngeal masses (Som, 1984). They may also displace the internal carotid anteriorly, but the angiogram will demonstrate the intense and typical vascularity of the lesion. Carotid body tumours occur lower in the neck. They arise medial to the carotid bifurcation and displace the carotid artery laterally, or at a higher level splay the carotid bifurcation. Although the internal jugular vein can usually be recognized displaced posteriorly on the CT scan, the carotid arteries are usually incorporated in the hyperdense mass.

Vascular masses such as glomus tumours and haemangiomas, which also occur in the neck, in the salivary glands or the base of the tongue, are extremely difficult to excise and embolization techniques may be necessary to reduce the blood supply prior to surgery. These techniques are described briefly in Volume 1, Chapter 17.

**Summary**

Plain radiography will continue to have a limited role for assessing the outlines of the upper aerodigestive tract, for showing foreign bodies and occasionally for cysts and tumours, especially those presenting problems of assessment for endoscopy. Barium swallow examination still has a most important role for the study of the oesophagus and for some swallowing problems in the hypopharynx as well as diagnosis of pharyngeal pouches and achalasia of the cardia. Computerized tomography has a limited role in the investigation of laryngeal pathology. It is rarely required to assist the endoscopic assessment of tumours but may help to confirm persistence of disease and erosion of the laryngeal cartilage after radiotherapy. Assessment of laryngeal trauma by CT may be of value. Severe injuries to the framework of the larynx require open exploration, but CT may show that this is not required
in less severe case (Schaefer and Brown, 1983). Computerized tomographic scanning is especially useful for demonstrating the anatomical relations and extent of deep neck masses, but has frequently proved unreliable for distinguishing between benign and malignant tumours. Nevertheless, the combination of physical examination and CT gives the opportunity to stage these lesions more accurately than before.

Magnetic resonance promises to give even better discrimination of such masses and normal structures in the soft tissues below the skull. Malignant tumours of the oropharynx seem particularly well suited to assessment by magnetic resonance imaging, especially those in the base of the tongue. The extent of local deep infiltration should be demonstrated and any spread to adjacent areas such as the hypopharynx or pre-epiglottic space. The lateral projection possible with MR, but not directly with CT, is particularly useful. Carcinoma of the floor of the mouth is assessed clinically but its extent, including involvement of the mandible, can be well shown by MR. It is to be hoped that in the future better discrimination of pathology will be possible by magnetic resonance imaging and especially better differentiation of benign and malignant neoplasms.