Chapter 21: The management of cleft palate

R. W. Pigott and D. S. McManamny

Successful treatment of congenital and acquired conditions affecting the palate depends on an understanding of its functions. As the floor of the nose, it provides part of the airway, isolating nasal cavity from obstruction by food during mastication, and as the roof of the mouth, it provides a surface against which food may be broken up by the tongue and neatly passed back as manageable boluses for swallowing. In man its smooth surface is also concerned with the production of distinguishably different sounds which can be combined together to produce intelligible speech. The soft palate has the additional ability to contribute to closure of the velopharyngeal isthmus to prevent food entering the nose in swallowing and also to conserve and direct respired air through the mouth under pressure for speech.

Speech analysis

One of the main aims of the management of patients with cleft palate is the provision of an anatomical and physiological environment in which comprehensible speech can be produced. The speech of a patient with an unrepaired cleft palate is characterized by features which are instantly recognizable by most people, lay public and medical professionals alike. However, it is misleading to assume that the speech defects of patients with this problem are identical. The speech of any individual patient will alter, depending on such factors as the inability to bring the lips together, necessary to pronounce /p/ and /b/; the configuration of the hard palate and alveolar arch and the integrity of the dental arcade which may affect sounds such as /s/ and /z/; the presence of fistulae at different points in the palate which can alter air escape affecting consonants such as /d/, /g/ and /k/ made against the hard or soft palate and, most importantly, the competence of the velopharyngeal isthmus which conserves the air stream and directs it past the articulators or allows it to escape through the nose to produce nasal consonants. In this light, speech analysis may seem a difficult and complicated task, but it becomes straightforward when an ordered approach is taken.

As well as analysing the various components of speech, the degree to which the patient becomes breathless on talking is one of the first aspects to be noted. This can be assessed by asking the patient to count up to twenty rapidly. With velopharyngeal competence it should be unnecessary for the patient to take more than one breath to complete the task; with severe incompetence a breath may be taken for every few digits.

For the purposes of defining various speech defects with greater precision, and comparing different methods of treatment, articulation, velopharyngeal function and intelligibility are considered separately (see Chapter 11 on Disorders of speech).

Closure patterns of the velopharyngeal isthmus

From a few well documented direct observations following maxillectomy, but mainly from radiological and endoscopic studies, normal and abnormal patterns of closure of the velopharyngeal isthmus have been defined both for swallowing and for speech (Calnan, 1952; Astley, 1958; Massengill et al, 1966; Pigott, 1969; Skolnick, McCall and Barnes, 1973).
Further information has come from electromyography (Fritzell, 1969; Bell-Bertie, 1976; Mulder, 1976).

These patterns may be summarized as follows.

Swallowing

Swallowing is a relatively slowly developed, powerful sphincteric movement involving approximation of the posterior third of the palate to the pharyngeal wall. The action of swallowing is innervated by the ninth, tenth and eleventh cranial nerves via the pharyngeal plexus and invariably functions normally in the group of patients whose behaviour is considered in this chapter. One principal muscle is the superior constrictor with assistance from palatopharyngeus and to a lesser extent levator palati. Closure is below the level of the area of the atlas.

Speaking

Closure for speech, by contrast, occurs rapidly (for example the palate must rise and fall eight times to produce the 13 syllables in counting from 15 to 20 at a normal speed (in 3 seconds). If the movements were equally distributed this would give a cycle open-closed-open of 0.36 seconds, but very much higher speeds have been recorded. The role of the palate depressors is very important under these circumstances. The sacrifice of all the fibres of the palatopharyngeus muscle in certain pharyngoplasties may lead to the palate remaining up for open nasal sounds with resultant hyponasality; at least part of this muscle should be conserved during surgery. The closure takes place above the level of the arch of the atlas in adults, at the level of the basiocciput in children, and at the level of the basisphenoid in infants (Calnan, 1959). These changes are due to descent of the maxilla, and with it the hard palate and attached soft palate, with age and also to atrophy of the adenoids against which they actually make contact in infants and younger children. In these younger groups the palate rotates up as a fixed length structure to touch the adenoid mass, but with increasing age, it also lengthens (velar stretch).

Muscular control

The principal muscle is the levator palati and when this contracts alone the palate rises as a simple valve. More often there is a contribution to closure from the superior constrictor and/or the horizontal fibres of the palatopharyngeus which originate in the soft palate and sweep around the pharynx as the palatopharyngeal sphincter (Whillis, 1930; Calnan, 1952). It is likely that velar stretch is due to these horizontal fibres. Whatever muscle is responsible, the effect is advancement of the lateral and posterior walls, each to a greater or less degree, resulting in a final pattern of closure which may be coronal, sagittal or sphincteric (Skolnick, McCall and Barnes, 1973; Shprintzen et al, 1979) and is as idiosyncratic to that person as the movements of their mouth.

The less the movement of the palate, the greater the movement of the lateral and posterior walls, which may be compensatory, since in cases of unrepaired or inadequately repaired palate clefts, a well-defined semicircular shelf develops on the posterior wall, known
as Passavant’s ridge (after Gustav Passavant, a Frankfurt surgeon, who first described it in 1869).

Evidence from neurological syndromes (Sedlakova, Lastovka and Scar, 1973), observations on patients with facial palsy (Podvinec, 1952), from human observation studies (Nickl, 1950), and from animal experiments (Nishio et al, 1976a,b) supports the view that the seventh cranial nerve innervates the levator for speech, possibly via the chorda tympani, or the greater superficial petrosal nerves, sphenopalatine ganglion and lesser palatine nerves, in addition to fibres from the pharyngeal plexus.

The vertical fibres of the palatopharyngeus actively depress the palate, assisted by elastic fibres in the palatoglossus, the muscle fibres, like those of salpingopharyngeus, being small and inconstant (Kuehn and Azzam, 1978).

The upper surface of the soft palate is convex at the level of the levator eminence over its median third, due to the bulk of the paired musculus uvulae and the associated mass of mucosal glands (Pigott, 1969; Azzam and Kuehn, 1977). This allows it to fit snugly into the concavity of the posterior pharyngeal wall. Laterally, the inconstant ridges of salpingopharyngeus advance medially to fit against the sides of the musculus uvulae ridge.

**Diagnostic techniques**

**Oral examination**

Direct observation of the oral cavity provides essential but limited information about the cleft palate patient. Unfortunately, the competence or otherwise of the velopharyngeal sphincter cannot be determined by looking into the mouth, since the point of closure lies above the soft palate, not directly behind it. Examination of the oral cavity must include a good view right back to the uvula and pharyngeal walls. If there is an unrepaired cleft, note is made of the extent and the width of the defect.

The examiner should look particularly for signs of a submucous cleft. Not all the signs are found in each patient. There is often a translucent stripe running down the centre of the soft palate. This represents an area devoid of muscle. The posterior border of the palate should be palpated for a notch in place of the nasal spine. This is pathognomonic of submucous cleft and probably represents the anterior insertion of the palate muscles exactly as seen in over clefts. The levator lift dimples should be examined as the patient says ‘ah’. Lateral placement also indicates muscle separation. The uvula is bifid in four out of five cases of submucous cleft, but this is not a reliable sign of a submucous cleft, as it occurs in more than 1% of the population. Irregularities of the dental arcade and collapse of the arch should be noted as they will make articulation more difficult.

In the case of a repaired palate, examination will reveal the quality of the resultant scar and apparent mobility, and the presence or absence of a fistula. Although nasopharyngeal closure cannot be confirmed by oral examination, a fair assessment of palate mobility can be achieved. The time-honoured sound the patient is asked to utter, /ah/, is not as effective in achieving maximum velar elevation as the vowel /ee/. Formation of this sound normally lifts the soft palate to a lever well above the hard palate, and should be used instead. Both Calnan
(1952) and more recently Sommerland (1981) have pointed out that in the normal palate, elevation is accompanied by the presence of dimples on the oral surface at points of attachment of the levator palati muscles to the soft palate. In the cleft palate, these dimples may be displaced laterally, or grooves running forward to the posterior edge of the hard palate may be seen instead. Large tonsils may be responsible for obstruction of either nasal or oral air flow which can lead to hyper- or hyponasality or to a 'hot potato' quality of the patient's speech.

Some idea can be gained of the relative sizes of the oral cavity, palate and pharynx. In a small group of patients with velopharyngeal incompetence no abnormality will be found other than a disproportionately large pharynx. Passavant's ridge is sometimes visible on saying /ah/, but even if the ridge itself cannot be seen, bunching of the mucosa may be visible below the palate. Mirror examination will confirm this. Although further investigations are required, a provisional diagnosis of pharyngeal disproportion can be made on oral examination.

**Nasopharyngoscopy**

**Historical**

The anatomical position of the velopharyngeal isthmus has rendered it inaccessible to direct observation until relatively recently. Borel-Maisonny (1937) was able to view the isthmus during the production of isolated sounds using a laryngopharyngoscope and nasopharyngoscope, introduced over the dorsum of the tongue. In 1966, Taub introduced the use of an oral panendoscope with which cine and video recording was possible. It is a right-angled viewing instrument and has a 50° cone of acceptance. However, conversational levels of speech muscle activity cannot be assessed, and in particular, /s/ and /z/ blends, the sounds most likely to be mispronounced by cleft patients cannot be tested.

An instrument which enables observation of the velopharyngeal isthmus from the nasal site is required in order to do this. Using this approach, observation of soft palate function does not interrupt the normal flow of air during random connected speech. The ideal endoscope for nasal pharyngoscopy does not exist at present, but the introduction of light conduction by solid cable has at least made this technique feasible. There are several instruments available, of both rigid and flexible type.

**Rigid endoscopes**

One of the most important features of a rigid nasoendoscope is its angle of view. In the sitting patient with the head positioned so that the hard palate is horizontal, the plane of the nasopharyngeal isthmus can be related to the plane of the hard palate. The plane of the isthmus is defined when the point of contact, or attempted contact, between the genu of the soft palate and the posterior pharyngeal wall is known (Pigott and Makepeace, 1982). A tangent drawn to that point on the posterior wall lies at right angles to the plane of the isthmus. This tangent is termed the presumptive closure plane. The angle between the presumptive closure plane and hard palate is termed the 'presumptive closure plane angle'. If an accurate assessment of closure is to be made the endoscopic view must be at an angle normal to the presumptive closure plane angle. During growth the hard palate descends relative to the base of the skull, and therefore the presumptive closure plane angle will
increase with age. This must be considered when selecting a suitable instrument for a given patient. A direction of view that is not parallel to the presumptive closure plane will lead to foreshortening of the endoscope image and the isthmus may even be out of sight. The presumptive closure plane of 60 randomly selected patients with an age range of 7 to 23 years varied from 32° in the youngest to 112° in the eldest. The mean angle was in the region of 70°. A rigid endoscope can be tipped up, to decrease the angle of view, but it cannot be tipped down without causing significant discomfort to the patient.

The Storz Hopkins 70° nasopharyngoscope is the most commonly used rigid nasopharyngoscope. The optics are excellent. The angle of view is similar to the presumptive closure plane of the isthmus in an average examination. It has a cone of acceptance of 110°, which makes orientation and siting of the instrument quite straightforward. The tip can be lifted, and the field of view increased. The wide angle enables the circumference of the isthmus to be viewed in one field from quite close. The shaft of the endoscope is oval in cross-section, and measures 4.2 x 3.5 mm. This means that rotation beyond 30° may be uncomfortable, especially in children. Consequently, visualization of the eustachian tube orifices may not be possible.

For smaller children, the Storz 30° endoscope is useful. The cone of acceptance is smaller, but its 3.0 diameter requires less room for it to be passed, and its circular cross-section allows rotation to view the eustachian tubes.

**Flexible endoscopes**

The new Machida (3 mm od) fibreoptic endoscope (Wolff 7200) has an outside diameter of 3.0 mm and a small radius of flexion, which make it a very versatile instrument. A range of closure planes can be examined, and its small size makes it more acceptable to younger patients than the larger endoscopes. It is therefore a suitable instrument for a large number of patients. Shprintzen (personal communication, 1984) has achieved considerable success using the Machida endoscope in children from 3 years of age and, in practice, a child who will tolerate topical nasal anaesthesia will almost always tolerate endoscopy.

**The technique of endoscopy**

**Patient selection**

Patients must be conscious and cooperative to obtain speech samples. A child who cries produces mucus in the nose which obstructs the view. Using the Storz 70° nasopharyngoscope Pigott and Makepeace (1982) found that the success was proportional to age, with 30% success in 3 year olds rising to nearly 100% in 10 year olds, providing gross nasal obstruction was not present.

**Equipment**

The examination is performed in a dental chair with facilities for raising and lowering, and head rest adjustment. It is very important that the head is well supported as movement
when the endoscope is in place can disturb the image or the recording, and can be quite uncomfortable.

The endoscope is attached to a rigid multiarticulated teaching attachment (Storz) or to a fiberoptic teaching adjustment which connects to a high resolution black and white camera, if video recording is to be undertaken. Radiographic equipment, television monitor, video recorder and image integration unit should be available under ideal circumstances, to allow simultaneous fluoroscopic and endoscopic recording which permits a later review of findings (Pigott and Makepeace, 1982).

**Anaesthesia**

Patients are asked to rub a small quantity of cocaine paste (25%) on their little finger into both nasal vestibules 5 minutes before examination (Henderson, personal communication, 1983). Ciliary action carries this back to the inferior turbinate. For more posterior anaesthesia the two commonly used agents are 4% lignocaine hydrochloride solution, and 5% cocaine solution. Cocaine is the more effective of the two, however, a dangerous drug register must be used, and resuscitation facilities must be available.

Prior to anaesthesia the patient is asked to clear the nasal passages as must as possible by sniffing and blowing the nose, until it sounds quite dry, since mucous interferes with the effectiveness of the local anaesthetic.

One millilitre of cocaine solution is drawn up in a syringe, to which is attached a no. 10 Portex catheter. At the other end of a catheter a twist of cotton wool is held in place with Micropore tape. The cotton wool bud should be of a diameter similar to that of the endoscope. The nostrils are inspected, and the airway with the greater aperture is chosen. The tip of the catheter is inserted along the nostril floor and a few drops of anaesthetic are released. The catheter is advanced, slowly, and the entire nasal cavity floor is covered with solution, until the posterior pharyngeal wall is contacted. For flexible endoscopy it is useful to anaesthetize above the inferior turbinate. When examining children it may help to offer them a sweet to suck while this part of the procedure is being carried out, as the anaesthetic solution tastes bitter.

**Examination**

Previous experience of inserting an endoscope with adult volunteers is essential before undertaking clinical work. After allowing adequate time for the anaesthetic to take effect, the tip of the endoscope is placed on the nostril sill, and gently advanced with the nose tip held elevated with the free hand. Insertion is achieved by gently feeling for resistance and watching the angle of the endoscope and the head. In the case of a unilateral cleft, the non-cleft nostril should usually be used. However, the endoscope often requires angulation around the posterior border of the vomer because of the convexity of the septal midzone into the cleft nostril. If fluoroscopic screening is available, the position of the tip of the endoscope can be accurately sited to obtain the correct view of the nasopharyngeal isthmus. Care should be taken not to contact the posterior pharyngeal wall. This can cause severe bilateral earache despite otherwise adequate local anesthesia, and if even a spot of blood contacts the light emission pupil or objective lens of the endoscope, the examination is impossible.
The patient is asked to swallow. Velopharyngeal closure in this instance will be lower in the nasopharynx than that achieved in speech. The endoscope tip is manoeuvred until the best position for observation is obtained.

The following speech sequence is then used to test closure effort with the tongue in different positions. Each sequence is demonstrated and the patient then attempts to reproduce the sound.

Pah, pah, pah (bilabial plosive)
Tah, tah, tah (alveolar plosive)
Sah, sah, sah (alveolar fricative)
Cha, cha, cha (palatal affricative)
Kah, kah, kah (velar plosive, unvoiced).

The patient is then asked to count up to 20 slowly, and finally, as fast as possible.

The eustachian tube orifices may be examined, and the other nostril may be used for further viewing if indicated. During the examination, the size and shape of the resting isthmus are observed, as well as the degree and type of velopharyngeal movement. The presence of bubbles in the nasopharynx on attempted closure suggests failure of a complete seal. Movement of the lateral pharyngeal walls, or the development of a Passavant's ridge are noted.

Simultaneous recording of endoscopy with lateral fluoroscopy permits absolute measurements to be calculated (Pigott and Makepeace, 1982).

**Fallacies of endoscopic assessment**

The apparent size of an object in the field of view is misleading, since it is inversely proportional to the square of the distance between the object and the endoscope tip.

Misinterpretation may occur because of the angle of view of the endoscope to the closure plane. A tangential view will give the impression of a smaller isthmus and to prevent this, the endoscope should be gently manipulated until the best tip position is achieved. If there is a gross discrepancy between the angle of the presumptive closure plane, the point of closure may be missed completely. Movement may be underestimated if the instrument is maintained in one position. As objects move closer to the lens, they become more brightly illuminated, but the distance traversed is difficult to estimate unless the instrument is 'panned' across the isthmus.

The wide angle effect of the lens of the 70° Storz endoscope must be taken into account. Objects in the outer annulus of the field of view will have an image that is compressed by a factor of two to three. Thus, one is especially likely to underestimate the area of failure of a port to close on the far side of a pharyngeal flap, because it is viewed obliquely, and its image is compressed by the peripheral image distortion effect of the wide angle lens.
**X-ray examination**

**Historical**

Velopharyngeal function has been investigated by means of radiology for many years. Scheier used single-exposure lateral radiographs in 1897, and since that time basal and frontal views have been found to provide valuable information. The disadvantage of single films, including tomograms is the uncertainty over timing of the exposure.

Cineradiography became available in the 1950s (Carrell, 1952; Ardran and Wyatt, 1954), and to a large extent, this overcome the problem of coordinating exposure and palate movement. However, it involved relatively high doses of radiation. With the use of an image intensifier and videotape recording, the radiation factor can be reduced by a factor of ten, and exposure during an average one minute assessment is reduced to less than that of one chest film. Care must be taken to screen the eyes and thyroid.

**Lateral pharyngeal view**

Ideally a radiological examination will be performed during the same session as nasopharyngoscopy, but if this is not possible, a plain lateral view obtained prior to endoscopy allows the presumed isthmus closure plane to be seen and an appropriate endoscopy selected. In any case both uncoated and barium-coated lateral views should be obtained. Lateral fluoroscopy can be used during introduction of the endoscope to ensure correct positioning of the tip of the instrument for observation of the isthmus. The radiological shadow of the endoscope is measured and related to the known width of the endoscope. The dimensions of the hard and soft palate, the range and timing of gross velar movement, and the presence of Passavant's ridge can then be assessed.

After the endoscopic examination is completed, barium sulphate (mixed as for a barium swallow) is instilled into each nostril in turn using a no. 8 FG catheter passed 2.5 cm back along the nasal floor. About 2 mL of the mixture are injected from a 10 mL syringe. The patient is asked to sniff and swallow. This helps to coat the entire nasopharynx. The patient repeats the phoneme sequence used during nasopharyngoscopic assessment, and palatal mobility is observed with a true lateral fluoroscopic view. Posterior wall activity and especially the presence of Passavant's ridge is noted.

Because X-rays are two dimensional, velopharyngeal closure may appear adequate on lateral projection with air contrast. This impression can be false and significant gaps may exist centrally or laterally. Two layers of barium (on the shoulder and in the valley) are frequently seen in submucous cleft and failed repaired cleft palate patients. Obviously, this diagnosis can only be made having checked that the image is a true lateral.

**Basal view**

X-rays of the isthmus at right angles to the lateral view overcome this problem. Skolnick (1970) showed that the velopharyngeal isthmus could be viewed *en face* by positioning the patient with head and neck extended, and the X-ray beam at right angles to a line passing from the corner of the mouth to the external auditory meatus.
Difficulties may arise in attempting to execute this view. Even with the use of a Philips 'C' arm BV image intensifier, some adults with short necks are incapable of extending sufficiently, and some children have an isthmus orientated in a plane that is too horizontal to obtain an *en face* view. Also, patients in whom closure is barely adequate with head and neck in the normal position may become incompetent when the neck is hyperextended. The basal view is least reliable when incompetence is being investigated following pharyngeal flap surgery. The lateral ports may become blocked by barium and give the impression of closure when in fact they are open. The axis of the port may be at an angle to the vertical place, and several barium rings may be seen. In the absence of previous endoscopic information, accurate interpretation is impossible.

**Front-occipital view**

The plane of the isthmus in young children is disposed more horizontally, and closure occurs against the basisphenoid rather than the posterior pharyngeal wall. The basal view will not show the isthmus adequately, but a front-occipital view, despite the superimposition of the occipital bone, will do this.

**Frontal view**

This view is used to demonstrate the level at which maximal movement of the lateral pharyngeal walls occurs in order to place a pharyngeal mucosascular obturator between the pharyngeal wall and palate at that level, against which the lateral wall can adduct, although the level at which the flap finally lies is largely beyond the surgeon's control.

**Split screen recording**

There are obvious advantages associated with simultaneous recording of nasopharyngoscopy and fluoroscopy, some of which have already been mentioned. Nasopharyngoscopy provides the best method of qualitatively assessing velopharyngeal closure, and radiology the best quantitative method.

Simultaneous recording provides a three-dimensional concept of what takes place and has contributed much to our understanding of the strengths and weaknesses of both systems. Neither form of investigation can be performed for more than one minute because of the invasive nature of endoscopy and the radiation hazard of X-rays. Repeated viewing of even brief records, particularly with stop and slow motion facilitates accurate diagnosis and research. A split screen unit provides a very convenient method of doing this.

Ideally, three personnel - an endoscopist, a radiographer, and an audiovisual supervisor - are required to run the examination, and must perform tasks simultaneously. A number of pieces of audiovisual equipment are used during investigation. These include a video camera, teaching attachment, video recorded and monitor. The image intensifier has its own video camera and a split screen unit allows the images to be combined.

The simplest method (David et al, 1982) uses one half of a commercial split screen unit for the endoscope image, recorded on a colour video camera. The X-ray image is recorded by the other half by placing a second camera in front of the X-ray image intensifier.
monitor since commercial units (at a reasonable price) cannot displace the images from the centre of the screen. The two video cameras must be synchronized. The alternative system used by the authors involves a custom-built unit (Leendertz, Makepeace and Pigott, 1982) in which the images can be displaced. This obviates the degradation of the X-ray image involved in recording from the monitor. The brightness of both images is controlled independently and an electronically generated display provides a unique examination identification number and timing information to permit identification of a specific video frame.

The routine examination has the following parts:

(1) endoscopy with uncoated lateral pharyngeal X-ray;

(2) portrait view of the patient with barium-coated lateral X-ray (using another video camera mounted 3 m in front of the patient with a 300 mm zoom lens);

(3) basal and/or fronto-occipital and/or frontal views.

**Anemometry**

A number of devices have been developed to measure nasal air flow during attempted velopharyngeal closure. Although the presence or absence of nasal escape can be determined subjectively by ear, quantitative data are helpful to allow objective comparison before and after treatment and between series treated at different centres.

Blowing devices, U-tube manometers and mirrors that record nasal fogging are among the clinical tools that have been used to record the presence of absence of nasal escape, but the results are lacking in standardization and cannot be used in random connected speech. During manoeuvres such as blowing and sucking, apparently satisfactory nasopharyngeal closure can often be achieved by utilizing contact between the tongue and palate.

Using an analogue study of nasal escape and by taking oral and nasal air pressure and flow measurements, Warren and Devereaux (1966) and Warren et al (1985) were able to measure orifice size. They showed that for areas of incompetence more than 20 mm², there is poor correlation between area of incompetence and perceived levels of nasal escape, but good correlation below this. However, over 20 mm² nasal escape is likely to be perceived as moderate and therefore surgery will be indicated. Between 10 and 20 mm² escape will be perceived as slight to moderate and surgery may be indicated. Below 10 mm² escape will be perceived to be slight or nil and surgery is unlikely to be needed.

The equipment required for these measurements is expensive and more complex than that required in clinical context, and Warren (1979) has developed a simpler instrument - PERCI (palatal efficiency rating computed instantaneously) to confirm the presence of and quantify velopharyngeal incompetence. The technique also involves recording simultaneous pressures in the mouth and nose. Using this instrument reproducible pressure differences can be measured between the mouth and nose, and values for inadequate closure can be derived. However, the instrument cannot be used to measure incompetence in the not infrequent situation where the isthmus functions perfectly on plosives, but totally fails to attempt closure of fricatives particularly /s/ and /z/ blends.
Electromyography

This technique is not used extensively because of technical difficulties associated with the procedure, and the complex arrangement of the muscles of the region.

Fritzell (1969) and Lubker (1975) have undertaken some of the more extensive electromyographic studies of palatal function. Their investigations have required the insertion of electrodes via the nasal and oral cavities. They concluded that velopharyngeal musculature functions in a predictable fashion. However, the pattern of function depends on the order of the phonemes in the speech sequence and the action of individual muscles in the palate and pharynx are influenced by others about them.

Primary management of cleft palate

Classification

Kernahan and Stark (1958) termed the premaxillary complex the primary palate, because it develops in the embryo at 4-7 weeks, and the maxillary part the secondary palate, because it develops at 7-12 weeks. These structures combine at the incisive foramen to form the definitive palate. In this classification (Table 21.1), there is no facility for differentiation between clefts of the hard palate and the soft palate and, in an attempt to avoid sometimes confusing descriptions, Kernahan (1971) suggested a graphic method of representing clefts of the prepalate and palate, called the 'striped Y' classification.

Cleft palate repair

Timing

During the normal development of speech patterns, the first phonemes that require velopharyngeal closure are used between 6 and 9 months of age, suggesting that repair should precede this period. In 1927 Veau demonstrated that patients who underwent repair of the palate after 2 years of age had notably worse 'speech' than those whose palates were repaired before that age. Personal experience has indicated that there is a statistically significant higher rate of velopharyngeal sufficiency in children operated on under the age of one year compared with those operated on between one and 2 year (unpublished data). As infant nutrition and management of cardiac anomalies or diabetes, for example, improves, and as the experience of surgical, anaesthetic and nursing teams increases, the dangers of early operation becomes less.

However, there are arguments against operating on the palate before the age of 12 months. As the infant grows older, the blood volume increases, leaving a greater margin of error in resuscitation. A larger airway reduces the risk of airway obstruction postoperatively and at one year of age the bulk of muscle in the palate is much larger than at 3 months, making tension-free repair easier.
Extent of repair

Controversy still exists regarding how much of the palate should be repaired at the primary procedure. The most common approach is to repair the soft palate, and all of the hard palate in need of closure. This avoids the postoperative requirement of an obturator. Surgeons who advocate this approach believe that simple elevation of mucoperiosteum to close the hard palate is only one factor causing maxillary retraction. Inherent lack of growth potential in some cases and simple repair of the lip cleft may be of far greater significance. However, a number of authors are still of the opinion that a two-stage plan is better. Gillies noted that the maxillae of skulls which had not been operated upon grew virtually normally. This led Gillies and Fry (1921) to favour closure of only the soft palate before 2 years of age, and to leave a defect in the hard palate which was filled with an obturator. The remaining defect was sometimes repaired at 4 or 5 years of age, but many patients lived with their obturators until dental decay made this impossible. Others found that an obturator was a nuisance to manage, and preferred to be without one. Frequent remodelling of the plate is required as the palate grows and teeth erupt and are lost. Advocates who favour early repair of the soft palate and delayed repair of the hard palate, varying between 4 and 12 years, point out that considerable narrowing of the cleft takes place so that extensive mucoperiosteal undermining and displacement are not required (Hotz et al, 1978; Schweckendiek, 1978). Since maxillary retraction does not become fully evident until after the pubertal growth spurt, carefully planned long-term studies of speech and growth require completion before this issue can be resolved.

Table 21.1 Kernahan and Starke’s classification of clefts

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<td>Median</td>
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<td>incomplete (premaxilla rudimentary)</td>
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<td>Bilateral</td>
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<td>submucous</td>
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<th>Clefts of primary and secondary palates</th>
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Technique

Surgery is performed at 6 months of age unless there are any contraindications.

A modified von Langenbeck (1861) technique will be described. The use of this method depends on closure of the anterior palate at the same time as the lip is repaired in
those cases of complete cleft lip and palate. This is usually performed 3 months before palatal repair.

Longitudinal studies of facial growth (Ross, 1970) have shown a significantly greater proportion of midface retrusion in the patients who underwent the Veau procedure compared with the von Langenbeck procedure. This has been attributed to the reduced amount of dissection of the hard palate in the von Langenbeck procedure, anteriorly. Veau's technique has, in the past, been considered to give superior speech results because it lengthened the palate. However, in 1959 and 1960 Calnan reported that the palatal lengthening achieved by the Veau V to Y pushback operation, modified by Wardill and Kilner, is not sustained. Reports of better speech results with the Veau operation over Langenbeck's and vice versa abound but some authors find no real difference (Jolley, 1954; Witzel et al, 1979).

Preoperative preparation

Bacteriological swabs are taken from the nose and throat 3 days preoperatively. The operation is postponed if group A beta-haemolytic streptococci are cultured, and treatment with penicillin is commenced. Staphylococci are treated with nasal chlorhexidine and flucloxacillin.

Operation

Under endotracheal anaesthesia using a non-cuffed tube, gauze swabs soaked in 3% cocaine are placed along the margins of the cleft, and are inserted into the nostrils. Care is taken not to exceed a dose of 3 mg/kg body weight. An intravenous drip is inserted. The patient is positioned with a sandbag placed beneath the shoulders, and the head extended on the neck.

Both headlight and magnification with 2.5 loupes are used by the surgeon. Suction apparatus is available with a paediatric measuring facility. A Dott mouth gag and a throat pack are inserted. The palate is infiltrated with a solution of 1% lignocaine hydrochloride with 1:250,000 adrenaline. Seven minutes are allowed for the vasoconstrictor to take effect.

The initial incision is made in the oral mucosa down to bone just medial to the sulcus between alveolar and palatal mucosa, from a point a little anterior to the forward limit of the cleft, back to the maxillary buttress, then laterally to the outer margin of the alveolus and then back again to the tip of the hamulus.

A second incision is made on the oral side of the margin of the cleft, along a line between oral and nasal mucosa where a distinct colour change from the redder nasal to the whiter oral mucosa exists. A small periosteal elevator such as a Mitchell's trimmer is used to separate the mucoperiosteum from the underlying bony palate starting from the lateral incision and working across to the cleft margin. Care must be taken to avoid damage to the greater palatine vessels. After exposure of the bony cleft margin, the nasal mucosa is mobilized blindly for a short distance laterally from the cleft margin.

With the posterior border of the hard palate in view, the soft palate musculature is gently mobilized at the line of attachment to the posterior margin of the hard palate using a
combination of sharp and blunt dissection. Laterally, fibres of tensor palati can be seen passing around the hook of the hamulus. The tensor is preserved and the hamulus is not fractured. The lesser palatine nerve which supplies musculus uvulae is also preserved, if possible. The nasopharyngeal mucosa is mobilized from the medial surface of the pterygoid plate up to the base of skull. Both oral mucosa and mucous glands are separated from the muscular layer of the soft palate for about 1 cm to permit displacement of the musculus uvulae onto the palatal dorsum while uniting the levator and depressors beneath it. Oral and nasal flaps must reach easily to the midline. A similar procedure is performed on the remaining side.

The nasal layer is closed first using interrupted absorbable sutures, beginning anteriorly and working back. Then a heavy (3.0 chromic) horizontal mattress suture is placed at the junction of the middle and posterior thirds of the soft palate. It passes through both muscle and nasal mucosa layers lateral to the musculus uvulae fibres, with the aim of bunching up the tissue on the dorsum midline of the palate to recreate the uvula muscle ridge.

The oral layer is then closed with interrupted mattress sutures, one suture being placed between oral and nasal layers at the junction of the hard and soft palate to obliterate a potential dead space. Small wedges of absorbable haemostatic agent (Oxycel) are placed in the lateral defects, which heal rapidly by secondary intention.

Postoperatively thumb sucking is prevented by armsplints for 2 weeks. The patient remains in hospital for 10 days after surgery.

A routine postoperative follow-up is arranged for 6 months, and the first formal speech assessment is carried out at 18 months. By this time it is already possible to assess velopharyngeal competence in some children, but most children can be reliably assessed at 30 months (van Demark and van Demark, 1970).

Early complications

The majority of children recover quickly from cleft palate repair, and the incidence of complications is low in experienced hands. Of the problems that can occur postoperatively, airway obstruction and bleeding are the two most dangerous.

Difficult intubation due to micrognathia, subglottic stenosis, cervical spine anomalies or incorrect tube selection may cause oedema of the glottis and tracheostomy may be required. More often, a tongue-stitch may be used to hold the tongue forward for a few hours in some micrognathic infants. It also facilitates pharyngeal suction. Humidification has been found useful in about 10% of infants and betamethasone has produced dramatic improvement on rare occasions.

Usually, bleeding can be controlled in the ward with direct pressure, using a swab placed over the bleeding point and digital compression. Haemorrhage sufficient to require return to theatre has occurred in approximately 5% of cases. Secondary haemorrhage is very uncommon, but if it occurs it can be life-threatening. Return to theatre and surgical control of the bleeding is necessary, as are antibiotics. The most common pathogen under these circumstances is the group A beta-haemolytic streptococcus and penicillin is the drug of
choice for treatment, but mixed infections are not uncommon and flucloxacillin should be added pending swab results. Group A streptococcal infection may also result in wound breakdown and fistula formation. Fistula repair should be deferred for a minimum of 6 months to allow scars to mature and the tissues to soften.

**Late complications**

**Maxillary retrusion**

The significant long-term problem following early total cleft palate repair is the effect that this surgery has on the growth of the midface. Some 80% of children with total clefts will require orthodontic correction for dental arch collapse and 10% will require surgery in the late teens for severe maxillary hypoplasia. Against this must be set evidence suggesting that early repair of the palate may reduce the incidence of ear infections and deafness and also reduce the incidence of severe articulatory disturbances leading to markedly impaired intelligibility.

**Fistulae**

**Symptoms**

While many fistulae remaining after cleft palate repair are small and asymptomatic, the following symptoms may be sufficient to merit surgery. Nasal dribbling, especially of ice cream or chocolate rubbed against the palate for taste, is a significant social disability and may occur with pinhole fistulae. Alteration of nasal resonance and loss of oral air pressure may occur. The tongue may naturally occlude the fistula for some sounds but trick movements to occlude it for other sounds distort articulation. Symptoms of rhinitis are not uncommon and ironically an enlarged turbinate may obturate a large fistula. Fistulae are described as being pre-, per- or postalveolar, hard palate, soft palate or a combination.

**Treatment**

Treatment may be by dental obturation or surgical closure. Dental obturation is particularly suitable if the patient must wear a partial denture due to loss of teeth. However, retention with cribs causes eventual tooth decay. While some patients wish to avoid surgery if at all possible, others may find the need to wear a plate unacceptable.

Surgical management to close the fistula requires tissue which may be available locally or may need to be imported. A surprisingly large flap of oral mucosa may be 'hinged' on the scar and turned up to line the nose. This is then reinforced, often as a double-breasting manoeuvre, with a flap transposed from the opposite side. Another local flap may be developed by advancing a segment of palatal mucoperiosteum on the greater palatine artery. After teasing out the vessel from the foramen, up to 2 cm of anterior displacement may be obtained. This operation described by Widmaier in 1973 has been christened, most aptly, the tadpole flap by Henderson (1982).

Where local tissue is considered to be too scarred or insufficient in area, distant flaps may be obtained from the buccal sulcus or tongue. Buccal sulcus mucosa may be transposed
on a posterior base round behind the maxillary tuberosity, or anteriorly through the alveolar cleft.

The tongue provides a major reservoir of tissue where previous surgery has rendered repair with local tissue impracticable. A flap of mucosa with a shaving of muscle is raised, usually on an anterior base which should be sited beneath the posterior margin of the fistula and rotated through 180° to be sutured to the freshened edges of the fistula. Detachment of the pedicle is usually possible at 10-14 days. The mucosa retains its papillae and if a very large flap is taken sensation of the tongue may be impaired (Pigott, Reiger and Frazer Moodie, 1984).

**Velopharyngeal incompetence**

The concept of velopharyngeal incompetence or insufficiency has been covered, together with methods of investigations (see also Chapter 23). The incidence after cleft palate repair varies from less than 10% (Morley, 1970) up to more than 50% in other series, but many authors accept a figure in the region of 20% for patients operated upon in the first 2 years of life.

Improved velopharyngeal function in speech can be achieved by modifying one or more of the walls of the velopharyngeal isthmus.

**Anterior wall**

The failed repaired cleft palate shares several stigmata with submucous cleft (see below). In particular, the points of lift seen on the oral side of the palate are more widely separated than normal causing the palate to assume a square, rather than a Gothic pointed arch or the lift may be diffuse, producing a Norman or rounded arch. At the same time, ridges of muscle may be seen to build up toward the posterior nasal spine from the region of the eustachian tubes (Boorman and Sommerlad, 1985). The dorsal surface seen endoscopically has a V-shaped midline valley and this may be the site of failure to close as the palate shoulders reach the posterior wall. Alternatively, there may be a total failure of the palate to reach the posterior wall, a pharyngeal disproportion, indicating a degree of hypoplasia of the palate. Restoration of normal function may require some or all of the following:

1. realignment of muscles by intravelar veloplasty (Kriens, 1975);
2. reconstruction of the musculus uvulae ridge (Pigott, unpublished data);
3. correction of the disproportion by lengthening the palate (Honig, 1967);
4. augmentation of the palatal dorsum (Moore, 1960).

**Posterior wall**

The posterior wall may be advanced by insertion of materials such as cartilage, muscle, bone or synthetics such as Teflon and silastic. Alternatively the wall may be advanced by construction of a mucomuscular ridge on the posterior wall above the level of the arch of
the atlas vertebra (Hynes, 1953; Orticochea, 1967). In order to perform this part of the operation the soft palate is retracted out of the way, and a transverse incision is made across the posterior wall as far above the level of the arch of the atlas as possible.

Bilateral flaps of posterior tonsillar pillar are raised, with bases orientated superiorly, at the same level as the transverse pharyngeal incision. The posterior margins of the flaps are continuous with this transverse incision. The flaps must contain some palatopharyngeus fibres if they are to be dynamic, but some muscle must be left behind, otherwise active palatal depression is reduced, with subsequent hyponasality. The flaps are transposed through 90° and sutured end to end. The inferior border of this newly created horizontal bar is then attached to the inferior border of the transverse incision in the posterior pharyngeal wall.

The pharyngoplasty is given time to heal and, although it may initially be immobile, on reassessment some months later, it will be seen to contract during speech. There are two possible explanations for the delay in function of this muscle bar. One is that cortical representation of the muscle activity, which was originally concerned with palatal depression, must have time to reorganize to coordinate with palatal elevation, and velopharyngeal closure. Another explanation is that during elevation and transposition of the muscle flaps, they become denervated, and they do not become active again until they have reinnervated with nerve fibres from the posterior pharynx. This muscle ridge will usually produce a static advancement of 5 mm, but in some cases it is dynamic, thus permitting sphincteric closure of the isthmus (Lendrum and Dhar, 1984).

**Surgical obturation by pharyngeal flap**

A superiorly or inferiorly based trapdoor of mucosa and muscle from the posterior wall (Schoenborn, 1876) is attached to the soft palate to obstruct the central part of the isthmus. These operations rely on adduction of the lateral pharyngeal walls to the flap to complete closure. The defect on each side of the bar is known as a port or gutter. The bridge of the mucosa is usually passive, although a few studies have suggested residual activity of the accompanying superior constrictor muscle. The width of the flap may be adjusted to take advantage of observed mobility of the lateral pharyngeal walls which provide the opening/closing element as they adduct against the bridge.

A method of employing several of these techniques dependent on the endoscopic and radiological findings is given in Table 21.2. Although good success has been reported with any one of the above operations, better results follow selection of the operation to fit the individual patient.

Complications particular to these operations include hyponasality, due to overclosure of the isthmus or inability of the palate to descend rapidly between phonemes; pooling of mucus occurs and may be due to impaired nasal drainage or to importing oral mucosal glands onto the nasal surface of the palate; difficulty in eating may be experienced due to inability to inspire air with the mouth full due to overclosure of the isthmus. While snoring may occur due to altered air flow and turbulence, some patients who snore before operation are cured by pharyngoplasty.
**Prosthetic obturation**

An alternative approach is the non-surgical obturation of the defect with an acrylic mould. A piece of softened gutta-percha or other suitable dental impression material is introduced into the velopharyngeal isthmus on a bent wire attached to the back of the denture and the patient is asked to make a prolonged closure sound such as S-S-S, thus 'muscle trimming' the obturator. When the muscles relax there should be adequate space for nasal respiration and mucus drainage. Accurate addition and subtraction from the obturator is facilitated by nasal endoscopic control. Once a satisfactory shape has been achieved, the obturator is cast in acrylic.

**Table 21.2 Method of pharyngoplasty selection**

\[
\begin{array}{ll}
\text{Observation} & \text{Deduction} \\
(1) \ V\text{-shaped upper surface of palate. Anteroposterior gap less than 2 mm.} & \text{Inadequate muscle union. No disproportion. Lateral wall movement irrelevant.} \\
& \text{Re-repair palate.} \\
(2) \ V\text{-shaped upper surface of palate. Anteroposterior gap of 2-5 mm.} & \text{Inadequate muscle union. Moderate disproportion. Lateral wall movement irrelevant.} \\
& \text{Re-repair palate plus Hynes pharyngoplasty.} \\
(3) \ \text{Anteroposterior gap greater than 5 mm.} & \text{Severe disproportion. Lateral wall movement irrelevant.} \\
& \text{Palate re-repair with lengthening by pharyngeal flap (Honig).} \\
(4) \ Lateral walls adduct to close lateral 1/6 isthmus each. & \text{Disproportion irrelevant.} \\
& \text{Wide pharyngeal flap.} \\
(5) \ Lateral walls adduct to close lateral 1/3 isthmus each. & \text{Disproportion irrelevant.} \\
& \text{Narrow pharyngeal flap.} \\
(6) \ Asymmetrical movement. & \text{Modification of one of above to close residual defect.} \\
\end{array}
\]

**Submucous cleft palate**

Submucous cleft palate is an infrequently diagnosed condition, and anatomically is the least obvious form of cleft palate. However, it can be the cause of infant feeding difficulty, otitis media, deafness, and velopharyngeal incompetence, and treatment may be necessary. The term submucous cleft palate was first used by Kelly in 1910, although the condition had been described by Roux in the nineteenth century.
The incidence of this condition was thought to be quite rare. However, in 1972 Weatherley-White et al studied all 10,836 children enrolled in the Denver school system. As a result, nine submucous cleft palates were identified, providing an incidence of 1:1200. This is roughly equivalent to the incidence of complete clefts of the secondary palate. Seven of those nine pupils were entirely asymptomatic, and only one required surgery for correction of a speech problem.

**Aetiology**

The cause of submucous cleft palate is unknown, but cleft palate is hereditary, with variable penetrance, and submucous cleft should probably be considered the mildest form, with recessive autosomal inheritance.

**Classification**

Submucous clefts may be considered overt or occult. They may also be associated with pharyngeal disproportion (see also Chapter 23).

In 1954, Calnan described the classic triad of examination findings associated with this condition:

1. bifid uvula;
2. palatal muscle diastasis giving a translucent zone;
3. bony notch in the hard palate.

Essentially the same abnormal muscle configuration as seen in overt clefts leads to inadequate soft palate movement. This produces, initially, difficulty in feeding in a small number of cases, and subsequently, nasal escape on speaking. In addition, the same abnormality results in poor eustachian tube function.

As Kaplan (1975) has pointed out a spectrum of severity exists with regard to clefts of the secondary palate. This ranges from the complete overt cleft of both hard and soft palates, through to the classical submucous cleft and eventually to an entity termed the 'occult' submucous cleft in which velar function is abnormal, but there are no oral signs. The diagnosis is indicated by the symptomatology and must be confirmed by endoscopy, basal view X-rays and eventually by surgery. It is important to appreciate that submucous cleft may also be associated with pharyngeal disproportion, hypoplasia, etc.

Hypoplasia occurs in submucous cleft as it does in over clefts and probably becomes worse with age (Skoog, 1965). Well developed adenoids may mask the disproportion. It is most important, therefore, to be aware of submucous cleft prior to adenoidectomy, in order to warn the patient or family of the possibility of speech impairment. Furthermore, if adenoidectomy had been recommended for recurrent otitis media there is a real possibility that the deranged musculature is responsible and not the adenoidal cushion.
**Diagnosis**

The diagnosis should be considered in all children with evidence of palatal incompetence, especially if there is a history of feeding difficulty in infancy, and it becomes almost certain if there is also a history of otitis media. The corollary is that it should always be excluded before treating cases of otitis media. An oral examination allows the diagnosis to be made on Calnan’s criteria. In addition, on induction of a gag reflex, or if the patient is capable of saying ‘ee-ee’, the vault of the soft palate may be seen to rise and assume a box shape rather than the usual Gothic arch configuration, due to separation of the levator lift points. The soft palate itself may be seen to be short in comparison to the pharynx.

Kaplan has pointed out the association of the following facial features as characteristic of patients with classic submucous cleft, occult submucous cleft, and some overt clefts of the secondary palate; they are present to varying degrees:

1. maxillary hypoplasia - 'dish face;
2. lip contour deformity at vermilion border - 'gull wing';
3. drooping of oral commissure;
4. hypodynamic facial muscles;
5. external ear abnormality - flat arc of superior helix;
6. alveolar arch abnormality.

Submucous clefting has been associated with a number of conditions. These include cleft lip, Treacher Collins, Klippel-Feil, and Fanconi syndromes, congenital rubella, albinism, choanal atresia, Moebius syndrome, ring 18 chromosome and mental retardation. If any of these conditions is diagnosed early in life and a submucous cleft is recognized as well, speech development can be monitored carefully, and at the first signs of ear symptoms or speech problems associated with velopharyngeal incompetence appropriate measures can be taken.

**Investigation**

A speech assessment is undertaken, and if surgery is considered appropriate radiological and endoscopic assessments are made. The shape, size, and level of the incompetent velopharyngeal isthmus are recorded as for patients with an over cleft.

**Repair**

**Timing**

Inevitably most submucous clefts are diagnosed late compared with over clefts. The speech or ear problems with which they present will dictate correction as early as possible. Aberrant speech patterns may have become fixed, with grossly impaired intelligibility, and treatment can be quite difficult. Surgery should be combined with intensive speech therapy,
in a residential course if progress is slow. However, a child with a submucous cleft may have normal articulation and intelligibility where nasal escape has been masked by large adenoids. If adenoidectomy is performed with subsequent intractable nasal escape and hypernasal resonance, an excellent result can be achieved by repair of the submucous cleft with or without pharyngoplasty.

**Technique**

A number of options are available in the surgical management of these patients. The choice of procedure depends on the findings at investigation.

If a palate with good length and mobility has been demonstrated radiographically (reaching to within 3 mm of the posterior pharyngeal wall), a standard cleft palate repair is undertaken. The soft palate is split in the midline and the velar musculature mobilized. The muscles of the two halves of the palate are brought together in the midline. The nasal midline bulge is carefully reconstructed with judicious placement of a horizontal everting mattress suture and the palate closed. For a gap of 3-5 mm a Hynes-type pharyngoplasty is added to the procedures above. Palates so short that they fail to achieve closure by more than 5 mm are comparatively rare and may require a Honig pharyngoplasty.

**Results**

The results of surgery for submucous cleft palate are variable and in general are not as good as for cleft palate repair. The most important aetiological factor in this regard is that surgery is not undertaken until significantly later compared with surgery for the overt cleft, and it has already been mentioned that the earlier a cleft is repaired, the more likely a satisfactory outcome will be achieved.

Only one-third of patients over 2 years of age achieve palatal competence if no additional manoeuvre is undertaken. However, with intensive speech therapy, good hearing and intelligence and, perhaps most important, the incentive to relearn articulation patterns, dramatic improvements often follow quickly (within 6 months) of the provision of a competent velopharyngeal mechanism.

**The cleft palate clinic**

Because children with a cleft palate in particular, but also the condition of velopharyngeal incompetence in general, frequently suffer with problems of deafness and otitis, of speech difficulty, of dental arch malformation and maxillary growth impairment, the families will be faced with many separate clinics and locations to visit. These visits can be very disruptive of schooling and family life. Associated congenital deformities, such as cardiac and ophthalmic conditions, will require yet more visits, and secondary problems such as school placement for the partially hearing, partially sighted or mentally retarded can add yet more.

Cleft palate clinics can go a considerable way to reducing this burden for the child and family. They can also provide an invaluable forum for the interchange of ideas and aims between the specialists involved and reduce the amount of contradictory information received.
by the families. The group of specialists may also find it desirable to run update courses for other professionals who come across the problem infrequently. Pamphlets for parents and books for use of those who occasionally have to treat these children can be developed and are more likely to provide a coherent concept. The secretary with a specialist member of the clinic in whose department the clinic is held, will become an invaluable liaison point for enquiries from patients and coordination between professionals.

It is worth considering who should be a member of the team, where and how often clinics should be held. In principle each member should feel that they have an input to most of the patients who attend on a particular occasion. Children without a cleft of the primary palate (approximately 25% of clefts) are unlikely to have a dental problem. The cleft palate team at Frechay Hospital, Bristol (serving a population of about 800,000) therefore finds it useful to hold a monthly 'alveolar' cleft clinic. Here the orthodontist, plastic surgeon, speech therapist and clinical medical officer in audiology with an audiometrician, will find a high percentage of patients who require their advice. A second clinic called the 'speech' clinic will not require the orthodontist. The viability of this second monthly clinic depends partly on the special interest of one of the author's (RWP) in velopharyngeal incompetence.

These limited groups of specialists can sit together with the patient and family and, although each professional only contributes for about 25% of the time, on average, decisions are taken in concert and the family leaves with reasonably complete information. About three or at most four patients can be seen per hour, so about 12-15 patients would be the maximum per session. Routine records can often be obtained at the same visit. Audiometry is performed in a separate room and speech recordings, photographs, models and X-rays may be taken, ideally, before the consultation. If larger groups of professionals attend, it becomes impossible to sit in together, staffing meetings are required after the clinic and the patient does not receive the complete information for some time.

Clearly such clinics are for review only and are not working clinics. The actual visits for treatment tend to be relatively short bursts of time in the 20 year span of the child's association with the clinic. The exception may be the problems of otitis. Certainly it poses the greatest problem in providing adequate screening.

To keep the review clinic workload manageable, careful thought is required to avoid unnecessary visits. After primary repair of the lip and palate certain landmarks can be considered. Two and a half years is about the earliest reliable age to assess adequacy of palate function for speech. At 4 years, a general assessment of acceptability of all treatment is useful to allow time for desirable therapy or surgical revision prior to school. At 9 years, orthodontic assessment and treatment may be required over some 18-24 months as the permanent dentition erupts. Often this will be combined with bone grafting to the alveolus to allow optimal final tooth positioning. In the late teens, final orthodontic treatment will be combined with assessment of maxillary growth and possibly osteotomy of the mandible or maxilla. Soft tissue surgery for appearance, breathing and speech can often be combined with the two periods of bony surgery. In addition, children will be asked to attend for general record taking at the nationally agreed timing of 5, 10, 15 and 20 years to permit interunit comparisons.

Against these isolated occasions it is necessary to provide a relentless review system to maintain hearing levels during the critical years up to puberty. Such a high density review
will not usually be practicable at a general cleft clinic. However, a parallel clinic would be ideal for cross-referral at the same session.

The venue of the clinic will be dictated by local factors of available space, special interest, etc. The authors have found that childrens' centres, and orthodontic and speech therapy departments have all provided excellent locations. The location secretary and professional must be enthusiastic about the work and prepared to give time unstintingly to ensure efficiency of the service. The question of a clinic leader or chair person will often resolve itself quite effortlessly as some specialists would not wish to take the chair. Where several members are keen to chair the clinic, rotation would seem to be eminently sensible. No member of the team has a monopoly of responsibility for a successful outcome.

Cleft lip and palate and related anomalies are rare in the total of each professional's work spectrum. To make efficient use of time a certain minimum case load is desirable and the senior author has been privileged to treat a major share of the cases from the sub region served by the Department of Plastic Surgery at Frenchay Hospital, Bristol. In turn, this has made it possible to confine referral of the patients to only one otolaryngologist in each of four areas visited so that they should be enabled to develop a special interest, leading to adoption of a specific otolaryngological cleft palate review clinic. These are vital concepts since it has been seen that where individual specialists treat these complicated cases but rarely, rather poor results frequently follow.