Chapter 10: The nasal septum

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Injuries of the septum

The anterior part of the nasal septum projects in front of the plane of the pyriform aperture and is frequently damaged when the nose is injured. This may result in a haematoma formation and/or septal deviations.

Septal haematoma

When the septum is subjected to a sharp buckling stress, submucosal blood vessels are frequently torn and, if the mucosa remains intact, this will result in the formation of a haematoma. If the injury is severe enough to fracture the septal cartilage, the blood will often pass through to the other side and produce a bilateral haematoma. The blood mainly accumulates in the subperichondrial layer and this will usually interfere with the vitality of the cartilage which becomes avascular, as it depends on the perichondrium for its nutrition. Avascular cartilage can probably remain viable for 3 days, but after this the chondrocytes die, and absorption of the cartilage follows. Cartilage absorption can occur with alarming rapidity and Fry (1969) has suggested that the process is hastened by enzyme action, probably in the form of one of the tissue collagenases. Small haematomata will not cause this necrosis of cartilage, but may slowly absorb leading to permanent thickening of the septum with gross fibrosis.

Symptoms and signs

The dominant symptom is nasal obstruction, and initially there may be some discomfort. Examination is best made without a speculum, and will reveal a smooth rounded bilateral septal swelling which often extends to the lateral nasal walls causing complete obstruction.

Treatment

Fry (1969) has shown that the early surgical drainage of the haematoma reduces the risk of cartilage necrosis, and is therefore always indicated. A long hemitransfixion incision is made and usually the haematoma will have elevated the perichondrium from the cartilage. Blood is aspirated, together with any necrotic material. The state of the cartilage is carefully assessed and, if a defect is present, it is advisable to support the defect with homograft cartilage (Masing, 1965). This should be cut to a size slightly greater than the perforation and, after insertion, a small drain is inserted into the bottom of the cavity, and the mucosa is replaced and maintained in this position by nasal packing.

Cartilage grafts can be used even if abscess formation has occurred, as Masing (1965), Hellmich (1974) and Vase and Johannessen (1981) have all shown that these grafts take well, and effectively prevent the saddling deformities which otherwise invariably occur. The homograft cartilage can be harvested from patients who have undergone a submucous resection, and can be conveniently stored in 0.1% sodium mercuro-thiosalicylate.
Complications

External deformity of the nose

The cartilaginous dorsum of the nose is supported by the septal cartilage and, if this support is lost, dorsal saddling in the supratip area will result. If this type of injury occurs during childhood, it may also affect the development of the whole of the mid-third of the face with resulting maxillary hypoplasia.

Septal abscess

A haematoma may easily become infected and this will frequently lead to abscess formation. This complication is commonly associated with an increase in the severity of the pain, together with the usual manifestations of toxaemia, such as pyrexia and a raised pulse rate. The advent of secondary infection makes extensive cartilage necrosis virtually inevitable, and is an even more pressing indication for surgical drainage.

Septal deviation

Septal deviations are extremely common, but are not usually severe enough to affect nasal function. The incidence of these deformities is much higher in the leptorrhine type of nose found in the Caucasian races.

Aetiology

Many septal deviations are due to direct trauma and this is frequently associated with damage to other parts of the nose such as fractures of the nasal bone.

The birth moulding theory

In many patients with septal deviations there is no obvious history of trauma. Gray (1972) explains these cases by means of the birth moulding theory. Abnormal intrauterine posture may result in compression forces acting on the nose and upper jaws (the widest part of the face). Displacement of the septum can result and the nose can be exposed to further torsion forces during parturition. Jeppesen and Windfield (1972) found 29 cases of septal dislocation in 907 newborn infants (3.19%). Dislocations were more common in primipara and when the second stage of labour lasted more than 15 minutes. Dislocations were generally to the right in the case of left occipitoanterior presentations and to the left with right occipitoanterior presentations. Subsequent growth of the nose accentuates these asymmetries.

Pathological anatomy

Deformity of the nasal septum can be classified into the following types.

Spurs

These are sharp angulations which may occur at the junction of the vomer below, with the septal cartilage and/or ethmoid bone above. This type of deformity is usually the result
of vertical compression forces. Fractures through the septal cartilage may also produce sharp angulations. These fractures heal by fibrous union and the fibrosis extends to the adjacent mucoperichondrium. This increases the difficulty of the flap elevation in this area.

**Deviations**

These lesions are characterized by a more generalized bulge. 'C'- or 'S'-shaped deviations occur which can be either in the vertical or horizontal plane, and they usually involve both the cartilage and the bone.

**Dislocations**

Here the lower border of the septal cartilage is usually displaced from its medial position and projects into one of the nostrils.

Septal deviations are also frequently associated with anatomical abnormalities in adjacent areas.

*The lateral nasal wall*

A compensatory hypertrophy of the turbinates and ethmoidal bulla usually occurs on the side of the septal concavity.

*Maxilla*

The compression forces which are responsible for the septal deviations are often asymmetrical and may also involve the maxilla, producing flattening of the cheek, elevation of the floor of the affected nasal cavity, distortion of the palate and associated orthodontic abnormalities. The maxillary sinus is usually slightly smaller on the affected side.

*The external nasal pyramid*

Anterior septal deviations are often associated with deviations in the external nasal pyramid. Deviations may affect any of the three vertical components of the nose and there are three common types which are listed in order of severity.

*Cartilaginous deviations*

In these cases, the upper bony septum and the bony pyramid are central, but there is a deviation of the cartilaginous septum and vault.

*The C deviation*

In this lesion, there is displacement of the upper bony septum and the pyramid to one side and the whole of the cartilaginous septum and vault to the opposite side.
**The S deviation**

Here the deviation of the middle third (the upper cartilaginous vault and associated septum) is opposite to that of the upper and lower thirds.

With deviations of the nose, the dominant factor is the position of the septum. Beekhuis (1973) has succinctly summarized this principle with the dictum 'as the septum goes, so goes the nose'. The first step, therefore, in treating the twisted nose is to straighten the septum, and if this objective is not achieved, there is no hope of successfully straightening the external pyramid.

There is therefore a sound pathological basis to the concept of straightening a twisted nose by means of a one-stage septorhinoplasty procedure.

**The effects of septal deviations**

Only the more severe deviations affect nasal function and therefore require treatment.

**Nasal obstruction**

This is always found on the side of the deviation and is also often present on the opposite side as a result of the hypertrophic changes in the turbinates.

**Mucosal changes**

The inspiratory air currents are often abnormally displaced and frequently become concentrated on small areas of nasal mucosa, producing an excessive drying effect. Crusting will then occur, and the separation of the crusts often produces ulceration and bleeding. The protective mucous layer may then be lost and resistance to infection reduced. The mucosa around a septal deviation may become oedematous as a result of Bernoulli's phenomenon, which states that 'when there is a flow of gas through a constriction, it produces a negative pressure'. This negative pressure will, in turn, predispose to mucosal oedema in the affected area thus further increasing the obstruction.

**Neurological changes**

It is possible that the pressure exerted by septal deviations on adjacent sensory nerves can produce pain. This concept was first elaborated by Sluder (1927) and the resultant condition has been called 'the anterior ethmoidal nerve syndrome' (Shalom, 1963). In addition to their direct neurological effects, reflex changes perhaps may result from septal deformities which affect the nasopulmonary and nasal reflexes.

**Symptoms**

The symptoms caused by septal deviations are entirely the result of their effects on nasal function. The dominant symptom is nasal obstruction but this is rarely severe enough to cause anosmia. Douek (1974), in a review of many patients suffering from anosmia, never found this symptom to be the consequence of an uncomplicated septal deviation.
Signs

Septal deviations are usually quite obvious on anterior rhinoscopy. It is important first to inspect the nasal vestibule without using a speculum because the blade of this instrument can easily straighten the septum and thus hide a caudal deviation. Local anaesthesia with cocaine may facilitate the inspection of some of the more posterior deviations. Sometimes the patient complains of unilateral nasal obstruction and anterior rhinoscopy will reveal that the septal deviation is to the opposite side. This phenomenon has been called 'paradoxical nasal obstruction' (Arbour and Kern, 1975). These patients have a long-standing, fixed, unilateral nasal obstruction to which they may have become accustomed, and of which they are no longer aware. The mucosal swelling associated with the nasal cycle, results in an additional intermittent nasal obstruction on the wider side of the nose, and this becomes the dominant symptom to be appreciated by the patient.

Septal deviations in the region of the nasal valve area cause the greatest obstruction, because this is at the narrowest part of the nasal cavity. The Cottle test will confirm the fact that the obstruction is in the valve area. In this useful and simple test, the patient pulls the cheek outwards and opens up the internal nares and thus reduces the blockage.

The septum cannot be considered in isolation and it is therefore necessary to perform a careful inspection of the lateral nasal wall to determine the size of the turbinates. Examination must also include the external nasal pyramid, the palate and the teeth as these structures are often also involved to some degree with septal deformities. Whenever sinus complications are suspected, X-rays of the paranasal sinuses are indicated.

Septal deviation in the newborn is sometimes associated with asymmetry of the nostrils, an oblique columella and tip which points in the direction which is opposite to the deviation. The nostril on the affected side may look distinctly flattened. These characteristic features are rarely present, and most cases are diagnosed by anterior rhinoscopy and the use of Gray's struts. These struts are 4 mm wide and 2 mm thick and, after lubrication, are inserted into the nostrils, and then gently pushed backwards along the floor of the nose, hugging the septum. Normally the struts can be introduced for a distance of 4 or 5 cm, but in cases of deviation, a frank obstruction is encountered, usually 1.5-2 cm back from the nostril. This is the most reliable test, and is well tolerated during infancy. Less frequently, the compression test may be positive. In this test the nasal tip is pushed backwards and if there is a septal dislocation, it will collapse against the philtrum of the upper lip.

Indications for submucous operations on the nasal septum

Septal deviations

Cottle has classified septal lesions into three types.

Simple deviations

Here there is a mild deflection of the septum which does not cause obstruction. The majority of Caucasians have this type of septum, and it certainly does not require any surgical treatment.
**Obstruction**

This is a more severe deviation of the nasal septum which may touch the lateral wall of the nose, but on vasoconstriction the turbinates shrink away from the septum.

**Impaction**

This is a very marked angulation of the septum with a spur which lies in contact with the lateral nasal wall, even after the application of a vasoconstrictor. Surgical treatment is reserved for some of the obstructing lesions and most of those associated with impaction, the essential indication being a skeletal septal obstruction.

In many patients with septal deviations there is also some generalized mucosal pathology in the form of a perennial rhinitis, and this will not be corrected by septal surgery. Thomas (1978) has shown that the most common cause of poor results following a submucous resection operation is the presence of a coexisting perennial rhinitis. A test that would differentiate between the obstruction caused by a skeletal septal deviation and that as a result of mucosal pathology, would therefore be very helpful in assessing the suitability of patients for septal surgery (Cottle, 1968). Claims that this can be achieved by performing measurements of nasal resistance before and after vasoconstriction with either drugs or following physical exercise have been made by Broms (1982) and by Jessen and Malm (1984). Unfortunately, McCaffrey and Kern (1979) did not find these tests of much help for this purpose.

**Closure of septal perforations**

Most techniques which have been described for the closure of septal perforations involve the submucous elevation of the flaps for this purpose.

**Source of grafting material**

Submucous resection of nasal cartilage and, less commonly, vomerine bone, is sometimes required to obtain graft material for such operations as rhinoplasty and tympanoplasty.

**To obtain surgical access**

Submucous resection of the septum has been advocated as giving the necessary access for the following surgical operations to be performed:

1. hypophysectomy (Hirsch, 1952)
2. vidian neurectomy (Minnis and Morrison, 1971).

**The development of septal surgery**

The study of the history of septal surgery is both interesting and instructive. It clarifies the basic problems encountered in treating septal deviations, and demonstrates the limitations of the various techniques which have been evolved to solve them. During the nineteenth
century, surgeons started tackling these problems by a variety of techniques which have now been completely abandoned. Acute spurs and angulations were removed either by shaving down the convexities (Langenbeck, 1843; Dieffenbach, 1845; Chassaignac, 1851), or by performing a complete removal of the deviation by punch forceps (Rubrecht, 1868). The usual result of these operations was to exchange a septal deviation for a perforation. These techniques are only of historical interest, and there is little doubt that the first major breakthrough in surgical therapy occurred about the turn of the century with the development of the submucous resection operation.

As so often happens, the idea of effecting a submucosal removal of the deviation occurred to several surgeons working independently at the same time. Probably the earliest was Ingalls in 1881, but the names of Killian and Freer are usually associated with the refinement and popularization of the actual procedure (Ingalls, 1882). It was Killian (1904) who described the technique which is most commonly practised today, with a retention of both dorsal and caudal struts of cartilage to prevent any subsequent change in the external shape of the nose. Freer (1902) adopted a much more radical approach as, in his view, the septal cartilage did not contribute to the support of the nasal pyramid and could be completely removed if necessitated by the extent of the pathology. He admitted that 'saddling' of the dorsum did sometimes occur in the supratip region, but said that this was always due to rough surgery, which had damaged or partly removed the upper lateral cartilages.

The submucous resection operation was undoubtedly a great advance and was widely adopted throughout the world. With subsequent experience, however, it was evident that there were certain associated problems. For surgical purposes, the septum can be divided into anterior and posterior parts by a vertical line drawn from the frontal nasal spine to the maxillary nasal spine. Deviations posterior to this line can be easily and effectively treated by the submucous resection technique. The problems occur when using this technique in the anterior part of the septum. All too frequently, the operation was followed by a supratip depression and columellar retraction. To minimize these complications, most surgeons adopted the conservative Killian technique, but retention of dorsal and caudal struts does not ensure complete immunity; in addition, the deviations may be found in the region of the dorsal and caudal struts, and would therefore not be corrected by this operation. These complications occur much more frequently than is generally realized because they often take many months to develop. Immediate saddling is rare; usually it occurs as a result of scar contraction in the septum. Some surgeons have attempted to solve the problem of scar contraction by replacing all or part of the excised cartilage, while others have avoided producing a large defect in the cartilaginous septum by mobilizing and repositioning the septum in the central position, so that the bulk of the cartilage is retained and is still attached to its mucoperichondrium as part of a compound flap.

The first significant improvement was made by Metzenbaum (1929) in Chicago, using the latter concept. The operation was applicable only to caudal dislocations of the septum without fragmentation of the cartilage and gross fibrosis. He likened the principle to that of a swinging door, but late failures were fairly common. A swinging door has a hinge on one side and free edges on the other three borders. In the Metzenbaum operation, the hinge was effectively produced by the incision at the level of the deviation. There was an existing free border inferiorly and one was produced posteriorly by separation of the cartilage from the vomer. There was not, however, a free border anteriorly where the septum was often tethered.
to displaced upper lateral cartilages and the traction from this source, and also sometimes from the mucoperichondrium which was liberated only on one side above the incision, produced increased tension on the unfreed side during healing, which was prone to cause a recurrence of the deflections. To overcome these problems, Peer, in 1937, completely excised the deviated caudal segment of the cartilage. If possible, he reinserted it as a free graft, but if the tissue was either unsuitable or inadequate, he obtained a similar sized graft resecting cartilage from the central or more posterior part of the quadrilateral cartilage. This operation developed the concept of cartilage excision followed by cartilage replacement. The original Peer operation was extended to include removal of the entire cartilaginous septum. This concept reached its logical conclusion in the Galloway operation (1946). Galloway removed the entire nasal cartilage, and replaced the anterior septum with a single free autograft cut from the excised cartilage. He also described a useful detail of operative technique, in the manner in which he facilitated the placing of the graft with traction sutures.

Afterwards, the graft was held in place with mattress sutures, and the traction sutures were removed. Subsequent experience with this operation showed that it was by no means always successful because:

1) unequal scar contraction between the two septal flaps sometimes led to a recurrence of the deviation

2) absorption of the autograft sometimes occurred leading to saddling of the supratip region

3) the lower end of the graft sometimes immobilized the membranous septum and gave it a rather peculiar and unnatural appearance.

In 1948, Fomon et al endeavoured to solve the first and third of these problems by the use of small autografts. The whole principle of septal removal, followed by septal replacement, has some inherent drawbacks and consequently the alternative solution of mobilization and repositioning of septal cartilage has been revived and further developed. This septoplasty concept, in particular, has been popularized by Cottle and his associates.

More recently, the permanent change in the shape of septal cartilage by morselization has been advocated by Rubin (1983). The deviated cartilage is crushed by a morselizer after the mucosal flaps have been elevated on both sides, and it is claimed that the new flattened shape of the cartilage is retained on a permanent basis.

The principles of septal surgery

From the experience over the last 90 years, it is evident that, from a surgical point of view, the septum can be divided into anterior and posterior segments by a vertical line drawn between the nasal processes of the frontal and maxillary bones. Deviations in the posterior segment can be easily and effectively treated by the classic Killian submucosal resection operation, whereas those in the anterior segments should be treated by a more conservative septoplasty technique.
Anaesthesia for septal operations

Septal surgery can be satisfactorily performed under either local or general anaesthesia. The high quality and ready availability of anaesthetists has resulted in a preference for general anaesthesia in the UK. A general anaesthetic is also invariably required for children and nervous adults. It is necessary to pack the nose about 15-20 minutes before the operation with 1.25 cm (0.5 inch) ribbon gauze which has been soaked in cocaine and adrenaline. This will greatly diminish the amount of bleeding at operation. The postural nerve block technique described by Curtiss (1952) is easily the best of the local anaesthetic methods. It was evolved from the earlier technique of Moffett (1941), but is much simpler and quicker, and is quite as effective. The patient is placed in the Proetz position with the chin and external auditory meatus in the same vertical plane. Then 2 mL of 4% cocaine solution are introduced into each nostril using a special angulated needle. The cocaine gravitates into the superior meatus where it blocks both the ethmoidal and sphenopalatine nerves. The patient is kept in this position for 10 minutes. A small quantity of 2% lignocaine is finally injected into the columella. This method gives far better results than the older technique of using cocaine and adrenaline packs as it is often difficult to push these packs beyond the septal deviations.

Septoplasty

Septoplasty is an operation which should be performed under direct vision. To achieve this it is necessary to obtain adequate illumination. A satisfactory headlight is therefore essential and can also be supplemented by using an expanding nasal speculum fitted with a light carrier. Bleeding can obscure the operative field, and it is therefore very important to obtain maximum vasoconstriction of the mucosa before making the first incision.

This operation should not be a single standardized procedure, but should be tailored to the needs of the individual patient. For example, if the deviation is confined to the caudal border of the septum anteriorly, there is no need to touch the posterior part of the septum. There are however, certain general principles and these include:

(1) Incision.

(2) Exposure: the cartilaginous and bony septum is exposed by the complete elevation of a mucosal flap on one side only. Contact between the cartilaginous septum and the mucoperichondrial flap on the other side is maintained as much as possible because, in addition to ensuring the viability of cartilage, it also greatly reduces the risks of complications such as haematoma and abscess formation, perforation and over-riding of the different segments of the cartilages.

(3) Mobilization and straightening: the septal cartilage is then freed from all its attachments apart from the mucosal flap on the convex side. Many deviations are maintained by extrinsic forces such as the caudal dislocation of the cartilage from the vomerine groove. Mobilization alone will often correct this type of problem. When deviations are due to intrinsic causes, for example healed fractures, it is necessary to combine mobilization with some direct surgery on the cartilage such as a strip excision of the fracture line. Bony deviations are treated either by fracture and repositioning or by submucous resection of the deviation.
(4) Fixation: the septum is then maintained in its straightened position during the healing phase by sutures and splints.

**Incision**

The incision is best made at the lower border of the septal cartilage as was originally advocated by Freer. A unilateral (hemitransfixion) incision is adequate for a septoplasty and, for the right-handed surgeon, this is usually most conveniently made on the left side. The advantages of this incision have been tabulated by Bernstein (1973a) in the following fashion:

1. The incision is placed in a relatively avascular plane.
2. The mucosal edges here are both thick and tough, thus reducing the risk of tears. If tears do occur, a satisfactory repair is normally quite easily performed.
3. It provides easy access to the whole of the septum, including the caudal septal border, and the region of the anterior nasal spine with its associated premaxillary crest.
4. If the septoplasty is to be combined with a rhinoplasty, it is easy to extend the incision through to the opposite side and thus produce a full transfixion incision. It is important to make the incision as high as possible because a low incision through the membranous septum may be followed by a retraction of the columella. The first step is therefore to displace the columella downwards and to the opposite side by means of traction, exerted with dissecting forceps or a Cottle columellar clamp. The lower border of the septal cartilage will then be plainly visible and the incision made down to the perichondrium, which is incised and the subperichondrial flap elevation then commenced.

**Exposure**

It is usually best to expose the cartilaginous and bony septum by elevating the mucosal flap on the concave side. The difficulties of the flap elevation are partly a result of the anatomy of the various tissue layers and can often be greatly increased by fibrosis and scarring in these layers following previous trauma. The surgical anatomy of this region is of extreme importance and must be clearly understood if mucosal tears are to be avoided. It is easy to elevate the mucosal flaps across both the ethmoid-vomerine suture and the ethmoid-septal cartilage suture, because very few periosteal or perichondrial fibres pass into either of these suture lines. The difficulties of flap elevation occur mainly at the junction of the septal cartilage above, with the anterior nasal spine, premaxillary crest and vomer below. This is because the perichondrium encloses the cartilage in a complete envelope which does not fuse with the periosteum. The periosteum forms another inferior envelope over the adjacent bony septum and may result in a pseudo-joint capsule which can permit a side-to-side movement of the septal cartilage. The subperichondrial plane over the septal cartilage is therefore not continuous with the subperiosteal plane below and the difficulty in uniting these two planes can easily lead to tears. For this reason, most iatrogenic perforations occur along the chondro-vomerine suture, particularly anteriorly because the bony groove is widest here, and the problems are greatest.
As a general principle of flap elevation, it is usually best to leave the most difficult areas to last, since they can then be approached from several directions and under direct vision. A suitable technique for dealing with these problems has been evolved by Cottle et al 1958 who started the elevation over the septal cartilage and worked upwards and backwards always keeping above the chondrocranium junction. This step in the operation was called the production of the 'anterior tunnel'. Once this had been accomplished, attention was then directed to the posterior end of the incision, and the periosteum over the anterior nasal spine was incised and then elevated backwards on both sides over the premaxillary crest, then the vomer, again keeping below the chondrocranium suture. These were the so-called 'inferior tunnels. Finally, the most difficult elevation was performed which involved uniting the anterior and inferior tunnels under direct vision using a sharp dissector or knife. This is the so-called 'maxilla-premaxilla' approach of Cottle.

It is unusual for all the steps in this particular technique to be required, but in the really difficult demanding case, and particularly when performing revision surgery, it is the best method of choice.

Mobilization and straightening

The first step is to separate the lower border of the septal cartilage from its osseous base. In many cases, this lower border has been dislocated from its osseous groove and there is also a considerable amount of fibrosis which can greatly distort the anatomy. A sharp dissector knife is always required. The lower border of the septal cartilage is encased in a perichondrial envelope, and it is usually possible to continue the subperichondrial elevation downwards over the concave side of the septum, then around its lower border and upwards for a few millimetres in the convex side. When the cartilage has been freed, an attempt is made to reposition it back into the midline where it should rest in its osseous groove. Usually this is impossible because of the excess height of the septal cartilage and it is then necessary to remove a strip of cartilage about 3-4 mm wide from its lower border. This excised cartilage is part of the quadrilateral plate and may be up to 4 cm long. It can make an ideal autograft, should one be required at a later stage in the operation. It should therefore be kept in sterile saline during the rest of the operation in case the need arises. It is usually also necessary to straighten and lower the vomerine crest in order to make a suitable bed to accommodate the septal cartilage. The anterior nasal spine must not be removed. When deviated it can be fractured and repositioned in the midline. If the bony septum is deviated it is sometimes possible in the less severe cases to reposition it in the midline with a heavy elevator after preliminary fracture. However, this technique is inadequate for the angulated spurs which are often encountered at the junction between the ethmoid plate and vomer. Here a vertical incision is made through the septal cartilage, just behind the line joining the nasal process of the frontal and maxillary bone. The mucosal flap is then elevated off the cartilage and bone on the opposite side, and the deviated cartilage and bone may be removed back to the face of the sphenoid. When making this vertical incision through the cartilage, it is important not to make it too anteriorly, as otherwise the nasal dorsum will only be supported by a narrow strip of cartilage, and this can fracture superiorly and lead to a saddling deformity.

If the external nasal pyramid is twisted, it is important to separate the skin and subcutaneous tissue off the underlying upper lateral cartilages. This will allow the skin to be
draped easily over the straightened cartilaginous dorsum without the risk of cutaneous traction on the upper lateral cartilages producing a recurrence of the deviation.

This uncovering of the cartilaginous dorsum is easily performed through the classic intercartilaginous incisions. Usually a 15 blade Bard Parker knife is used to make the incision at the level of the internal nares. Anteriorly, each cartilaginous incision is united with a transfixion incision. A series of opening and closing movements with a pair of Knapp scissors will enable the elevation of the subcutaneous tissues off the cartilaginous dorsum to be easily effected.

The plane of dissection should be directly above the perichondrium as most of the blood vessels are found in the more superficial layers. The upper lateral cartilages are firmly united to the cartilaginous septum. There are often secondary changes in the upper lateral cartilages associated with a twisted nose. When this occurs it is necessary to separate the upper lateral cartilages from the septum and this is best done submucosally. By now the septal cartilage has been fully mobilized and, in the absence of intrinsic deviations, should be easily repositioned in the midline. A careful examination should be made at this stage and the mobility of the septum checked by moving it from side to side with a septal elevator. If there is any reduced mobility, its exact site should be noted and further trimming at this point may be necessary.

Other possible factors include a large turbinate, which will require treatment, the details of which are given later in this chapter.

At times, the mucosa on the narrow side of the nose is too short to allow the septum to return to the midline. This problem can be solved by cutting through the mucosa at the junction of the nasal floor and the septum. There will be a residual dehiscence on the floor of the nose after the septum has been repositioned into the midline, but this will re-epithelialize quite rapidly afterwards. Any residual obstruction is usually the result of intrinsic deviations in the septal cartilage. Old fractures in the cartilage often heal by fibrous union and this may result in severe angulations, which are best treated by the removal of a narrow strip of cartilage along the line of the deviation. This will break the spring of the cartilage which can then usually be repositioned into the midline.

Sometimes the septal lesion is so severe, either because of previous disease (for example, a septal haematoma), or where extremely radical surgery is necessary to correct the deviation, that too little supporting cartilage remains anteriorly to maintain the normal shape of the nasal pyramid and the columella. This is the type of problem that is not infrequently found in the professional boxer. In such a nose, the anterior residual septal cartilage can be supported with a free bone graft, taken preferably from the thinner part of the perpendicular plate of the ethmoid or, if this is impossible, from the rather thicker vomer. A suitable piece of bone can be obtained with a pair of heavy angled Fomon scissors and chisel. It can then be cut to the shape of the dorsocaudal septum, and two holes drilled in it to accommodate the fixation sutures. The bone graft is placed alongside the residual septal cartilage and sutured in position. Bernstein (1973b) has shown that bone is much more satisfactory when used in this support role than cartilage, which frequently become absorbed.
Fixation

At the end of the operation, the septum should be lying freely in the midline and if this objective has not been achieved, neither suturing nor splinting will prevent subsequent failure. If it has been necessary to make multiple incisions in the cartilage, over-riding of the segments can be a problem and this is best corrected by a Wright (1967) suture. Here, a through-and-through mattress suture is used, with one arm passing between the segments of the cartilage, and the other through all three layers of the septum. A figure-of-eight suture, immobilizing the lower border of the septum to the anterior nasal spine, is then inserted. Finally, the septo-collumellar incision is closed with a few sutures. Silastic splints are then inserted into the nose. The nose is packed with 1.25 cm (0.5 inch) ribbon gauze impregnated with bismuth iodoform paraffin paste (BIPP).

The classic submucous resection operation

The Killian incision is most commonly used for this operation. This is in an oblique incision about 5 mm above the caudal border of the septal cartilage. Elevation of the mucosal flap through this incision is usually easier than with the hemitransfixion incision, although this can also be used for this particular operation. The exposure stage is similar to that for septoplasty. Afterwards, an incision is made through the septal cartilage about 1 cm above and parallel to its lower border. The incision should be made through the cartilage, but not through the opposite perichondrium. The mucoperichondrium can then be elevated off the far side of the cartilage through this incision. A pair of angled scissors is introduced and used to cut through the septal cartilage in a direction which is parallel to and at least 1 cm posterior to the nasal dorsum. It is then possible to remove the obstructing cartilage and bone leaving these dorsal and caudal struts of cartilage to maintain the support of the nasal dorsum and columella. The cartilage is removed with Luc's forceps or a Ballenger's swivel knife. Any deviated bone in the region of the vertical plate of the ethmoid is then removed. The next step is to elevate the flaps off the maxillary crest and vomer. The periosteum covering this is not in the same plane of cleavage as the cartilaginous dissection. A separate breakthrough has to be made with a knife or dissector on to the bone to elevate the periosteum. The crest is finally removed with a hammer and gouge or with Jansen-Middleton bone forceps.

If the flap is torn, this does not matter unless there is another tear on the other side exactly opposite, when a septal perforation will inevitably result unless a satisfactory repair is effected. The site of the tear is first reinforced by the introduction of a small autograft of septal cartilage or bone between the flaps and the lacerations are then sutured. Some surgeons routinely replace septal cartilage and bone after performing the classic Killian technique. The almost universal use of central heating in North America tends to produce atrophic changes in the nasal mucosa and Briant (1977, personal communication) considers there is a very definite risk that this is increased after the loss of support of the septal cartilage and bone, and that septal perforations for this reason are by no means uncommon following a perfectly performed Killian-type operation. Therefore, he advocates that the excised cartilage and bone be straightened in a Cottle's crusher and then re-inserted between the flaps.
Postoperative care

Packs are removed after 24 hours and splints after 7 days. Antibiotics are not usually required.

Septal surgery in the growing nose

Since the turn of the century, it has been widely believed that the nasal septum plays an important role in the development of the facial skeleton and, in particular, the nose. For this reason most surgeons have avoided performing surgical operations on the growing septum for fear of producing some retardation of growth.

Some of the earliest work was undertaken by Hayton (1948), who made a careful study of 31 patients aged between 6 and 14 years who had been treated in Logan Turner's clinic in Edinburgh by the classic Killian operation. In 10 of the patients, there was some broadening of the nose, which was associated with a supratip depression.

Septal surgery performed during childhood carries with it the additional problem that it may interfere with the subsequent growth of the nose. Because of this risk, it was the usual practice to postpone all septal surgery until after the age of 16 years but, more recently, this view has been challenged by Cottle (1951), Jennes (1964), Huizing (1979), and others. Attempts have been made to elucidate this matter by animal experimentation (Ismail, 1964; Hartenstrom, 1970), and by observing the effects of injuries and operations performed during childhood.

Verwoerd, Urbanus and Nijdam (1979), Rhŷs-Evans and Brain (1981) and Sarnat and Wexler (1961, 1967) have all shown that removal of cartilage in experimental animals interferes with the subsequent development both of the nose and of the maxilla. Brain and Rock (1983) performed a cephalometric study of 29 adult patients awaiting surgical treatment for injuries which had occurred during childhood, and demonstrated significant differences in nasal and orthodontic development compared with a control population.

A septal abscess occurring during childhood invariably leads to a saddle deformity, and Hayton (1948) showed that this also frequently follows the Killian submucous resection operation. In addition to the saddling of the dorsum, damage to the caudal septum can interfere with the development of the nasal tip. There is, therefore, universal agreement that no operation should be performed on the septum during childhood, which involves radical removal of cartilage. Any surgery performed at this age should be of a very conservative nature, and should be confined to the repositioning of the septum. It may be necessary to incise the cartilage in order to achieve this. Verwoerd considered it advisable to avoid actually performing the operation during either of the two nasal growth spurts. The results of these conservative operations are far from good. The experimental work on rabbits by Rhŷs-Evans and Brain (1981) showed that a recurrence of the deviation often occurs and, in clinical practice, it is found that frequently up to 50% of these patients need revision procedures when they reach the age of 16 years.
Reduction of septal dislocation in the newborn

This should be undertaken as early as possible as it becomes increasingly difficult with the passage of time (Metzenbaum, 1936). The present author considers it to be impossible after about the age of 3 months, although Gray (1972) has had successes up to the age of 9 months. No anaesthetic is necessary, and both the instrumentation and technique have been developed by Gray, who inserts a special pair of neonatal nasal forceps in the nose. The middle of the palate is then firmly pressed downward for about 15-20 seconds to pull the septum straight. The septum is then manipulated into the midline.

The septum in rhinoplasty

It is necessary to consider the septum in rhinoplastic surgery because it is of great importance:

(1) in the deviated nose
(2) in reduction rhinoplasty
(3) as a support to the nasal dorsum
(4) as a source of graft material for augmentation
(5) there may be an unrelated septal problem requiring surgical treatment.

The septum is the central supporting strut of the nasal pyramid and it participates in every external nasal deviation. A look at a cross-section of the deviated nose shows that it is impossible to straighten the external pyramid by any combination of osteotomies without straightening the nasal septum, and it is for this reason that the most important skill required to correct a deviated nose is a capacity to deal with difficult septal problems, and this is why the author believes that this type of case is best treated by an otolaryngologist trained in rhinoplastic techniques.

The septum is also of importance in a reduction rhinoplasty. After the removal of a nasal hump, the nose, on cross section, resembles a truncated cone. It is then necessary to narrow the external pyramid, the result of which is that a modest septal deviation, which preoperatively was of no functional importance, will now produce obstruction and unfortunately, it is by no means uncommon for a patient with a functioning normal nose to have a cosmetic rhinoplasty resulting in iatrogenic obstruction.

Ulceration and perforation of the septum

These are usually different stages in the same pathological process and, apart from the traumatic cases, septal perforations are usually preceded by ulceration. The energetic and successful treatment of a septal ulcer will therefore prevent the development of perforation, and this is particularly important in the case of children, as the development of a perforated septum in the growing nose will often retard growth both of the nose and of the mid-third of the face.
Causes of septal perforations

1. Trauma
   (a) surgical
   (b) repeated cautery
   (c) digital trauma ('nose picking')
2. Malignant disease
   (a) malignant tumours
   (b) malignant granuloma (Wegener's)
3. Chronic infections
   (a) syphilis
   (b) tuberculosis
4. Poisons
   (a) industrial
   (b) cocaine addicts
5. Idiopathic.

Apart from syphilis which normally attacks the bony septum, most perforations are found anteriorly, in the septal cartilage. Unfortunately, most are iatrogenic in origin and usually occur as a complication of septal surgery, particularly when the Killian submucous resection technique is used. Although the septoplasty procedure does not give complete immunity against this complication, perforations are a rarity following this operation. Perforations result from mucoperichondrial tears, particularly when they are bilateral and overlapping. Gross post-traumatic fibrosis increases the risk, and the site of the perforation is usually along the line of the chondro-vestibular suture where the anatomy of perichondrial and periosteal layers also increases the difficulty of flap elevation. When mishaps of this kind occur during a submucous resection operation, every effort should be made to prevent this complication by inserting a bony or cartilaginous autograft between the torn flaps and also by closing the tears with catgut sutures.

Repeated cautery of the septum can lead to perforations. The risk is much greater when both sides of the septum are cauterized at one sitting, and it is therefore wise to have an interval of 3-4 weeks between the two treatments. In the author's experience, patients who suffer from Osler's disease are lucky to escape this complication.

Septal perforations are sometimes occupational in origin and the commonest such cause is penetration of the nasal mucosa by one of the hexavalent forms of chromium. In addition to its role in plating processes, this metal is used in certain tanning, dyeing and photographic processes. Workers engaged in the manufacture of dichromates are particularly at risk. Other causes include exposure to anhydrous sodium carbonate (soda ash), arsenic and its compounds, organic compounds of mercury, particularly mercury fulminate, alkaline dusts such as soap powders, hydrofluoric acid and fluorides, capsicain, the pungent active principle of capsicum (chillies), vanadium, dimethyl sulphate, cocaine and other drugs taken as snuff, copper salts (rarely), and lime (rarely).

The incidence of chrome perforation among platers has been greatly reduced by the use of exhaust ventilation and seromists. The highest incidence of chrome perforation is found in chemical workers engaged in the production of chromates. In one such factory in the UK,
236 out of 480 workers had chrome perforations. There was no obvious relationship between the incidence of the perforation and the length of exposure. There are suspicions that at least some of these perforations were self-inflicted, because the monetary award for this occupational disease is often considered to far outweigh the resulting minimal disability.

**Symptoms and signs**

Apart from the traumatic causes, septal perforations are usually preceded by ulceration. There are often four well-marked stages, starting with redness and congestion of the mucosa producing irritation and rhinorrhea. Shortly afterwards the mucosa becomes blanched and anaemic; later it undergoes necrosis as revealed by the development of tough adherent crusts over the affected area. Finally, the crusting extends into the substance of the cartilage and a perforation results. Septal perforations are quite often asymptomatic, but the development of large crusts may cause obstruction and the separation of these crusts may lead to bleeding. Patients not infrequently complain of abnormal dryness in the nose, and sometimes of a dull discomfort over the bony dorsum. The passage of respiratory air often produces a whistling noise. Crusting problems are usually much worse when there is any interference with the normal respiratory air currents, as may occur with such obstructive lesions as septal deviations behind the perforations.

Brain (1980) has shown, in a series of 69 septal perforations, the 62.4% were completely free from any symptoms. The two main factors found to affect the function of the nose and produce symptoms, were the size and position of the perforation. The larger the perforation, the more likely it was to cause problems (Table 10.1). This relationship is of considerable importance, since the 1922 edition of Coate's text book actually advocates the surgical enlargement of perforations as a form of treatment. This operation can lead to intractable problems and should never be performed. The only symptom found more often in the case of small perforations was a 'whistling' noise during inspiration.

**Table 10.1 Symptoms in relation to size of perforation**

<table>
<thead>
<tr>
<th>Size</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>2 out of 20</td>
</tr>
<tr>
<td>Medium</td>
<td>11 out of 33</td>
</tr>
<tr>
<td>Large</td>
<td>13 out of 16</td>
</tr>
</tbody>
</table>

The position of the perforation is the second major factor, and undoubtedly the more anterior the lesion the more likely it is to cause symptoms (Table 10.2). The state of the residual nasal mucosa is also of importance. Some cases of perforation are due to malignant disease or to a midline granuloma and may have been heavily irradiated, and this does often lead to a severe atrophic rhinitis which greatly increases the crusting problem.

**Table 10.2 Symptoms in relation to position of perforation**

<table>
<thead>
<tr>
<th>Area 1</th>
<th>Area 2</th>
<th>Area 3</th>
<th>Area 4 and area 5</th>
</tr>
</thead>
</table>
| present in 1 out of 1 | present in 4 out of 8 | present in 5 out of 42 | all perforations present in these areas also extended anterior to involve other areas
**Diagnosis**

The history is of importance in the diagnosis of traumatic and occupational cases. When the edge of the lesion looks raised or hypertrophic, a biopsy should be performed to exclude malignancy. A biopsy is also essential in suspected cases of Wegener's granuloma. Serological tests for syphilis should always be performed if the lesion is involving the bony septum, and the erythrocyte sedimentation rate is invariably raised in cases of Wegener's granuloma; this can be a useful confirmatory diagnostic test for this condition, together with the biopsy.

**Treatment**

The first objective in the management of septal ulcers and perforations is to cure the causative disease process. Conditions such as malignant tumours, malignant granuloma, and chronic infections are discussed in other chapters. In the occupational cases, it will be necessary to obtain the cooperation of the industrial medical officer to prevent further exposure to the toxic agent. Most recent cases have occurred when the exhaust ventilation system in the chrome plant has become defective.

The second objective is to encourage natural healing of the lesion and, if this does not occur, to consider performing a surgical repair. The patient must be told to treat his nose with great care, and to avoid traumatizing actions such as vigorous blowing and nose picking. The patient should also apply some Cicatrin cream on the tip of the little finger to the lesion, twice daily. This treatment will heal most ulcers, although the original area will often permanently remain white, dry and scarred.

Perforations never heal spontaneously, but fortunately most do not cause symptoms, and therefore do not require any treatment. Crusting and bleeding are the main problems associated with the more troublesome minority. Less severe cases can be satisfactorily controlled by the use of a nasal douche (Collunarium alkalinus), but should this prove to be inadequate, the closure of the perforation, either by filling it with an obturator, or by means of a surgical operation, will have to be considered. Obturators are a simple, safe, and reliable method of closing almost any septal perforation. This method can be used to close large perforations, and the author has managed defects up to 4 cm in diameter by this technique.

Cooperation with a specialist in dental prosthetics is essential. The obturators are constructed from Silastic and are made from an impression of the perforation. The results of this form of treatment have been recorded by Brain (1980) for both medium (Table 10.3), and large (Table 10.4) perforations.

**Table 10.3 Results of obturator closure: medium-sized perforations**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>50%</td>
</tr>
<tr>
<td>Fair</td>
<td>41.7%</td>
</tr>
<tr>
<td>Poor</td>
<td>8.3%</td>
</tr>
</tbody>
</table>

The poor result was in 1 patient with severe atrophic rhinitis.
Table 10.4 Results of obturator closure: large perforations

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>50%</td>
</tr>
<tr>
<td>Fair</td>
<td>12.5%</td>
</tr>
<tr>
<td>Poor</td>
<td>37.5%</td>
</tr>
</tbody>
</table>

The worst results are obtained in patients with the largest perforations. None of the small perforations was troublesome enough to require closure. An obturator will reliably close almost any perforation, and eliminate the crusting which occurs around its edges. What it does not do is to replace the normal functioning septal mucosa. In the smaller and medium-sized perforations, the compensatory capacity of the residual mucosa is sufficient to overcome this deficiency, whereas this is not the case with nearly 40% of the larger perforations. This is a very unfortunate finding, because the difficulties in effectively closing a septal perforation surgically are directly proportional to the size of the perforation.

Another problem with surgery is the fact that, not infrequently, an unsuccessful operation actually enlarges the perforation and can make the patient considerably worse. It has been the author's policy to close all troublesome septal perforations with obturators, and only to consider surgical closure as a secondary treatment when the obturator fails to reduce dramatically the symptoms.

If the services of a specialist in dental prosthetics are not available it may be possible to close the perforation with prefabricated Silastic buttons, which have been popularized by Kern, Facer and McDonald (1977). The retention of this type of device is, however, far less satisfactory.

The operative closure of septal perforations is a rather unsatisfactory chapter in the subject of nasal surgery. It is extremely difficult to close surgically any perforation larger than 2 cm in diameter. Masing (1965) has shown that the partial anterior closure of larger perforations does frequently greatly reduce the symptoms.

These operations are technically difficult to perform, and it is therefore important to effect an adequate exposure of the perforation and this is not generally possible with the usual endonasal approach. When the upper limit of the perforation is 2 cm or less from the nasal floor, it is usually possible to obtain a reasonably good exposure by making an incision through the alar facial crease. Higher perforations are best reached through the external rhinoplasty approach, which has been popularized by Goodman and Strelzow (1978).

Perforations can be closed either by grafts or by flaps. Good results have been obtained by Fairbanks and Fairbanks (1973), using temporalis fascial grafts. An alternative graft is the three-layer composite graft from the pinna, using the technique popularized by Walter (1969). Free grafts taken from the turbinate have been employed to close small septal perforations (Ismail, 1964; Seiffert, 1967), but unfortunately the amount of tissue available is extremely limited, and it is impossible to close a defect which is 1 cm or more in diameter with this technique. These small perforations rarely need treatment and should this be necessary, they usually do well with obturators.
Flaps, on the whole, are a more reliable method of closing the septal defects. The mucosal flaps can be cut from the septum, the inner surface of the upper lip, or the lateral nasal wall. Septal mucosal flaps are rarely satisfactory as the mucosa around the perforation is usually thin and atrophic. Cartilage has often been extensively removed and the normal tissue planes have often been completely obliterated with fibrous tissue. The amount of the mucosa available for closure is inversely proportional to the diameter of the perforation. A buccal flap from the inner margin of the upper lip can be brought through a stab incision in the floor of the nose and used to close septal perforations.

The maximum width of the flap is, however, only 2 cm and this limits the size of perforation which can be treated by this technique, popularized by Tardy (1973). Masing (H., 1978, personal communication) has successfully used a vestibuloconchal flap from the lateral wall of the nasal cavity, which is elevated anteriorly and then swung medially to be sutured to the anterior edge of the septal perforation. Six weeks later the pedicle of the flap is divided and then rotated into the posterior part of the perforation, where it is sutured in place.

The enlarged turbinate

Many cases of nasal obstruction are the result of enlargement of the turbinates. There is almost always a compensatory structural hypertrophy of the inferior turbinate on the concave side of the septal deviation, and there are many patients complaining of nasal blockage with a fairly central septum, in which the obstruction is entirely due to turbinate hypertrophy. The inferior turbinate contains by far the greatest quantity of erectile tissue and this is the structure which is usually most severely involved.

Most of the bilateral cases are the result of some form of perennial rhinitis which may be either of the allergic or non-allergic type. Frequently, the problem is compounded by the development of a rhinitis medicamentosa due to self-treatment with topical decongestants.

Medical treatment

The first step in the management of these patients is to identify and treat the cause of the enlargement. Many cases are a consequence of perennial rhinitis and often medical treatment is extremely effective in controlling the discharge and sneezing, but is far less successful in relieving the blockage. Despite this, however, it is extremely important to treat the cause otherwise the results of surgical treatment of the condition are likely to be far from permanent.

The only medical treatment which appears to reduce the size of the turbinates is the administration of corticosteroids. The author has never achieved any success with drugs such as pseudoephedrine hydrochloride. The corticosteroids are best given by mouth and a 7-day course of prednisolone, starting with 35 mg on the first day and then reducing the dose by 5 mg on each successive day, is recommended. This treatment will frequently open up the nose and it is then possible to maintain the beneficial effect by the use of topical steroid sprays which are now able to adequately penetrate the nasal cavities. The injection of corticosteroids into the nasal mucosa is only mentioned to be condemned as, in the literature, there are at least three cases of blindness following these injections (Plate and Asboe, 1981).
Surgical treatment

Anatomically the whole turbinate is usually thickest in its middle third, although the bone is thicker anteriorly. Posteriorly the turbinate usually diverges away from the septum and in many cases where there is no mulberry hypertrophy of the posterior end, it may be possible to leave this segment.

Numerous surgical techniques have been described and advocated for the treatment of these patients, and they basically involve either altering the position of the inferior turbinate or reducing its bulk.

Changing the position of the inferior turbinate

(1) Lateral outfracture of the inferior turbinate.

(2) A submucous resection of the inferior turbinate. This can achieve a reduction in the bulk as well as change in position of the turbinate.

Reducing the bulk of the inferior turbinate

(1) Cautery
(2) Submucosal diathermy
(3) Cryosurgery
(4) The laser
(5) Submucous resection of the inferior turbinate
(6) Turbinectomy.

Lateral outfracture of the inferior turbinate can produce a modest but definite improvement in the airway, and its main indication is probably when dealing with the slight to moderate structural enlargement of the inferior turbinate, which is so often associated with the deviated septum. This minor procedure can then be usefully combined with the septal surgery.

Linear cautery of the inferior turbinate can produce a contracting scar which in turn will reduce the size of the turbinate. It is a fairly successful treatment for the slight to moderate cases of hypertrophy and is free from major complications. About 60% of patients obtain an improvement in their airway, although, of the successful cases, at least 10% develop some recurrence of the blockage which will require treatment at a later stage. David (1985, personal communication) has shown that it is necessary to protect the septum with a sheet of Silastic while the cautery is being performed to prevent adhesions which are likely to develop in 20-30% of all cases.

Submucosal diathermy also produces fibrosis and works in a similar fashion. This treatment has been popularized by Groves (1976) and has the advantage that the maximal effect is on the erectile tissue and not on the surface of the mucosa.

Some quite serious complications have been reported including devitalization of the bones which will then slowly separate as a sequestrum, leading to irritating crusting and
bleeding for a period of up to 2 or 3 months. Very severe nose bleeds have occasionally followed this procedure, usually in the form of a secondary haemorrhage.

Cryosurgery can produce necrosis of the turbinate mucosa thus reducing its size, and this treatment has been strongly advocated by Bicknell (1979). Secondary haemorrhage can, however, be a major complication of this operation and the present author has known of at least two cases requiring multiple transfusions and repeated packing.

More recently the argon laser has been developed as a form of treatment for the enlarged turbinate (Soldatov, 1985).

In the more severe cases, submucous resection of the inferior turbinates can be quite an effective procedure. Removal of the bone not only reduces the bulk of the organ, but also its skeletal support and the residual mucosa then falls away downwards and laterally, thus further opening the airway. Unfortunately, the inferior turbinate bone is very irregular and it is impossible to perform a blunt elevation of the overlying mucosa. It is vital, therefore, to use a sharp elevator, such as the Cottle knife, if one is to avoid tearing the mucosa into shreds and it is very important to try not to mobilize the bone before the mucosal elevation is complete, otherwise it becomes much more difficult. For this reason it is best to start with the elevation of the lateral flap, in case this occurs, as it is always easier to perform the medial elevation afterwards.

For the really severe case, turbinectomy is the only effective treatment. For many years it was widely taught that ozaena was a common and incurable complication of this operation. These fears appear to be groundless and Courtiss, Goldwyn and O'Brien (1978) were unable to find, in the world literature, one single documented case of ozaena following turbinectomy. The turbinate does have an extremely rich blood supply, especially posteriorly, and bleeding can be a problem, but this can often be reduced by applying a large pair of Birkett artery forceps over the base of the inferior turbinate for 30 seconds before cutting through the crushed tissue with a pair of turbinectomy scissors. The operation is facilitated by preliminary in-fracture of the turbinate.