Chapter 14: Pharyngeal pouches

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The leading symptom of diseases of the pharynx and oesophagus is dysphagia, one of the less common causes of which is a diverticulum. Pharyngeal diverticula may be posterior, posterolateral or lateral, but the most commonly encountered type is the posterior pharyngeal pulsion diverticulum.

Diverticula can present at any age, are benign lesions, and are therefore eminently curable. The diagnosis and treatment is well established, but the aetiology of the different types of diverticulum is still uncertain and controversial.

Embryology and anatomy

Knowledge of the embryological development of the branchial apparatus is essential when considering a classification of pharyngeal diverticula.

Each of the six branchial arches consists of a cartilaginous bar, from which the skeletons of the mandible, pharynx and larynx are derived, and is surrounded by mesoderm from which the muscles differentiate; an artery and cranial nerve supply each arch. Between the arches are depressions which, on the pharyngeal aspect, are lined by endoderm and called pouches, and on the external surface are lined by ectoderm and called clefts.

The fifth arch and pouch regress during development. The remaining four pouches, except the first, each grow laterally into a dorsal and ventral component, which contribute to the structures of the head, neck and mediastinum, although the development of the lower two pouches is not fully understood.

Splanchnic mesoderm migrates around the pharynx, investing it with a cover of three constrictor muscles; these are deficient anterolaterally where the neurovascular bundle to each branchial arch enters, representing potentially weak areas.

The constrictor muscles overlap each other; the superior lying innermost and the inferior outermost, inserting into a posterior midline raphe. A gap lies above the superior constrictor through which the eustachian tube passes.

A potential gap, overlain by the tonsil in life, remains between the superior and middle constrictors, bounded anteriorly by the hyoglossus muscle. The neurovascular bundle of the third arch, of which the nerve is the glossopharyngeal, passes through this gap.

The inferior constrictor is described in two parts, the thyropharyngeus and the cricopharyngeus. Thyropharyngeus arises from an oblique line on the thyroid ala and a fibrous arch between the thyroid and cricoid cartilages, its upper fibres overlapping the superior and middle constrictors increasingly as they pass posterosuperiorly, its lowest fibres lying horizontally edge to edge with the cricopharyngeus. A potential weakness exists between the middle and inferior constrictors, bounded anteriorly by the thyrohyoid muscle, and is pierced by the fourth arch neurovascular bundle, of which the nerve is the superior laryngeal. Below
the level of the vocal cords the thyropharyngeus is unsupported by the other constrictors, resulting in an area of weakness posteriorly, which is known as Killian's dehiscence.

The cricopharyngeus muscle is thicker and bulkier than thyropharyngeus, passing uninterrupted from one side of the cricoid to the other around the back of the pharynx. The sixth neurovascular bundle, of which the nerve is the recurrent laryngeal, enters the pharynx under the lower border of cricopharyngeus. The circular fibres of the oesophageal musculature lie below and parallel to the cricopharyngeus, but the longitudinal muscles at the upper end sweep forward to insert into the cricoid cartilage, leaving a relatively weak area, first described by Laimer and Hackermann, whose names are given to this area. The cervical oesophagus is not exactly midline tending to veer to the left.

The motor supply to the constrictors arises from the pharyngeal branch of the vagus nerve, which forms a plexus on the middle constrictor. The cricopharyngeus muscle is an exception being supplied by the recurrent laryngeal and external laryngeal nerves. The sensory supply of the pharynx is via the glossopharyngeal nerve, the internal laryngeal nerve and the recurrent laryngeal nerve.

To summarize there are several relatively weak areas through which mucosal bulges or diverticula may develop.

**Lateral**

1. Above the superior constrictor
2. between the superior and middle constrictors
3. between the middle and inferior constrictors

**Posterolateral**

4. Laimer-Hackermann point

**Posterior**

5. Killian's dehiscence.

**Classification**

Classifications are based on developmental, anatomical and aetiological grounds (Korkis, 1958; Wilson, 1962). In earlier classifications an anterior pharyngeal diverticulum was described but is now recognized to be an overdeveloped or deep vallecula, and not a diverticulum. The classification below is based primarily on anatomical site, and then subdivided by aetiology (*Table 14.1*).

**Lateral pharyngeal diverticulum**

Lateral pharyngeal diverticula are uncommon and arise from the posterior faucial pillar, and the upper or lower pyriform fossa. They are best observed with frontal cineradiographic views using a contrast material, while being emphasized by raised intrapharyngeal pressure.
**Congenital**

Congenital lateral pharyngeal diverticula are extremely rare. In most reported cases the aetiology has been attributed to a branchial cleft remnant which opens into the pharynx, usually at the lower pole of the tonsillar fossa by the posterior faucial pillar. Most arise from the second branchial cleft, the track passing between the internal and external carotid arteries before opening into the pharynx, but some have been reported in association with the third and fourth clefts.

**Table 14.1 Classification of pharyngeal diverticula**

**Lateral**
- (1) Congenital
- (2) Acquired
  - (a) normal bulges
  - (b) traumatic
  - (c) raised intrapharyngeal pressure 'pharyngoceles'

**Posterolateral**

**Posterior**
- (1) Congenital
- (2) Acquired
  - (a) traumatic
  - (b) posterior pharyngeal pulsion diverticulum (Zenker's diverticulum).

They are usually unilateral and diagnosed in the first two decades of life, although occasionally in much older patients. The patients present with a history of recurrent infected swellings in the neck, previously treated with antibiotics or by incision and drainage, before the correct diagnosis is established. The signs are a tender fluctuant swelling in the anterior triangle of the neck, pyrexia, mild dysphagia and occasionally mild stridor. Investigation with radiological contrast studies after the infection has settled with antibiotics may demonstrate the narrow tract leading to a cyst in the neck.

Treatment is by excision of the cyst and tract to the pharyngeal wall, where the neck is closed and oversewn. Histological examination of the sac reveals an epithelial lining of stratified squamous or columnar epithelium surrounded by chronic inflammation with lymphocyte infiltration.

**Acquired**

Argument about the aetiology of acquired lateral pharyngeal diverticula still continues. Some authorities consider the basic defect to be a congenital weakness and so classify these diverticula as congenital, but the potential weak areas are present in all individuals, the variable or precipitating factor being raised intrapharyngeal pressure causing protrusion of pharyngeal mucosa through those areas which are developmentally deficient in muscle. These
diverticula do not seem to occur in the absence of such a predisposing factor and are usually found in patients well into adulthood, supporting the argument that they are acquired lesions.

**Normal bulges**

Frequent and incidental findings on routine barium swallows are small lateral pharyngeal bulges which can be seen either arising in the pyriform fossa or, more rarely, in the tonsillar fossa. They are more common in the elderly, probably due to reduced muscular tone and loss of elasticity of the tissues, and they are usually asymptomatic and bilateral, which is the reason they are thought by many to be normal variants.

Radiological contrast studies demonstrate the bulges as smooth, hemispherical prominences arising from the pyriform fossa or tonsillar fossa, the appearance lending itself to the name pharyngeal 'ears'. These are largest when a modified Valsalva manoeuvre is performed (blowing hard against pursed lips), collapsing down to a normal pharyngeal contour under normal pressure. They are most easily seen in frontal views. At this stage they require no treatment, but it is probable that they represent an early stage in the evolution of larger symptomatic diverticula.

**Traumatic**

Colonel M. Morris (late RAMC), while in India, recorded certain nomadic groups of habitual criminals from the Central and United Provinces, with self-inflicted diverticula. These were produced by pushing a piece of lead, the size of a pigeon’s egg, into the tonsillar fossa. Repeated use eventually created a diverticulum that could be kept patent with a finger. Coins or jewellery could be hidden in this diverticulum and be delivered when required, by tilting the head forwards and effecting a vomiting motion. The diverticulum probably lies between the middle and superior constrictors, and if not used or maintained constantly would rapidly disappear (Atkinson, 1952).

**Raised intrapharyngeal pressure (pharyngocoeles)**

As stated above these large and occasionally symptomatic diverticula may arise from precursor pharyngeal 'ears'.

Two factors are implicated in their development, either separately or together: the first is frequent repetitive increases in intrapharyngeal pressure and the second is loss of muscular resilience associated particularly with advancing years. The diverticula evolve, from large outpouchings of the lateral pharyngeal wall, into sacs with obvious necks that are sometimes called 'pharyngocoeles'.

A pharyngocoele was first described by Wheeler (1886), in a patient who had been in the army and took considerable pride in his ability to command a full brigade on the parade ground with his own voice. Pharyngocoeles were also noted in Egyptian muezzins who sang verses of the Koran from the minarets of mosques. Many developed pharyngocoeles which often became so marked, that special collars were required to restrain them, must as a man wears a truss for an inguinal hernia. These uncommon pulsion diverticula are usually unilateral and asymptomatic affecting men more frequently than women, in a ratio of 8:1.
Occupations in which the intrapharyngeal pressure is raised, such as glassblowers or trumpeters, have been implicated in the aetiology of this condition.

Symptoms may develop due to food entrapment in the diverticulum, and are insidious in onset, so that the patient presents with long-standing problems. The main symptom is dysphagia which is usually intermittent and mild, the patient complaining of a sensation of food sticking in the throat, although it may become severe. Occasionally there is regurgitation of undigested food, with associated foul taste and fetor, which may lead to nocturnal coughing and choking. Dysphonia results from the effects of spillage into the larynx, although it is also suggested that this is due to a compression of the recurrent laryngeal nerve by the sac. Chronic pulmonary problems may be the first hint of the condition.

Signs are few. There may be a palpable lump in the neck, just anterior to the sternomastoid muscle, which is soft, compressible and which may gurgle due to a mixture of air and fluid within the diverticulum sac. Indirect laryngoscopy shows little although a slit-like ostium may be observed in the region of the posterior faucial pillar or the upper part of the pyriform fossa. The sac can usually be inflated voluntarily by the patient by blowing against closed lips in a modified Valsalva manoeuvre.

**Investigation and diagnosis**

Plain radiograph may show the sac as a translucency, lateral to the pyriform fossa which can be increased in size by a modified Valsalva manoeuvre. However, the mainstays of diagnosis are fluoroscopic and cineradiographic techniques which are most efficient in delineating the diverticulum, using high density barium which coats the mucosa more effectively and is retained longer. The patient is asked to take a small amount of contrast material and then to perform a modified Valsalva manoeuvre to emphasize the diverticulum. It will be seen as a rounded, contrast-lined opacity communicating with the pyriform fossa by an isthmus or neck. Ultrasound has also been used to make the diagnosis. Occasionally barium studies fail to reveal the sac and direct inspection is necessary. Direct pharyngoscopy shows a slit-like opening to a diverticulum, the search being concentrated in the areas where they are known to occur, although they can still be easily missed.

**Treatment**

If the diverticulum causes no symptoms, no treatment is required except for diligent follow-up. In those who develop symptoms, the diverticulum should be surgically excised through a neck incision. The sac is followed through the thyrohyoid membrane to its opening in the pharynx, amputated at its neck and the pharyngeal mucosa oversewn. Postoperatively, it is advisable to feed the patient by nasogastric tube for 3-5 days to ensure healing and to diminish the risk of fistulae.

**Differential diagnosis**

The main lesions that can be confused with a pharyngocoele are: branchial cyst; posterior pharyngeal pulsion diverticulum; laryngocoele; external or internal jugular phlebectasia; and pseudodiverticulum.
While the history and examination may allow exclusion of most other cervical lesions, laryngocoeles and venous phlebectasia closely mimic pharyngocoeles altering in size with a Valsalva manoeuvre.

**Posterolateral pharyngeal diverticulum**

This diverticulum, which protrudes through the Laimer-Hackermann point, may be either true or false being differentiated by its collapsibility with the passage of peristalsis. It presents in older people, again probably due to weakness of musculature. It is almost always asymptomatic, requiring no treatment. These are probably more common than reported. Being asymptomatic they are rarely noted endoscopically or radiologically and vary in size according to the position of the peristaltic wave (Ekberg and Nylander, 1983).

**Posterior pharyngeal diverticulum**

*Congenital*

Congenital posterior pharyngeal diverticula are very rare and were first described by Brintnall and Kridelbaugh (1950) in two infants who, soon after birth, developed symptoms similar to oesophageal atresia. Radiological evidence of air in the stomach, in the absence of a tracheo-oesophageal fistula, confirms oesophageal patency. The diverticular sac arises from above the cricopharyngeus and is lined by normal pharyngeal mucosa, distinguishing it from a traumatic pseudodiverticulum. The whole sac is covered with muscle, differentiating it from a pulsion diverticulum. The treatment is excision of the diverticulum to restore pharyngeal continuity.

*Acquired*

**Traumatic pharyngeal pseudodiverticulum**

This rare condition usually presents in newborn infants, but has been reported in adults. The aetiological factor is hypopharyngeal trauma, either from damage caused by the obstetrician's finger during breech delivery, or vigorous instrumentation with suction tubes or endotracheal tubes, although in one of the adult cases the cause was spontaneous rupture of a retropharyngeal abscess in an immunosuppressed patient (Morton, 1983). Patients develop symptoms some hours after the traumatic episode, which causes a hypopharyngeal mucosal tear, either transmural or submucosal, the former causing more severe symptoms as a result of a false passage tracking down into the posterior mediastinum in the prevertebral space. This leads to cricopharyngeal spasm which precipitates the early symptoms of increasing dysphagia with excessive oropharyngeal secretions and inability to ingest feeds. Eventually, attempts to feed cause coughing and choking due to spillage into the larynx, sometimes resulting in cyanotic episodes and, at worst, aspiration pneumonia. The patient becomes pyrexial and increasingly ill, developing symptoms and signs of mediastinitis. There may also be cervical subcutaneous emphysema. The symptoms and signs mimic other conditions including oesophageal atresia or duplication, and congenital posterior pharyngeal diverticula, although a clear antecedent history helps distinguish it from the above conditions.
The management is not clearly established as few cases have been reported. To confirm the diagnosis an attempt is made to pass a nasogastric tube into the stomach; if gastric fluids can be aspirated, oesophageal atresia is excluded. Contrast material is then passed down the tube which is slowly withdrawn to give a retrograde picture of the upper alimentary tract, to demonstrate the pseudodiverticulum. If a nasogastric tube cannot be passed into the stomach, contrast material is injected down the tube at pharyngeal level which again should demonstrate the diverticulum. Alternatively, the patients sucks a contrast material feed. However, with the two latter methods, there is a considerable risk of inhalation and worsening of the pulmonary condition.

The radiological appearance of a traumatic pharyngeal pseudodiverticulum is an irregular elongated tract originating in the pharynx and passing behind the oesophagus into the posterior mediastinum.

The management is either conservative or surgical. Conservative treatment consists of intravenous antibiotic therapy and nutritional support either by nasogastric tube or intravenously. The surgical treatment consists of drainage of the pseudodiverticulum either via a cervical incision or a thoracotomy, at which time it is usual to perform a gastrostomy for nutritional support. Antibiotic cover is given. The excised track shows fibrous or inflammatory tissue rather than epithelium.

**Posterior pharyngeal pulsion (Zenker's) diverticulum**

**History**

The posterior pharyngeal pulsion diverticulum is known by many names including pharyngo-oesophageal pouch or diverticulum, retropharyngeal pouch or diverticulum, posterior pharyngeal pouch or diverticulum, and Zenker's diverticulum.

The first case of posterior pharyngeal pulsion diverticulum was described in 1764 by Mr A. Ludlow, a surgeon from Bristol, in a letter to Dr William Hunter of the Society of Physicians in London. A paper entitled 'A case of obstructed deglutition, from a preternatural dilatation of, and bag formed in the pharynx' was published in 1769 in *Medical observations and Inquiries*. The description of the symptoms and morbid anatomy is remarkably accurate when compared to present-day knowledge. From the history and examination Ludlow though that the obstruction was in the cervical region of the oesophagus due to a stricture. Initially he attempted to treat the patient by asking him to swallow a weighted silk thread, but this caught in the diverticulum. Blind dilatation was then attempted using whalebone bougies, but this also failed, next, half a pound of quicksilver or mercury was given but, alas, this again lodged in the diverticulum without passing into the stomach; in spite of the treatment the patient died after 13 days. A post-mortem was carried out revealing that the 'bag' or diverticular sac lay between the oesophagus and the vertebral column, originating from the posterior wall of the pharynx. The diverticulum was thought to have been caused by a cherry stone lodging in the posterior wall some time earlier.

A further 22 cases were described between 1764 and 1874. Zenker and Van Zeimssen collected these reports and with five patients of their own described the site of origin of the diverticular sac as between the pharynx and oesophagus, its possibly aetiology, and
differentiated between pulsion and traction diverticula. Zenker's name is still associated with the posterior pharyngeal pulsion diverticulum. Early surgical attempts at curing the condition were unsuccessful but in 1886, Wheeler reported the first successful excision of a posterior pharyngeal pulsion diverticulum, performed the year before in 1885. It was an incidental finding while operating on a patient with a large acquired lateral pharyngeal diverticulum or pharyngocoele. The patient recovered completely and deglutition and voice returned to normal. However, the mortality rate due to sepsis, in particular mediastinitis, was extremely high, making the procedure hazardous. Other methods were therefore advocated including inversion of the sac, diverticulopexy, dilatation and endoscopic division of the party wall, and a two-stage diverticulectomy. The two-stage procedure was popular in the USA and the UK but since the advent of antibiotics it has become normal to perform a one-stage excision, usually combined with cricopharyngeal myotomy, which today carries a low mortality rate. However, despite all the surgical advances in the relief of symptoms the aetiology of the condition remains uncertain.

**Aetiology**

Swallowing is a complex mechanism by which a bolus is passed from the mouth to the pharynx, and into the oesophagus and stomach, in a quick, coordinated fashion. The shortest phase is the pharyngeal, or second stage of swallowing, lasting less than one second. The mechanism of the second stage comes into action as the first stage is completed with the bolus being ejected into the oropharynx. The larynx is elevated with the hyoid to lie under the mandible and base of the tongue. The aryepiglottic folds contract to complete closure of the larynx, already closed at glottic level due to adductor contraction. The epiglottis is inverted by the bolus passing down the pharynx, and the pharynx is elevated over the bolus simultaneously. A pharyngeal peristaltic or stripping wave then pushes the bolus down through the pharynx and cricopharyngeal sphincter, which is passively or reflexly relaxed as the second stage of swallowing begins. Most of the bolus has preceded this wave, which clears only the more solid particles.

The aetiology of posterior pharyngeal pulsion diverticula is still unknown, although many theories have been advanced. There is much conflicting evidence from investigations using radiographic and manometric techniques, even when using the same method of study. The early theories fall into four main categories:

1. tonic spasm of the cricopharyngeus (Negus, 1950)
2. lack of inhibitory stimuli to the cricopharyngeus (Dohlman and Mattson, 1959)
3. the second swallow (due to pharyngeal laxity) (Wilson, 1962)
4. neuromuscular incoordination and congenital weakness (Korkis, 1958).

1. Negus was the proposer of this theory. As man evolved to an erect position, so the larynx and pharynx moved lower in the neck and the circular muscles or constrictors became more oblique with the exception of the lower fibres of the inferior constrictor or cricopharyngeus. A weakened area, Killian's dehiscence, was left between the cricopharyngeus and the thyropharyngeus. Negus believed the weakness was compounded by the lack of
longitudinal muscle support posteriorly. However, the anatomical factor is common to all humans so could not alone account for sac formation. One factor is variable, that of incoordination of the second stage of swallowing, in particular relaxation of the cricopharyngeus in front of the pharyngeal stripping wave. Negus believed that a predisposing factor to diverticular formation was cricopharyngeal sphincter spasm due to chronic inflammation, stenosis from healed inflammation, or an unknown neurological deficit. When the bolus reached the sphincter, which was in spasm, it would be forced posteriorly and cause a mucosal bulge. As this enlarged between the cervical oesophagus and vertebral column the sphincter would move anteriorly and so the bolus would impinge directly on the posterior pharyngeal wall with resultant expansion of the pharyngeal diverticulum.

(2) Dohlman and Mattson felt that the sphincter failed to relax, rather than being in active spasm. They believed that the cricopharyngeus was normally tethered to the prevertebral fascia, but that this attachment weakened with ageing so that, the larynx was elevated on deglutition pulling the cricopharyngeus with it rather than stretching the muscle, which would normally trigger off a reflex relaxation of the sphincter in readiness for the bolus. Failure of relaxation would increase intrapharyngeal pressure causing mucosal bulging posteriorly, which was further compounded by a negative pressure in the prevertebral space, sucking the mucosa outwards.

(3) The second swallow theory was proposed by Wilson, who noted that in his patients there was a high incidence of enlarged pharynges or megapharynx which, he believed, was due to a lax pharyngeal musculature. Furthermore, he observed that there was always a residue of barium in the pharynx after the swallow was completed. He speculated that part of the bolus failed to pass into the oesophagus before the sphincter closed and so the patient made a second voluntary swallow in order to clear the residue, but that this occurred against a closed sphincter, resulting in an area of high cricopharyngeal pressure between the sphincter and pharyngeal stripping wave, causing the mucosa to bulge posteriorly, leading to the development of a posterior pharyngeal pulsion diverticulum.

(4) Korkis believed that there was some neuromuscular incoordination which was compounded by congenital weakness and he supported the argument by recalling the congenital posterior pulsion diverticulum described by Brintnall and Kridelbaugh.

However, all agree that the weakness lies at Killian’s dehiscence and that, in order for it to occur, there should be raised intrapharyngeal pressure.

Both Negus and Dohlman's proposals have been shown to be inaccurate. Kodicek and Creamer (1961) first described manometric studies using open-tipped recording tubes in the pharynx and oesophagus attached to a capacitance manometer. They were able to show that the cricopharyngeus relaxed normally and that there was no incoordination, although others have subsequently questioned this premise. However, their results are supported by Hunt, Connell and Smiley (1970) who, while demonstrating a high resting cricopharyngeal pressure, showed normal relaxation of the cricopharyngeus in relation to swallowing in patients with diverticula. More recently Knuff, Benjamin and Castell (1982), using modern manometric techniques including a low compliance infusion system and oval-shaped catheters, studied nine patients with known posterior pharyngeal pulsion diverticulum initially diagnosed by barium swallow studies. The result of this research showed normal relaxation of the
cricopharyngeus which did not contract until the end of the pharyngeal stripping wave, although a low resting pressure was found in the sphincter or pharyngo-oesophageal segment.

Ardran, Kemp and Lund (1964) argued that since most studies were performed in patients with established diverticula, which must upset the normal physiology of swallowing, the results might be due to the disease and not reflect the cause. Using contrast cineradiography with a speed of 25 frames/second on 35 mm film, they examined 16 patients with diverticula of differing sizes and 17 normal subjects. After the initial part of the swallow, during which barium passed easily into the oesophagus, the main bolus descended into the pharynx to be moved on by the pharyngeal stripping wave. In patients with diverticula they found this to be defective in two ways; first, the oropharyngeal contraction was weak or absent, and second, pharyngeal constrictor function below this level was disturbed, which together with premature cricopharyngeal closure, caused a residue to remain in the pharynx with a bulge or diverticulum forming as a result. Consequent upon their studies they proposed a mechanism of diverticulum formation. The cricopharyngeus contracts prematurely and the posterior wall bulges backwards. As the stripping wave descends to the closed sphincter, it pushes the posterior wall down and forwards to meet the back of the cricopharyngeal sphincter, which is facing upwards and forwards, and so a dimple is produced which might well go on to enlarge and become a diverticulum.

In some patients they noted failure of complete cricopharyngeal relaxation which led to a nipping between the sphincter and the stripping wave with a consequent bulge, which they suggested could also exacerbate diverticulum formation. In their study they noted no megapharynges in normal subjects and only one in 16 patients with known diverticula, which contradicts the findings of Wilson. Also, the cricovertebral distance was the same when comparing normal subjects with patients with diverticula, which does not support the Dohlman and Mattson theory.

Ellis et al (1969), and later Lichter (1978), confirmed by manometric techniques the early cricopharyngeal closure proposed by Ardran, Kemp and Lund. Lichter found that there was also premature relaxation of the sphincter, which was followed by early contracture leading to raised intrapharyngeal pressure. They did not demonstrate any weakness of pharyngeal contraction, but in some patients noted a repetitive swallowing pattern, probably as a result of the obstruction. They examined patients, all of whom had had cricopharyngeal myotomy, after surgery and demonstrated reduced resting pressures in the region of the sphincter. They suggested that cricopharyngeal myotomy should be performed whenever it was noted to be radiologically prominent.

Smiley, Caves and Porter (1970) noted that in 32 out of 34 patients with Zenker's diverticulum, there was associated oesophageal reflux or hiatus hernia. On studying patients with oesophageal reflux alone, they noted a high resting sphincter pressure but no incoordination of swallowing. They proposed that oesophageal reflux or hiatus hernia might well play a causal role in the formation of Zenker's diverticulum.

A familial tendency has also been noted by McNab-Jones (1959) in a report on a patient whose mother, sister and two brothers all had posterior pharyngeal pulsion diverticulum. Groves (1968) found three sisters who had diverticula, and the possibility, although unproven, of other members of the family being likewise affected.
Incidence

It is difficult to quantify the incidence of pharyngeal diverticula in the general population, as not all cases are reported, and centres with a special interest in these diverticula attract cases from other areas, thus falsifying their figures in relation to population. The only report that gives figures in this manner is from Ipswich (Juby, 1969), where 17 cases were reported in a population of 300,000 over a 12-year period; an incidence of 0.47 cases/100,000 persons per year. Most figures refer to numbers seen over a fixed period or relate them to hospital admissions, operations or radiographic studies. Shallow and Clerf (1948), stated an incidence of one in 1400 admissions, or 800 operations, MacMillan (1932) recorded finding 18 diverticula in 1000 contrast radiographs for patients with dysphagia, and Baron (1982) reported one in 800 routine barium studies.

Age, sex and race

Figures for age and sex are more certain, although there is variation between different centres. A collection of some of the largest series gives a ratio of about two men to one woman. Patients are generally aged over 50 years at diagnosis, but occasionally present as young as 29 years old. From a number of American series it is apparent that negroes are rarely affected by this condition.

Symptoms

Patients present with variable severity of symptoms, not necessarily related to the size of their diverticulum. Although some patients present after only a few months of symptoms, most complain of long-standing problems, the patient having adapted to the slowly progressive symptoms. Indeed, it is the insidious nature of the onset that causes most patients to present with a well-developed diverticulum. There have been attempts to stage symptoms in relation to diverticulum size, in particular by Lahey (193) who described three stages:

- **stage I:** small mucosal protrusions (the initial stage)
- **stage II:** a definite sac but with the oesophagus and hypopharynx still in line (the intermediate stage)
- **stage III:** a large sac with the hypopharynx in line with the neck of the diverticulum, and the oesophageal inlet pushed anteriorly.

Each stage was said to be associated with a symptom pattern: stage I, being associated with the sensation of food sticking in the throat; stage II, having regurgitation and gurgling from the pouch; and stage III, with development of severe dysphagia. The main use of this classification is in relation to the mortality and morbidity of operative procedures. The symptoms are listed in their frequency of occurrence.

Dysphagia

This symptom may be misinterpreted by the clinician, leading to prolonged periods when no treatment is administered. Initially the patient may complain of a sensation of a lump in the throat, which can frequently be misdiagnosed as globus hystericus. Other early symptoms are a feeling of food sticking in the throat, requiring repeated swallowing attempts.
Generally, however, the story is of increasing difficulty in swallowing solids, requiring the patient to chew every mouthful finely. As the condition progresses it becomes impossible to enjoy a meal with friends, due to the length of time taken to eat. Eating becomes acutely embarrassing. Eventually difficulty with semi-solid foods and then liquids develops. Occasionally a patient cannot swallow his own saliva, having to expectorate the excessive oropharyngeal secretions, which rapidly leads to dehydration. It has been suggested that pressure of the diverticulum on the upper oesophagus causes obstruction but manometric studies detected no change in oesophageal pressures, even with large diverticula.

**Regurgitation**

Patients suffer from regurgitation, undigested food welling into their mouths, sometimes during a meal, although more often afterwards. It is exacerbated by positional change, especially lying down in bed at night. This symptom can wake the patient in the middle of the night, when spillage from the diverticulum causes choking. A few adapt to this by evacuating the sac before going to bed, by pressing on the side of their neck over the diverticulum.

Associated with this symptom, the second most common after dysphagia, is a foul taste in the mouth due to the prolonged retention of undigested food. A gurgling sound on swallowing is sometimes noticed by the patient due to a mixture of air and fluid in the sac.

**Weight loss**

Due to dysphagia which may be evident for a considerable time before examination, some patients present with severe weight loss and malnutrition complicating the treatment of this benign condition.

**Hoarseness**

Overflow of sac contents into the larynx causes chemical irritation and laryngitis. It is suggested that this can be due to pressure of the sac on the recurrent laryngeal nerve, although vocal cord paralysis is more likely to be a result of the presence of a carcinoma in the diverticulum.

**Pulmonary complications**

A serious sequel to the spillage of sac contents into the larynx is aspiration pneumonia. Pulmonary complications, including pneumonitis or lung abscesses, are well recorded with large sacs, and treatment of these is necessary before surgical resection.

**Miscellaneous**

There is usually no pain except in the presence of carcinoma. Occasionally other strange presentations occur. Bleeding has been reported from a diverticulum, due to ulcers and carcinoma. Also rare, is a diverticulotraheal fistula which causes the patient to cough when eating, and leads to pulmonary complications. Resection of the tract and diverticulum cures
this problem. One odd symptom was a patient's failure to absorb medication due to the tablets lodging in the sac. This was also cured by resection.

**Signs**

The signs include emaciation, which can be severe, although it is uncommon nowadays as diverticula are usually picked up earlier. A swelling may be found in the neck, usually on the left side, in the lower part of the anterior triangle, which is soft, and may gurgle on palpation. This is known as Boyce's sign. A spasm of coughing may be caused by palpation due to spillage of contents into the larynx. Indirect laryngoscopy demonstrates red larynges and pooling of saliva in the pyriform fossa in which undigested food particles may be seen.

**Investigations**

While the history and the examination may be virtually pathognomonic, it is necessary to confirm the diagnosis with radiological evidence, generally contrast radiography, employing either fluoroscopy or cineradiography.

**Plain radiography**

Plain lateral radiology of the soft tissues of the neck may give a clear impression of a diverticulum, the features of which are a triangular translucency seen in the prevertebral soft tissues, with its apex at the cricoid level. The base of the translucent triangle has a meniscus, due to the fluid in the fundus of the sac, with the air above it, and the sides curve to join each other superiorly.

**Contrast radiology**

Single shot barium swallow radiographs may not demonstrate a diverticulum if it is small or if they are taken from the wrong angle or at the incorrect stage of the swallow. Therefore, it is normal to use continuous monitoring methods, such as fluoroscopy or cineradiography, which allow good observation from different angles of all stages of the swallowing mechanism.

While a diverticulum usually projects posteriorly, as it increases in size it may be displaced to overlie the oesophageal shadow on lateral views. Therefore, with larger sacs an oblique lateral view is frequently needed. Fluoroscopy is especially useful in this respect. Using fluoroscopy or cineradiography the sac is seen to change shape in different stages of the deglutition cycle, its classic pear-shape appearing during the contraction of cricopharyngeus at the end phase of the pharyngeal stripping wave. An anteroposterior view is required by the surgeon in order to assess to which side of the neck the sac is deviating, so that the best approach can be planned. It usually deviates to the left. Further features of interest are the formation of an upper lip to the sac, caused by the contracting thyropharyngeus, and a lower lip caused by the cricopharyngeal impression at the end stage of deglutition. The cricopharyngeus may be seen to be a pronounced bulge in the diverticulo-oesophageal septum either at this stage, or even earlier if there is incomplete sphincter relaxation, and it is in these patients that Lichter recommends a cricopharyngeal myotomy.
The radiographic study is incomplete if it does not include the lower oesophagus, stomach and duodenum, in order to look for other abnormalities such as hiatus hernia or peptic ulceration with which there is a strong association (Smiley, Caves and Porter, 1970).

Although many long-term radiographic follow-up studies have been performed no one as yet has seen a diverticulum develop in a patient. Previously untreated radiologically diagnosed diverticula have been noted to increase in size over the years, but there are only sporadic reports of a transitory diverticulum developing into a posterior pharyngeal pulsion diverticulum. Radiological staging has been attempted: stage I, small, that is, less than one vertebral body; stage II, medium; stage III, large, that is, greater than three vertebral bodies. As with the Lahey classification, the main value of staging is in relation to the mortality and morbidity of surgical procedures. As well as noting the size and position of the diverticulum, the internal contours should be examined. An irregularity or filling defect within the diverticulum itself may be caused by solid food remnants or by a carcinoma; if due to a food remnant then the defect should not be constant on repeated examinations. The presence of a constant filling defect is highly suggestive of carcinoma.

A tracheogram is often produced. Ekberg (1983), in a radiological investigation of 250 patients with dysphagia, noted epiglottic dysfunction in one-third of the subjects. This included many with cricopharyngeal spasm and one with a posterior pharyngeal pulsion diverticulum. Twenty-seven subjects had barium spillage into the larynx and trachea. It is possible that pharyngeal dysfunction is the cause of pulmonary problems rather than the diverticulum itself, although it is not possible to confirm this. Diagnosis has also been confirmed by ultrasound, but radiological investigations remain the sharp end of the diagnostic armoury.

Occasionally the diagnosis is not made by barium studies, which have a failure rate in examinations of the gastrointestinal tract, and oesophagoscopy may be required. Oesophagoscopy and biopsy are also necessary to confirm the diagnosis of suspected carcinoma of a diverticulum, which may influence the treatment.

**Pathogenesis**

The diverticulum starts as a small bulge at Killian's dehiscence. As it enlarges it lies between the oesophagus and the vertebral column and may remain static for many years or slowly increase in size until eventually it passes into the posterior mediastinum. The plane of the diverticular neck alters as the size increases until it, rather than the oesophagus, lies in line with the hypopharynx, such that the food will pass into the sac preferentially. This feature also makes identification of the oesophageal opening quite difficult at oesophagoscopy, and often presents blind attempts to pass a nasogastric tube into the oesophagus.

It has been suggested that a diverticulum exerts pressure on the oesophagus from behind, causing the dysphagia, but this has not been proven in manometric studies on patients with known diverticula. The diverticulum is usually in the midline but, if it deviates it usually does so to the left.

The histology shows a sac consisting of an epithelial lining which is stratified squamous epithelium and submucosa, often with fibrous tissue surrounding it. Nearer the neck
of the sac scanty muscle fibres are found in the wall. Occasionally there are variations, in particular carcinoma in situ and frank invasive squamous cell carcinoma. Other histological oddities have been reported, including ulceration of the pouch with underlying submucosal infiltration by plasma cells, lymphocytes and eosinophils. Harrison and Tighe (1970) reported a sac which appeared to be covered completely with a fibromuscular layer, as one might expect in a true diverticulum. The sac was lined with hyperplastic stratified squamous epithelium with some acute inflammation and ulceration, but underlying this were cysts lined with stratified columnar mucous-secreting epithelium. The only explanation that could be offered for this rather odd findings, was of a developmental abnormality of the diverticulum, much as the congenital posterior pharyngeal diverticula described by Brintnall and Kridelbaugh (1950).

**Treatment**

No treatment is indicated for a diverticulum with few symptoms, if the patient's general condition is poor, or for transitory diverticula. Clearly each case must be judged on its individual merits, with the patient being fully aware of the possible complications and potential benefits of operation. Some patients, especially when old, are happier, and perhaps wiser, to live with minor inconveniences rather than embark on potentially major surgery. The basis of treatment is to correct the cause and remove the effect. The method for achieving these aims may be endoscopic or external surgery. It is agreed by most surgeons that the cricopharyngeal sphincter is probably the main factor in the aetiology of posterior pharyngeal pulsion diverticulum although the interrelationship between it and the pharyngeal constrictors in the aetiology is not yet understood. Operations in which the sphincter is not divided have a higher recurrence rate, supporting the argument for myotomy in all cases.

**Endoscopic treatment**

Ever since endoscopic techniques were developed, surgeons have been evolving new procedures to avoid the necessity for external surgery. The main endoscopic techniques for treatment of posterior pharyngeal pulsion diverticula are dilatation of the sphincter and endoscopic diathermy of the diverticulo-oesophageal septum.

**Dilatation**

Early treatment of diverticula was aimed at dilating the cricopharyngeal sphincter to alleviate the dysphagia. Dilatation with bougies is effective, but only temporary, in relieving symptoms and does not remove the diverticulum, resulting in an eventual recurrence of symptoms. There is an additional risk of perforation of the sac. This was especially true in the early days when blind bouginage was practised. An alternative method of dilatation is extensive stretching of the sphincter using a hydrostatic bag. However, dilatation is not frequently used nowadays except to dilate a postoperative stenosis.

**Endoscopic diathermy (Dohlman's operation)**

This operation has failed to gain wide acceptance as the treatment of choice in the UK or the USA, but is more popular in some European countries. It was first described by Mosher (1917) in the USA, in a series of six patients in whom the septum between the diverticulum
and the oesophagus was divided with scissors. The technique was modified and made popular by Dohlman and Mattsson (1960) who used it extensively and recorded over 100 cases in which there were no deaths or serious complications, although the recurrence rate was 7%.

The rationale behind this operation, in preference to an external approach, is based on the general consideration of these patients. The patients are often old and unfit due to emaciation and pulmonary complications from aspiration of the sac contents. Being elderly they also have a higher incidence of cardiac and pulmonary disease, and therefore represent a poor anaesthetic and surgical risk. Endoscopic diathermy of the diverticulo-oesophageal septum is a short operation, lasting only 5-10 minutes, and can be carried out under local anaesthetic, if a general anaesthetic is contraindicated. Recovery is rapid and the patient is normally ready for discharge 4 or 5 days after operation. Furthermore, the size of the sac does not affect the division of the septum. While the procedure does not remove the pouch, it relieves the symptoms and restores swallowing by dividing the cricopharyngeus and widening the mouth of the diverticulum. Also, re-operation is far easier than after external operations where scar tissue makes identification of recurrent diverticula hazardous.

Specialized instruments have been developed for this technique. The oesophagoscope is split distally, the upper beak being longer than the lower with a slit between them. The instruments include a diathermy forceps, which has teeth on the jaws to prevent slipping, a knife and a suction tube, all of which are insulated except at their working ends, and a pair of insulated paddles.

The patients are admitted one day before the operation and the sac is cleared of food debris by washing out with a stomach tube. The patients are restricted to clear fluids, and on the evening before the operation a weighted thread is swallowed, the proximal end being taped to the cheek, so that the oesophageal opening can be more easily found.

At operation, under either general or local anaesthesia, the long beak of the oesophagoscope is inserted into the oesophagus being guided by the thread, and the short beak into the diverticulum. The wall between the diverticulum and the oesophagus lies in the slit as a horizontal spur, containing the cricopharyngeal muscle. The diverticulum is cleared of any excess debris by suction and the spur is then grasped in the midline between the jaws of the diathermy forceps and coagulation diathermy applied until blanching occurs. The forceps are removed and a diathermy knife is then used to divide the coagulated strip of tissue longitudinally. In order to avoid coagulating or cutting the wrong wall, insulated paddles are passed down, one into the pouch, the other into the oesophagus so that the knife cuts down on to the paddle. Small bleeding points are coagulated with the suction diathermy. This process may be continued caudally until the fundus of the diverticulum is seen. With large sacs the operation is often staged, being completed after one or two repeat operations, each separated by 5-6 days. To minimize the risk of mediastinitis the procedure is stopped before the floor of the diverticulum is reached. The success of the operation is gauged by postoperative barium studies performed at 5 days, at which time a decision can be made to stop or to proceed further. Although some residue may be noted temporarily in the fundus of the sac, the operation is deemed successful if there is only a short party wall remaining with minimal delay in the emptying of the pouch into the oesophagus, and of course an absence of symptoms. The patient's fluid balance is maintained by intravenous infusion until the following morning when fluids are given orally, if there are no contraindications. If there are
no problems with fluids, soft diet is instituted on the second or third day and the patient is discharged after 5 days. Normal diet is allowed after 2 weeks.

Endoscopic division of the diverticulo-oesophageal septum provides a quick, safe technique for relieving symptoms, the major risks being haemorrhage, mediastinitis, emphysema and stenosis, the latter being treated by further division or dilatation. However, there is a risk of carcinoma in pouch being missed. The method has been criticized because of the recurrence rate and the possibility of carcinoma developing after treatment, a fact which has caused many to abandon its use.

**External surgical approach**

In the late 1800s and early 1900s the high mortality of diverticulum surgery promoted a search for differing methods of treatment to minimize the complications, so common in the pre-antibiotic era; all were variations on treatment of the sac, once dissected. Diverticulopexy, securing the fundus of the sac high in the neck, is rarely performed now. Two-stage diverticulotomy, once the mainstay of treatment, has been superseded by one-stage excision. Inversion has been reported more often in recent years and has considerable advantages, the only drawback being the possibility of missing a carcinoma. Cricopharyngeal myotomy remains a point of controversy.

**Two-stage diverticulectomy**

In 1909 Goldman ligated the neck of the sac and brought the fundus to the surface of the wound. When the sac sloughed a controlled fistula resulted which closed within a few weeks. This technique was subsequently modified by suturing the sac to the skin and opening it 2 weeks later, dissecting the mucosa down to the neck of the sac and packing the tract to leave a fistula which closed by secondary intention. This was a safe method minimizing mediastinitis and the staunchest advocates of this method were Lahey and Warren (1954), from the Mayo Clinic, where 365 operations were performed with only two deaths.

**Inversion**

Inversion of the diverticulum was first described in 1895 by Girard. Bevan, in the Sippy-Bevan operation (1917), modified the inversion by placing a series of purse string sutures along the length of the sac in order to obliterate it. This technique was developed to avoid the risk of opening the sac, associated as it was with serious problems of sepsis. Inversion is being used more often nowadays as it has considerable advantages. There is a low complication rate, in particular of fistula, and the patient has a short hospital stay of 4-6 days. The patients occasionally complain of a sensation of a lump in the throat for 2 or 3 days, but this quickly subsides. Patients are able to drink the day after surgery.

The operation is carried out routinely to the point of full mobilization of the sac and cricopharyngeal myotomy, the pouch is then invaginated into the oesophagus and its neck oversewn with interrupted catgut sutures. A small drain is placed in the wound which is closed in the normal manner.
**Diverticulo-oesophagostomy**

Described by Jackson, Slack and Williams (1960), this operation was used for a patient who had a very large diverticulum entering the mediastinum. The barium studies suggested that it was adherent to structures in the right thorax, implying potential risk when mobilizing the pouch up into the neck. The diverticulum was drained into the thoracic oesophagus at its fundus; the operation was successful and the patient rapidly gained weight.

This is clearly a specialized idea for a particular problem and will rarely be deemed necessary, but does offer an alternative for larger sacs.

**Cricopharyngeal myotomy**

This has been used to treat neurological disorders of swallowing including achalasia of the sphincter, muscular dystrophy, and myasthenia gravis. It is strongly argued that it should be a standard part of the operative treatment of diverticulum, although the evidence to support this is controversial.

The procedure is simple and relatively risk free, being advocated as the only treatment needed for small diverticula. As this procedure takes only 5 minutes to perform it should be part of the standard operation.

**One-stage diverticulectomy**

Although this was the first successful method it did not become popular until antibiotics were readily available. The preoperative examination is important, the patient being admitted 2 days preoperatively and the sac emptied by periods of resting in the head-down position. The patient is restricted to clear fluids for the last 24 hours. It is suggested that a black silk thread be swallowed, the proximal end being secured to the cheek, in order to facilitate identification of the oesophagus, down which it should pass.

The patient's general health is assessed with particular emphasis on the chest. Treatment of any chest pathology is essential prior to surgery. The operation is usually performed under general anaesthesia with the patient intubated and paralysed. The radiographic films are examined again in theatre and it is confirmed to which side the pouch has deviated. The operation is performed in two stages, the first of which is oesophagoscopy and the second, the external approach. Once the patient is anaesthetized, an oesophagoscopy is passed and the openings to the sac and oesophagus identified. A nasogastric tube is passed through the cricopharyngeal sphincter to the stomach after which the diverticulum is inspected to exclude carcinoma and to suck any debris from it before packing with ribbon gauze soaked in proflavin, the proximal end of this strip being brought out through the mouth to the head of the table so that the anaesthetist can remove it at the appropriate time without disturbing the drapes. Attempts at passing the nasogastric tube after packing the pouch can be hampered by the bulk of the pack impinging on the oesophagus, it is therefore recommended that the nasogastric tube be passed first.

The patient is then placed in the reverse Trendelenburg position with a sandbag under the shoulders and the head extended and rotated away from the side of the incision. The
operation area is sterilized and draped, and a collar incision marked out on the skin with methylene blue at the level of the upper border of the cricoid from the midline to halfway across the sternomastoid muscle, preferably in a skin fold. Some surgeons advocate an incision along the anterior border of the sternomastoid muscle, but this is generally unnecessary and uncosmetic. The incision line is infiltrated with adrenaline to minimize bleeding and the incision made through skin, subcutaneous tissues, and platysma to the strap muscles and sternomastoid. The deep cervical fascia is then incised anterior to the sternomastoid muscle which is retracted laterally. The omohyoid is identified, mobilized and divided between clamps, at which point the internal jugular vein comes into view. The middle thyroid veins are clamped, divided and ligated so that the dissection may proceed medial to the carotid sheath, which is gently retracted laterally avoiding undue pressure on the carotid artery. The inferior thyroid artery is identified and divided as necessary and, if possible, the recurrent laryngeal nerve is identified at this point of the operation. The diverticulum, which is packed with proflavin gauze, may be easily identified by colour or palpation. The fundus is grasped with Babcock forceps and carefully dissected free of the oesophagus inferiorly, while, in order to improve the exposure, the thyroid gland and thyroid cartilage are retracted medially, care being taken not to put pressure on the recurrent laryngeal nerve. The sac is then held by the surgeon while sweeping muscle fibres from the proximal part of the body of the diverticulum, with special care being taken to clear the neck so that its junction with the pharynx, which is identified by palpating the nasogastric tube, can be clearly seen. Great care must be taken to avoid tearing the sac at this juncture as it can easily extend into an oesophageal tear leading to considerable difficulties. The proflavin pack is then removed and stay sutures are inserted into the neck of the sac inferiorly and superiorly, care being taken not to place them too medially, thus causing a stricture.

The cricopharyngeal sphincter and upper circular fibres of the oesophagus are then divided posteriorly thereby avoiding the recurrent laryngeal nerve. There are many ways to facilitate myotomy but the easiest method is to place an artery forceps between the submucosa and the cricopharyngeus muscle from above, the blades are opened and a knife used to divide the fibres, which are stretched between the two jaws of the forceps. Stretching the muscle by the intrapharyngeal introduction of stomach tubes or inflated Foley catheters and endotracheal tubes, has been described; in addition the operating microscope has been used to ensure division of every single muscle fibre. After the myotomy, the wound inferior to the neck of the sac is packed with gauze to catch any debris which may discharge when the sac is amputated. The mouth of the neck is then closed with a continuous inverting suture and the stay sutures removed. A second layer of interrupted catgut or silk is then used to bury the first. Haemostasis is secured before wound closure, and a drain is inserted inferiorly. Suction drainage is avoided due to the risk of salivary fistula or damage to the recurrent laryngeal nerve. The wound is closed in two layers with continuous chromic catgut subcutaneously and prolene to the skin. Antibiotics should be reserved for complications and are not routinely used. The drain is removed when there is minimal drainage, usually after 2-3 days. Nasogastric feeding is continued for 5-7 days, after which fluids are given. If there are no complications or leakage, the nasogastric tube is removed and soft diet started the next day. Normal diet is given after 10 days.
Recent advances

Debate continues about whether endoscopic or external surgery is the best form of treatment, both having their staunch advocates and, equally, both having some advantages over the other. Endoscopic surgery is rapid and minimizes the effect of an operation in an elderly person, whereas external surgery, while longer, ensures (except with inversion) excision of the sac and relieves the risk of carcinoma developing later. It also has a lower symptomatic recurrence rate. Some surgeons have therefore tried to improve on the existing techniques.

Endoscopic modifications

Knegt, De Jong and Van der Schans (1984) reported on 28 patients on whom they had used carbon dioxide laser to divide the diverticulo-oesophageal septum. Twenty-two patients had complete relief and the remainder were considerably improved. There was one of mediastinitis, which responded to antibiotics, and 21 of the 28 patients had a sharp rise in temperature for the first 24 hours, but were otherwise symptom free. This phenomenon remains unexplained. Van Overbeek, Hoeksema and Edens (1984) used laser surgery in 12 patients, but felt it conferred no advantage to the patient over traditional diathermy techniques.

External approaches

The stapling gun has been in use in bowel surgery for many years but, until recently, otolaryngologists have not taken advantage of this apparatus. It is now becoming increasingly popular for resection of the diverticulum. In the 1980s it has been reported more frequently and offers a real contribution to the safety and ease of surgery, the closure of the sac being most important in preventing infection, emphysema and mediastinitis.

Complications

Complications may disrupt the smooth recovery of the patient. They can be divided into immediate, early and late.

Immediate

1) Haemorrhage. This usually results from poor haemostasis at surgery, or a ligature slipping from one of the vessels ligated during surgery.

2) Pneumothorax. While this is uncommon it may occur during the mobilization of a large sac particularly if adhesions are present.

3) Surgical emphysema. This may result if an unseen mucosal tear is left or the suture line is not complete.
Early

1. Secondary haemorrhage is usually due to secondary infection.

2. Hoarseness. Endoscopic surgery avoids the recurrent laryngeal nerve, but in external approaches, there is always the danger of damage to the nerve, either temporary or permanent.

3. Wound infection or wound abscess. These are more likely if there has been spillage from the sac or oesophagus during surgery, although they may result from a leak through the suture line. Infection will predispose to fistula formation.

4. Fistula is usually a result of infection. Saliva or food leaking from the external excision are diagnostic of this condition, which may be confirmed by a gastrograffin swallow. Fistulae usually close spontaneously if the pharynx is bypassed with a nasogastric feeding tube.

5. Mediastinitis may result from a leak tracking downwards. If it is not noticed at surgery the patient develops symptoms several hours or days later, complaining of pain in the neck and back, and becoming severely distressed and dyspnoeic. Plain radiographs of the chest will show air in the mediastinum or neck. If doubt exists, a small quantity of gastrograffin is swallowed and radiographs repeated. Treatment should be rapidly instituted with intravenous antibiotics, and the patient should be monitored for evidence of deterioration in the vital signs. If this occurs the neck should be reopened and any leak closed with sutures, a large drain being inserted into the posterior mediastinum. It may be necessary to perform a thoracotomy for drainage.

6. Aerocoele. This is rare but has been described by McArthur (1980), as a complication following diverticulectomy. A large aerocoele formed in the superior mediastinum communicating with the pharynx; it resolved spontaneously several weeks after surgery, having discharged briefly via the neck.

Late

1. Persistent hoarseness occurs when the recurrent laryngeal nerve has been divided. No recovery can be expected.

2. Stricture results from taking too much mucosa when dividing the neck of the sac, and closing the pharynx. If too much traction is applied to the sac during excision it pulls the pharynx laterally so that inadvertently zealous excision can result. It is treated by dilatation which is generally successful, although repeated applications are often necessary. Occasionally radical surgical correction is necessary.

3. Recurrence. All methods have a recurrence rate although it is higher for endoscopic diathermy and two-stage diverticulectomy than one-stage diverticulotomy. However, it is easy to reoperate endoscopically, whereas reopening a neck to identify the recurrent sac, with fibrosis and scarring, is difficult. The recurrence rate for endoscopic diathermy is about 6-7% against 2-3% for one-stage diverticulectomy, if the latter is combined with cricopharyngeal
myotomy. If a myotomy is not performed the recurrence rate of diverticulectomy is much higher. Bertelsen and Aasted (1976) using excision of the sac, believed that there is a considerable difference between symptomatic recurrence rate, which they reported at 2% and radiological recurrence which they reported as high as 11%. However, they did not perform cricopharyngeal myotomy. Gammelgaard (1955) reported on 20 patients who had diverticulotomy without myotomy. When reviewed at up to 8 years after surgery 14 had developed radiological recurrence. Complications using external approaches are higher when the sac is larger, being greatest in those patients falling into the stage III group.

**Carcinoma of the diverticulum**

This is a rare problem with only about 30 reported cases in the English literature. The Mayo Clinic, in a series of 1249 patients, found four cases of malignancy arising from the diverticulum, which is an incidence of 0.32%. The true incidence is probably between 0.5-1.0%. It affects men predominantly in a ratio of about 5:1 and usually occurs in a long-standing diverticulum, the average duration of symptoms being greater than 7 years. The age of diagnosis is usually over 50 years. The main predisposing factor is thought to be chronic irritation and inflammation of the diverticular lining from food retention. Symptoms indicating carcinomatous change are an acceleration of dysphagia and weight loss and occasionally blood in the regurgitated food. Nodes or a mass may be found in the neck whereas there are normally few palpable signs.

The usual lesion is an invasive squamous cell carcinoma, but a few cases of carcinoma in situ have been reported in the literature.

Barium studies show a constant filling defect, unlike food debris which moves between films or repeat swallows. It is usually seen in the distal two thirds of the pouch but can easily be missed, the diagnosis frequently being made at surgery when careful examination with the oesophagoscope should be performed.

The treatment best suited to this lesion is uncertain. Radiotherapy alone has always failed to effect a cure. Most commonly a simple diverticulectomy is performed but there are only a few cases reported to be free from disease at 5 years, the longest survival being 8 years (Huang, Unni and Payne, 1984). Following the operation radiotherapy is often given. Some authors advocate a more radical treatment as for a carcinoma of the cervical oesophagus.