Chapter 42: Nasal Fractures

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Fracture of the nasal bones is generally considered the most common site-specific bony injury of the facial skeleton. Where there is a loss of structural integrity, unfavorable changes in nasal appearance and function may occur, therefore the managing physician should render appropriate and timely treatment based on the nature an extent of the injury.

Epidemiology

Many authors have reported on the high incidence of nasal fractures in newborns and children (Courtiss, 1978; Hinderer, 1976; Kaban et al, 1977; White et al, 1971) and in adults (Holt, 1978; Schultz, 1973; Schultz and DeVillers, 1974; Stranc and Robertson, 1979). In a 2-year prospective study of 1000 cases of maxillofacial fractures in Gothenburg, Lundin et al (1972) reported that nasal fractures constituted 39%. Nasal fractures have a sexual predilection in favor of males by a ratio of roughly 2 to 1 and tend to have a higher incidence in the 15- to 30-year age group (Dickson and Sharpe, 1986; Harrison, 1979; Illum et al, 1983). Murray and Maran (1980) noted a bimodal distribution in 199 females with a preponderance in the 15- to 25-year age group and in the over-60 age group (the latter caused by personal accidents). Considered collectively, most adult nasal fractures can be attributed to interpersonal altercations and sporting injuries, with a smaller number being the result of motor vehicle accidents, falls, and miscellaneous causes.

In children, a predilection between the sexes is less clear cut. East and O'Donaghue (1987) reported a greater than 2 to 1 male-to-female association among 50 patients whereas Dommerby and Tos (1985) noted a lack of statistical significance with regard to gender among 79 pediatric fracture cases. Injuries occurring during play and in sporting events seem to be more likely to result in nasal fractures; interpersonal conflicts and motor vehicle injuries are less likely to result in nasal fractures in children than in their adult counterparts.

Pathogenesis

Because of its prominent position, central location, and the low breaking strength of its skeletal support, the nose is particularly susceptible to fracture. Swearinger (1965) determined that the nasoethmoidal complex has a maximum tolerable impact force before fracture of 35 to 80 g. These forces are relatively small compared to those required for other fractures of the facial skeleton. The pattern and extent of the fracture varies as a function of the site, direction, and intensity of the impact, as well as nasal bone density (generally related to age). The concentration of the force is also important. In general, younger patients are more prone to fracture-dislocations of larger nasoseptal segments, whereas older patients with brittle osteoporotic bone are more susceptible to comminution (Dingman, 1964).

Anatomically, the paired nasal bones project like a tent on the frontal processes of the maxilla and articulate in the midline with each other. Beneath this junction lies the nasal septum, but little support is provided as a midline scaffold. Its articulation superiorly with the nasal process of the frontal bone where the bone is much thicker, represents an area of relative stability. Approximately 80% of nasal fractures occur at the transition zone between the thicker proximal and thinner distal segments in the lower one third to one half of the nasal bones (Kazanjian and Converse, 1959).

Trauma to the cartilaginous structures of the nose, by virtue of their attachments to and interconnections with the nasal bones, may be incurred either directly (usually from frontal or inferior directed forces) or indirectly (lateral blows). The resilitent properties of the upper lateral and lower lateral cartilages, with their loose associations to bony structures, permit considerable absorption and dissipation of impact energy. As a result, dislocation, displacement, or avulsion injuries are more common than true fractures. By contrast, the cartilaginous septum is posteriorly interposed between two bony structures (the perpendicular plate of the ethmoid and the vomer) with a strong osseochondral junction. As noted by Masing (1965), weak areas of the cartilaginous dorsum (between the septum and upper lateral cartilages and just below the Y-shaped juncture of the upper lateral cartilages) and the weak connections between the septal cartilage and maxillary crest account for a high incidence of fracture-dislocation of the septum following nasal trauma. Most commonly, fracture lines are oriented vertically in the caudal portion of the septum and horizontally further posteriorly (Krause, 1984).

Despite a lower predilection for maxillofacial trauma in children, many authors have reported on the relatively high incidence of nasal fractures (Courtiss, 1978; Grymer et al, 1985; Hinderer, 1976; Kaban et al, 1977; Schultz and DeVillers, 1974; Stranc and Robertson, 1979). As discussed by Martinez (1987), certain anatomic and developmental features of children afford increased protection against central facial trauma: (1) the small size and weight of the child decreases inertial impact force, (2) the disproportionate amount of soft tissue relative to hard tissue provides increased skeletal shielding and (3) the elasticity and stability of the craniofacial unit is increased because of developing bone, a state of mixed dentition, and immature pneumatization. In addition, a less prominent nasal projection allows centrally directed forces to be absorbed and distributed earlier to the adjacent maxilla (Stucker et al, 1984).

As a result of these differences, the pattern and types of injuries occurring in children are different from those of adults. A child's nasal bones are small, and the cartilaginous part of the nose is relatively large (Fig. 42-1). Bailey and Caruso (1978) noted that in the newborn the length of the nasal bones is approximately equal to the width, whereas in the adult the length is three times the width. It therefore follows that nasal injuries in the younger child are more apt to occur in cartilage than in bone. The flexibility and resilience of cartilage and bone in the child account for the tendency of these structures to fracture without any significant displacement (greenstick fractures), and in many cases the dislocated bones and cartilage will spring back to normal position (Moran, 1977).

The fact that cartilaginous structures are capable of distortion and buckling following impact, in part explains the greater degree of force needed to cause nasal fractures following frontal and inferior blows as compared with lateral blows (most common mechanism of injury) where no significant soft-tissue intermediary exists. Murray et al (1984) demonstrated experimentally that a lateral force of 16 to 66 kPa was required (in cadavers) to cause a bony displacement of the dorsum, compared with 114 to 312 kPa when the force was applied frontally. In this model system, lateral injury patterns involved an ipsilateral fracture just above the nasomaxillary suture and a contralateral fracture immediately below the dorsum, associated with a cartilaginous septal fracture extending into the perpendicular ethmoid plate. The larger frontal forces tended to drive the caudal portions of the nasal bones posteriorly, causing an associated septal fracture in the upper part of the perpendicular plate parallel to the dorsum. These findings were consistent with Harrison's earlier report (1979) in which he found the pattern of septal fractures and displacement to be relatively constant, irrespective of the direction of nasal trauma (frontal versus lateral). In a more detailed analysis of septal injuries, he described the fractures as beginning just behind the nasal spine and running posteriorly approximately 2 to 3 mm above the bone-cartilage interface with the vomer, then passing backward and upward into the perpendicular ethmoid plate, and finally turning forward below the cribriform plate and the upper part of the nasal bones.

Injury to the septum and the effects of this injury on the nose have been the subject of many studies. According to Fry (1966, 1967), who evaluated cadaveric cartilage and retrospective clinical data, injury to the septal surface can activate interlocked stresses, which can cause the cartilage to twist. Harrison (1979) disagreed with this theory and attributed the progressing deformity to a lack of centralization of the displaced septal fracture. The latter theory has been supported in experimental and clinical studies by Dickson and Sharpe (1986), Murray et al (1984), and Murray and Maran (1986).

Classification

Most clinical classifications (Courtiss, 1978; Harrison, 1979; Schultz and DeVillers, 1974; Stranc and Robertson, 1979) are based on the degree and direction of force and are characterized as frontal or lateral injuries of varying degrees (Fig. 42-2). Other authors (Murray and Maran, 1986) have devised a more complicated system based on seven types of fractures; this system emphasizes the deviation of the nasal pyramid from the midline as being a clinical predictor of treatment outcome.

According to Stranc and Robertson (1979), the less common frontal types can be divided into three categories depending on the depth of the injury. Plane 1 injuries do not extend behind a line from the lower end of the nasal bones to the anterior nasal spine. In these injuries, the majority of the impact is transmitted to the lower cartilaginous vault and tip of the nasal bones. Separation and avulsion injuries of the upper lateral cartilages may occur, and occasionally posterior dislocation of the septal and alar cartilages may be encountered. Plane 2 injuries involve both the external nose, the nasal septum, and the anterior nasal spine. More extensive deviations of the nasal bones (flattening or splaying apart) and septal cartilage (mucoperichondrial tears, segmental overriding, or loss of central support) are seen. Plane 3 injuries extend to involve orbital and possibly intracranial structures. These injuries typically involve comminution of the nasal bones and extend to adjacent bony structures such as the frontal processes of the maxilla, ethmoid labyrinth, and lacrimal bones. Upward extensions may include the cribriform plate and orbital plate of the frontal bones. Injuries to the nasal septum are severe, and they are often associated with collapse and telescoping of septal fragments.

Other classifications include subclasses to include fractures of the nasal tip and anterior nasal spine, fractures of the dorsum with or without septal deflection, and comminuted nasal fractures (Harrison, 1979). Courtiss (1978) described specific additional combinations of depression and twisting. Septal injuries have also been divided into types, classified as dislocation, fracture, or fracture-dislocation (Holt, 1978).

Lateral impact injuries are recognized to be the more common injury pattern (Clark, 1983; Colton and Beekhuis, 1986). In Illum's study (1983) of 173 consecutive cases of nasal fracture, 66% were found to be of the lateral type compared with 13% being classified as having frontal injuries. In this type of injury a depression of the ipsilateral nasal bone occurs, typically involving the lower half of the nasal bone, part of the nasal process of the maxilla, and a variable amount of the pyriform margin (Harrison, 1979). If the impact force is weak, nasal bone displacement is usually present without septal fracture. Significant forces on the other hand, usually cause medial displacement of the ipsilateral nasal bone and lateral displacement of the contralateral nasal bone. In these instances, the septum is dislocated or fractured as well.

Because nasal fractures frequently occur along with other maxillofacial injuries, the classification should include all the known injuries. In severe trauma, the nasal fracture is often associated with a midfacial injury involving the frontal, ethmoid, and lacrimal bones (Mathog, 1984). Such an injury will cause a distortion of the glabellar angle, displacement of the medial canthal ligaments, and possible disruption of the lacrimal collecting system. The medial wall of the orbit can be fractured and displaced, and medial rectus entrapment and enophthalmos may occur. Fractures extending to the cribriform plate can be associated with cerebrospinal fluid leaks, disruption of olfactory function, and brain injury. Fractures extending laterally across the orbital floor may indicate a maxillary LeFort I, II, or III fracture. An open-bite deformity and posterior maxillary displacement along with lengthening of the lower face will be further indication of such fractures.

Diagnostic Assessment

History

Fractures of the nasal skeleton will be associated with a history of impact to the midfacial area. The cause of the injury is important because estimation of location, magnitude, and direction of the blow(s) can provide information about the presumptive extent of the injury. A patient involved in an automobile accident in which the face struck the dashboard must be considered to have a potentially more significant injury than the patient who has received a blow from a clenched fist. Equally important is consideration of the nature of the applied force with respect to force per unit of area. A narrow solid object that strikes a well-defined area over the nasal dorsum will concentrate the energy of impact and result in more extensive localized injury (comminution) than an impact that delivers the same force distributed over a greater surface area.

The appearance and function of the nose before the injury must be ascertained whenever possible. Knowledge of previous injuries to the nose may offer insight into existing deformities and nasal airway complaints. In her series of 107 patients, Mayell (1973) noted that 30% of the patients had preexisting nasal deformities. Photographs of the patient taken before the injury can be of help in providing a gross baseline of nasal contour and midline relationships. Additional information regarding nasal obstruction and loss of smell following nasal injury should be obtained. A history of nasal bleeding usually indicates a mucosal laceration and should be identified. The patient's past medical history should elicit information regarding nasal allergy, sinusitis, illicit use of inhalant substances, previous septonasal surgery, and any systemic or localized inflammatory disorders. The review of systems should rule out evidence of associated injury to adjacent structures. Information pertaining to loss of consciousness or changes in mental status suggest central nervous system involvement. A history of change in visual acuity, gaze restriction, diplopia, regional anesthesia/hypoesthesia, or epiphora warrants the examination of ocular and adnexal structures. Anosmia or hyposmia typically follows acute nasal trauma secondary to mucosal swelling, collection of blood and secretions, or internal derangements, but involvement of the cribriform plate should be considered and ruled out. Finally, injury to the adjacent maxilla may be suggested by complaints of malocclusion and sensory deficits in the cheek and anterior dentition.

Physical examination

Regardless of the nature of the nasal injury, the examining physician must perform a thorough internal and external assessment of the nose. This is especially true in children in whom fractures of the greenstick variety are often encountered, and despite little external deformity, may involve dramatic internal derangements (East and O'Donaghue, 1987). The key to a successful examination is to ensure patient comfort, adequate lighting, and proper intranasal preparation. With the patient seated in a slightly reclined position, the external nose should be examined from the frontal view and from both sides in oblique and lateral views. Changes in dorsal contour such as humps and abnormal elevations or depressions should be noted. Abnormal shortening of the nose may suggest a loss of central support and a telescoping of cartilaginous fragments. This often coexists with a retracted columella, an increased columellar-labial angle, and widening of the base of the nose. In frontal view, abnormal widening or flattening of the nasal root, deviations of the nasal dorsum tip deflections, or the presence of a flat, broad tip may suggest recent or past nasal injury. In the absence of other ocular findings, periorbital ecchymosis is highly suggestive of nasal fracture. In most cases posttraumatic edema will mask subtle deformities; a more accurate external examination is possible after resolution of the swelling 2 to 4 days after the injury.

Assuming ongoing epistaxis has not necessitated earlier treatment, preparation of the intranasal tissues should be performed next. All clots must be carefully removed by swab or suction. Minor bleeding can usually be controlled by application of cotton pledgets soaked in 0.25% phenylephrine (Neosynephrine) or by spraying the vasoconstrictor. When available, the use of 4% cocaine has the additional advantage of providing topical anesthesia. Following anesthetic effect, gentle palpation of the bony pyramid should be performed to check for mobility, crepitance, and specific areas displaying point tenderness. Step deformities are diagnostic of fracture sites (old or new).

Intranasal anatomy should be assessed using a nasal speculum and proper external lighting. Abnormal positioning, instability, or abnormal movements of the upper and lower lateral cartilages may suggest avulsion-type injuries, which often coexist with mucosal lacerations. The septum should be checked for discoloration, dislocation, and abnormal swelling. Any suggestion of a septal hematoma should be investigated using direct aspiration or a mucosal incision. Because septal deviations may be found in at least 48% of normal individuals (Illum, 1986), abnormal positioning in and of itself is not the sine qua non of septal fracture or dislocation. Rather, bimanual palpation, using cotton-tipped applicators placed through each nares and against the septum, is a useful technique to confirm mobility and direct attention to the injury. Septal dislocation may or may not be an indication of recent fracture in the adult, whereas a septal deformity is generally considered to be abnormal in children (Goode and Spooner, 1972; Moran, 1977; Olsen et al, 1980).

Palpation of the anterior nasal spine via the sublabial route should also be performed because fractures in this area are highly correlated with significant septal trauma (Clark, 1983). Finally, the ascending processes of the maxilla and adjoining orbital rim should be palpated for deformity and crepitation. Paskert and Manson (1989) have described a technique of bimanual exam using a finger and a Kelly hemostat to assess the stability of the frontal process of the maxilla.

Radiographic evaluation

The effectiveness of radiographic evaluation for routine nasal fractures has been questioned by many (Clayton and Lesser, 1986; deLacey et al, 1977; Facer, 1981; Mayell, 1973; McArthur, 1971). Most of the criticism centers around the high incidence of false-positive and false-negative interpretations and the lack of predictive value with regard to management of the injury. In an early review, Becker (1948) reported a 47% false-negative incidence whereas more recently Clayton and Lesser (1986) reported that 25% (7 of 28) of their patients required surgical intervention on clinical grounds despite having negative x-ray reports. The deLacey study (1977) of 50 normal patients examined with a Waters' view x-ray (Fig. 42-3) suggests a high incidence of false-positive readings (33 of 50), which is attributed to misinterpretation of the midline nasal suture, the nasomaxillary suture, and developmental abnormalities of the nasal wall as representing fractures. Soft-tissue techniques on profile or lateral view were found to be more accurate in demonstrating fractures of the anterior nasal bones, but could not provide information about lateral displacement. In addition, these views also were unable to distinguish recent from old fractures. Perhaps the greatest weakness in using plain films is their inability to evaluate the injury for appropriate management. McArthur (1971) found a correlation between the demonstration of a fracture and the need for reduction in only 10% (2 of 20), whereas deLacey reported a similar figure of 6.% (3 of 45).

Because the treatment of nasal fractures is based solely upon those cosmetic and functional effects of the injury that are inadequately addressed by radiographic evaluation, there is ample justification for not obtaining nasal x-rays "routinely" following trauma. On the other hand, when associated midfacial injuries are suspected after physical assessment, a facial x-ray series should be done. Tomography and computed tomography (CT) scans should be considered when extensive fractures are present.

In a child, x-ray evaluation of nasal trauma proves to be of even less value than in the adult. The fact that the child's nasal bones are small and not fused complicates the interpretation. Furthermore, the majority of injuries occur in the cartilaginous skeleton, which comprises two thirds of the nasal substructure, and cannot be demonstrated by x-ray examination.

Management

Control of bleeding

In patients with recent nasal trauma, bleeding from the nose may be profuse and demand immediate emergency treatment. If application of 0.25% phenylephrine and 4% cocaine is not successful in controlling the area of hemorrhage, tamponade (eg, packing, balloon catheterization, nasal stat) or ligating the feeding vessels (eg, maxillary artery/ethmoid vessel ligation, embolization) may be necessary.

Nasal packing is the most common method of controlling bleeding within the nose. The packing should be placed precisely at the bleeding site(s) to provide uniform pressure over the entire area. If the bleeding site is located in the anterior part of the nose, anterior packing will usually be sufficient. In such a situation, 0.5-in plain gauze impregnated with an antibiotic ointment should be layered from the floor to the roof of the nose. If the bleeding is from a more posterior site, traditional posterior packs may be necessary. Bilateral packing is important for maintaining persistent pressure over a wide area.

In most patients packing will control nasal bleeding. After 2 to 5 days the packing can be removed, a topical and local anesthetic applied, and a reduction of the nasal fractures can be carried out. Occasionally, the patient will continue to bleed, requiring ligation of the internal maxillary artery and/or the anterior ethmoidal artery. Carotid artery ligation is rarely indicated and rarely effective in controlling persistent bleeding because of its great distance from the bleeding site, which permits collateral blood flow to feed the bleeding.

Timing of reduction

Significant swelling of the soft tissues of the nose and surrounding areas can preclude effective early management. Within 5 to 10 days after injury the nasal bones can become somewhat adherent and difficult to move. Fixation is usually observed within 2 to 3 weeks if the patient is young and healthy. According to Martinez (1987), fracture fixation in children requires only one fourth to one half the time it requires in adults. The physician must choose a time for reduction when evaluation can be accurate and the bones are still mobile. The usual recommendation is that closed reduction be carried out within 3 to 7 days for children and within 5 to 10 days for adults.

In patients with very little swelling, early reduction can be performed. If the patient is scheduled to be in the operating room for other procedures, valuable anesthesia time can be used to complete the nasal repair. When significant other injuries exist, reduction of a nasal fracture takes low priority and surgical intervention can be delayed.

Open versus closed reduction

Several authorities claim that closed reduction is adequate for most nasal fractures (Facer, 1981; Farrior, 1984; Illum, 1986; Kaban et al, 1977) but if reduction is not maintained, open reduction can be done months later by a traditional septorhinoplasty. These authors believe that early open reduction, which requires separation of bony fragments from the periosteum, make accurate rasping impossible. They also cite the additional cost of open reduction and the possibility that the open methods might produce undesirable sequelae (Kaban et al, 1977) as reasons against such an approach.

Those specialists who favor open reduction believe that they can obtain better long-term results than with closed methods (Harrison, 1979; Kane and Kane, 1978; Peerless, 1984; Wexler, 1975). They suggest that open methods provide better visualization and precise repositioning of the structures. They have also observed more accurate evaluation for hematoma and improved splinting than with closed reduction.

Historically, the challenge has been to select the most conservative surgical procedure that would ultimately lead to the best long-term results. Mayell (1973) reported good functional and cosmetic results in only one third of cases selected for closed reduction. In Harrison's 1979 retrospective review of 40 cases, only 13 were found to have obtained perfect results. Murray et al (1984) offered insight into the possible cause of surgical failure following closed nasal manipulation. Prompted by a 30% to 40% failure rate in their own cases, they studied the mechanics of nasal fractures in fresh cadaver noses and found that if the nasal bones were deviated by more than one-half the bridge width, there was a concomitant C-shaped fracture adjacent to the osseochondral junction of the nasal septum. They attributed late failures (deviations) to the interlocking of these fractured septal segments, which would drag the mobile nasal bones toward their initially displaced position. As pointed out by Murray and Maran (1986), the septal component of the nasal fracture must be reduced in an open fracture when there is significant deviation of the bony dorsum if subsequent deformity is to be avoided.

Colton and Beekhuis (1986), Dickson and Sharpe (1986), Holt (1978), and Krause (1984) also recognize the advantages of open methods where there has been significant displacement of the nasal septum, bilateral fractures, or unsatisfactory reduction of the nasal and septal components following attempts with the closed approach.

Although closed reduction of nasoseptal fractures remains the mainstay of surgical management in cases of pediatric nasal trauma, indications for open reduction do exist and are similar to those for adults. Stucker et al (1984) point out the difficulty in determining when complete reduction has been achieved after closed reduction in children because the nasal skeleton is largely cartilaginous, making mobilization and recognition of proper positioning more difficult than in adults.

Open techniques may be used when it is apparent that attempts at closed reduction are inadequate, but these should be guided by conservative principles that emphasize repositioning rather than excision of fractured segments. In contrast to adults, septal cartilage in children maintains its regenerative potential (Pirsig and Lehmann, 1975) and overzealous resections around the septovomerian junction may lead to subsequent growth impairments. Because cartilaginous regeneration arises from interstitial growth and from appositional growth from the perichondrium (Pirsig, 1977), open approaches should emphasize preservation of intact mucoperichondrial flaps and investing soft tissue.

Part of the difficulty in analyzing the long-term results of nasal fractures in children arises from the difficulty in differentiating the effects of the nasal injury itself from those of the surgical intervention. Rock and Brain (1983) compared cephalometric radiographs of 29 adult patients who sustained nasal trauma as children against matched controls, and demonstrated significant differences in midfacial growth (smaller forward component; greater downward component in the study group). In Pirsig's study (1977) of 261 children who underwent nasal septal reconstruction (involving septoplasty and osteotomies) no arrest of nasal growth was noted. Similarly, Chmielik et al (1986) analyzed 159 children for nasal growth after fracture reduction and concluded that an adequate reduction (using the closed technique) caused no disturbances in nasal growth. They did recognize, however, the potential for external nasal deformities resulting from fracture healing, which was consistent with Dommerby and Tos' observations (1985).

In summary, it appears that most nasal fractures in children can and should be managed by closed reduction techniques. Occasionally, conservative open reduction of the septum and nasal bones must be used when closed techniques prove inadequate to correct a severe deformity or marked nasal obstruction. The surgeon should realize that the effect of the nasal trauma left uncorrected, or the method of open intervention (particularly if aggressive), may influence subsequent midfacial growth.

Prophylactic antibiotics and decongestants

Because most nasal fractures are associated with lacerations of the mucosa or skin and with the attendant potential for bacterial contamination, prophylactic antibiotics are often desirable. The antibiotics may also afford some protection against infection if a hematoma should form. Antibiotics commonly selected include penicillin, ampicillin, or cephalosporin derivatives. Saline irrigations are also useful adjuncts to maintain humidification and to clean the mucosa. If obstruction of the nose or paranasal sinuses occurs, decongestants can be added to the medical regimen.

Anesthesia

Surgical procedures to reduce the nasal fractures can be performed in either an outpatient or a hospital setting. The choice of location will often depend on the type and extent of the associated injuries, the patient's general condition, and the nature of the treating facility.

Preoperative medication should be administered according to the condition of the patient. Depending on patient preference, simple nasal fractures in adults can usually be managed with topical and local anesthetics. It is often helpful to provide preoperative sedation to allay patient anxiety, and supplement this with intravenous medications intraoperatively. In a child or young adult, general anesthesia usually is the procedure of choice.

When local sedation is selected, the vibrissae should be trimmed and topical anesthesia achieved through the strategic application of cotton pledges moistened in a solution of 8 cc of 4% cocaine containing 5 drops of 1:10.000 epinephrine (Fig. 42-4). This solution will provide excellent vasoconstriction for the duration of the procedure. The pledgets are usually placed beneath the nasal dorsum (ethmoidal nerves), at the posterior edge of the middle turbinate (sphenopalatine nerve), along the septum, and on the floor of the nose for 10 minutes (Fig. 42-5).

After application of topical anesthesia, the surgeon should also infiltrate a local anesthetic to provide external nasal anesthesia and vasoconstriction, and to supplement internal mucosal anesthesia (Fig. 42-6). A 2% solution of lidocaine containing 1:100.000 epinephrine should be injected over and beneath the bony nasal dorsum to block the infratrochlear nerve, into the infraorbital foramen bilaterally to block the infraorbital nerve, and at the base of the columella. Additional infiltration of the soft tissues of the nose may be helpful, and the addition of hyaluronidase may facilitate anesthetic dispersion and enhance the resolution of swelling (Holt, 1978).

Profound local anesthesia is rarely achieved in a recently injured nose because tissue acidosis interferes with the conversion of anesthetic agents to their active state (Clark, 1983). The addition of sodium bicarbonate in a 1:10 (vol:vol) dilution to the anesthetic mixture may counteract this effect, and also reduce the injection pain associated with acidic solutions (Oikarinen et al, 1975). Other injection techniques outlined by Arndt et al (1983) help minimize the pain of local injection. These include: (1) the use of a narrow-gauge needle (30-gauge); (2) injecting in the deep dermal-subcutaneous plane rather than within the dermis; and (3) injecting slowly to avert tissue distention, which is the primary cause of pain.

An alternative technique using topical anesthesia only to manage simple fractures in the adult has been suggested by El-Kholy (1989). This techniques uses a combination of topical anesthetic EMLA cream applied externally (each gram containing equal parts of lignocaine and prilocaine) plus intranasal cocainization. The cream has the advantage of good cutaneous penetration and does not require needle injections. This must be weighed against the drug's availability and the need to wait 1 hour following topical application.

When general anesthesia is preferred, one should also consider application of topical and locally injected anesthetics to augment visualization and control bleeding. Although most general anesthesia is safe, catecholamines can cause unwanted physiologic responses, and the use of these drugs should be discussed with an anesthesiologist.

Reduction and Fixation

Closed techniques

Reduction of nasal fractures requires simply reversing the direction of force that caused the fracture. Following adequate anesthesia and removal of the cotton pledgets, the nose should be evaluated for additional unsuspected anatomic alterations. Typically, fractures involving the bony nasal pyramid are reduced first, followed by reduction and then stabilization of the septum. For a simple, depressed, unilateral, nasal bone fracture, an appropriate elevator (Boies or Salinger) is inserted into the nose under the depressed fragment (Fig. 42-7) and is elevated into the proper position. The depth of insertion is determined by measuring the distance from the alar rim to the depressed segment on the external surface of the nose, and the instrument is inserted for similar distance into the nose. The thumb is often used to mark this distance.

The force needed to reduce the depressed fracture will depend on its type and duration of the nasal fracture. Steady outward pressure should be applied to the nasal bone that one wishes to elevate. Because most unilateral depressed fractures involve some degree of rotation with respect to the dorsal longitudinal axis, an outward as well as a forward movement should be applied about the posterior edge of the fractured nasal bone. The degree of elevation is controlled with external pressure by the other hand, molding the fragment(s) into appropriate position. Tip fractures and isolated nasal bone fractures are easily managed with this technique.

Often, the side opposite the depressed nasal fracture is displaced laterally. In such a situation the depressed side should be elevated first, followed by sliding the dorsal pyramid into the midline. Fortunately, in the newborn twisting the nose between the fingers may be adequate to provide reduction.

Many fractures require special forceps (Fig. 42-8). For example, Walsham's forceps are used to grasp and manipulate the nasal bones directly. The forceps should be inserted so that one blade is beneath the bone and the other opposes the external skin surface. The depressed bone is then elevated while the opposite side is moved into position. Deformities of the bony pyramid that persist despite efforts at manual reduction often imply incomplete (greenstick type) or impacted fractures or may indicate preexisting deformities. In such cases, consideration should be given to opening the fracture line with a 3-mm osteotome.

Nasal bones that are significantly comminuted may present problems. Marked instability is best treated with internal splinting (small packing high in the nose of Bacitracin-impregnated Nugauze) and an external splint such as Thermoplast or Aquaplast. The internal packing is usually left in place for 2 or 3 days and can then be replaced by small pieces of rolled Oxycel if extended internal support is needed. Care should be taken in placement of this internal packing so that the nasal dorsum does not widen excessively.

Nasal fractures that involve the ethmoid complex (typically caused by direct blows to the nose and its base) require additional management strategies that are beyond the scope of this chapter. These injury patterns are complex and frequently involve intracranial as well as orbital-adnexal structures. The extensive nasoethmoid fractures should not be managed by closed reduction techniques alone (Williamson et al, 1981). Beyer et al (1982) points out that closed reduction frequently results in a need for secondary corrective surgery. To correct nasal collapse and telescoping of nasofrontal-ethmoidal fracture segments, Williamson et al (1981) advocates the use of an external fixation device following open reduction rather than the more conventional approach using external lead or silastic splints. Gruss (1985) has classified nasoethmoid orbit fractures into five types. He believes an open, direct approach to these fractures with meticulous reduction and fixation (including appropriate bone grafting) is the treatment of choice for these injuries.

When external nasal compression with lead plates is chosen for management, the undersurface of the plate should be padded with a spongelike material, such as Ivalon, and the plates positioned as far back as possible to narrow the ethmoid complex and thus support the nasal pyramid (Fig. 42-9). Excessive pressure should be avoided because skin necrosis and permanent marking of the skin may result (Morgan et al, 1982). Wadley (1979) has recommended the use of intranasal silicone wedges with outside compression plates. Courtiss (1978) and Sear (1977) prefer using springlike clips, clamps, figure-of-seven splints, and digital compression. The efficacy of these methods is questionable.

With reduction of the external nose, the septum will often return to its preinjury position. However, the septum may not be so easily reduced or may actually become further dislocated during manipulation of the external nose. If the septum is not properly reduced and stabilized, there can be a loss of dorsal support and obstruction of the nasal airways.

A dislocated septum is best managed by first elevating the nasal pyramid and then applying pressure directly to the displaced portion of the septum to move it back into its proper position. These maneuvers can be simplified with an Asch forceps, which can be used to elevate the dorsum and to reduce the septum between the arms of the instrument. The septum should be inspected carefully and any hematoma should be drained directly through a small mucosal incision. Significant lacerations and displaced mucosa should be replaced in an appropriate anatomic position.

Following the reduction of fractures of the nasal bones and septum, the internal nose should be stabilized with small amounts of packing and/or septal splints (Fig. 42-10, A, B). When the septal injury has resulted in unstable segments, polyethylene plates should be placed on both sides of the septum and sutured together loosely through the septum. A minimal amount of layered packing with bacitracin-impregnated gauze or a commercially available tampon, such as Mericel (Fig. 42-10, C), is applied bilaterally. Even pressure should be exerted on the septum to stabilize it in the midline but without widening the external nose. With children in whom packing is poorly tolerate, silicone rubber tubing below the packing (Goode and Spooner, 1972) or prefabricated splints (Doyle) may be useful.

In most patients, a tape dressing is applied to the external nose (Steri-strips, Micropore) following application of a hypoallergenic adhesive (Mastisol). The tapes allow symmetrical swelling but resist the formation of a subcutaneous hematoma. An external splint of Thermoplast is then molded to the external nose (Fig. 42-10, D).

All packing and splints are removed 5 days after the reduction. Crusts that develop on the mucous membranes should be gently removed. Normal saline douches or Ocean Mist nasal spray reduces crust formation.

The long-term results of closed reduction are variable, reflecting the heterogeneity of injury patterns, the variations in the anatomic and physiologic state of the nose prior to injury, and the mode and timing of treatment following the injury. The results of closed reduction as reported in many series have been disappointing (Bowers and Lynch, 1970; Dickson and Sharpe, 1986; Harrison, 1979; Mayell, 1973; Moran, 1977). Murray and Maran (1980) reported a failure rate of 30% to 40%. In a subsequent article Murral et al (1984) attributed the poor results to an unrecognized and unmanaged C-shaped septal fracture that was responsible for development of nasal deviation during subsequent healing. Others contend that closed reduction approaches afford satisfactory long-term results. Kaban et al (1977) noted failure in only 2 of 55 patients whereas Illum's study (1986) of 106 patients revealed a satisfactory result with regard to appearance in 90%, and function in 84%.

In comparison with most other fracture sites, the results of treating nasal fractures are poorer with regard to aesthetics and function. As pointed out by Murray and Maran (1980), the nose (1) is very visible as it projects from the face, (2) possesses very little soft-tissue cover capable of camouflaging bony irregularities, (3) lacks the pull of strong muscles to remodel the one once fractured, and (4) consists of bone that heals with fibrosis and more soft-tissue shrinkage than do long bones.

Semiclosed techniques

Occasionally nasal trauma will result in a situation in which the dorsum cannot be maintained with packing, splinting, or plate techniques. This most often occurs when the nasal fracture is combined with midfacial fractures. In such cases, using external fixation for the nose and the other midfacial fractures may be desirable (Fig. 42-11). Available methods will require perforation of the nasal bones with a pin or wire and attachment to external traction from a halo, such as a Georgiade or external plaster head cap (Wurman et al, 1983). Lai (1983) described an orthodontic appliance for similar external traction.

Open reduction

Open reduction requires an intimate knowledge of nasal anatomy and function in addition to rhinoplasty techniques. The patient should be informed about the procedure and its potential complications.

Essentially two types of open reduction are performed. One is aimed at the early correction of nasal fractures that could not be properly reduced in a closed fashion. The other is used to correct a previously existing nasal deformity or malunion. The latter should be more properly classified as septorhinoplasty to correct an internal and external deformity.

Surgical exposure for open reduction is obtained through either intercartilaginous or intracartilaginous incisions that are extended into a hemitransfixion incision. The dorsal nasal skin is elevated from the upper lateral cartilages in the supraperichondrial plane, with further cephalad dissection proceeding in the subperiosteal plane to expose the nasal bones directly. Care should be exercised in the extent of lateral undermining, such that the soft tissue is elevated only slightly beyond the fracture lines. In this way, some degree of external stabilization is afforded by the soft-tissue/periosteal attachments. A small osteotome is tapped into the fracture lines and the nasal bones are gently mobilized and then moved into position as previously described (Fig. 42-12). Lateral fracture lines may easily be approached through small pyriform margin incisions just anterior to the inferior turbinate attachment.

When the nasal bones are comminuted and fail to reduce properly, open reduction should be considered. In the case of open fractures, access can often be obtained through the wound itself. If additional exposure is needed, intranasal rhinoplasty incisions should be added. The goals of treatment include conservative debridement of any devitalized tissues, extraction of periosteum and soft tissues from the fracture sites, and proper reduction-stabilization of the fractured segments. Because the periosteal and mucosal sleeves about the bony nasal skeleton provide blood supply as well as an internal tissue splint, excessive undermining about comminuted segments should be avoided.

When confronted with closed nasal fractures that require direct access, an elective transverse incision at the naso-frontal angle can provide adequate exposure to the entire bony pyramid (Fig. 42-13, A, B). Following reduction, the nasal bones can be stabilized directly with fine wires, and supported with internal and external splinting (Fig. 42-13, C, D). Kurihara (1990) used open reduction and interfragment wire fixation successfully in 21 cases of comminuted nasal fractures and noted no deviation or depression of the nasal pyramid for more than 2 years after surgery.

Although rare, there may be instances in which reduction of the remaining bone fragments fails to achieve the necessary projection and support of the nasal skeleton. In these cases, primary bone grafting should be considered (Fig. 42-14). David and Moore (1989) have successfully used cantilever nasal bone grafting with miniscrew fixation (2 mm, countersunk, self-tapping lag screw) in 25 cases, 6 of whom had posttraumatic nasal deformities. The authors point to the advantages of rigid stability including rapid bone healing and decreased bony resorption afforded by lag screw fixation over that of interosseous wiring.

Septal injury can also be treated using an open technique. If the septum will not stay in position after reduction, or if an obvious displacement of cartilage or bone persists, the offending pieces can be trimmed or scored and replaced in satisfactory position. The usual approach is through a Killian incision. Following elevation of a mucoperichondrium flap on one side, the fragments are visualized and repositioned. Harrison (1979) noted good results with resection of both horizontal and vertical sections of the septum compared with simple manipulative techniques (Fig. 42-15). Fry (1966, 1967) discussed the importance of scoring the concave or compressed side (Fig. 42-16). Occasionally an inferior slip of cartilage must be removed from the maxillary crest to allow the cartilage to swing back into a midline position. Even in children this method can be applied without damage to growth of the nasal skeleton (Bailey and Caruso, 1978; Bernstein, 1973; Moran, 1977; Olsen et al, 1980; Pirsig, 1977). When the septal reduction cannot be maintained, the suture techniques described by Wright (1969) can be applied (Fig. 42-17). Intranasal splints and packing can be placed to help support the repositioned septum.

Complications

Septal hematoma

As a result of nasal trauma, bleeding can develop in the subperichondrial plane of the septum. With fractures of the septum, blood can collect on both sides of the cartilage. If the hematoma is not drained, irreversible damage can occur to the underlying cartilage. Pressure on the cartilage coupled with a reduced blood supply from the elevated perichondrium makes the tissues more susceptible to ischemic necrosis and infection. Irreversible damage can occur in 3 to 4 days with loss of cartilage in important areas of the nose leading to a saddle deformity and retraction of the columella.

Although septal hematoma can occur in all age groups, it is a frequent complication of nasal injury in a child. It is suspected that the softer cartilage of children predisposes to a more significant injury (Hinderer, 1976).

The diagnosis of septal hematoma is made on finding persistent nasal pain and excessive swelling of the septum. Once the condition is suspected, the hematoma must be treated immediately. Following adequate topical anesthesia, one or several small incisions should be made through the mucoperichondrium to allow evacuation of the blood and prevent further accumulation.

If significant loss of cartilage exists at the time of treatment, Holt (1978) has recommended immediate autogenous auricular cartilage grafts. The perpendicular plate of the ethmoid has also been suggested as an appropriate implant (Olsen et al, 1980).

To prevent further accumulation of blood, the surgeon should leave the incision on the septum open or should suture a small Penrose drain into the incision. Suction drainage from vacuum tubes can be used, but application of gentle, firm pressure from plastic splints or intranasal packing is simple and effective. Antibiotic coverage is essential to prevent infection.

Nasal dorsum hematoma

According to Hinderer (1976), hematoma can also develop along the dorsum of the nose. This is usually associated with a tearing of the upper lateral cartilages from the nasal bones. Because pressure necrosis of the cartilage can occur, the condition must be recognized and treated immediately. The hematoma must be evacuated through external or internal incisions, and antibiotics are administered to prevent infection.

Infection

Although infections of the nose rarely occur following trauma, every precaution should be taken to prevent their development. Septal hematomas are particularly susceptible to this complication. Patients incapacitated by chronic disease or malnutrition are also predisposed to infection.

Early diagnosis of infection in the nose is critical. Persistent pain, swelling, and redness are important signs and symptoms. As a general rule, patients with facial trauma should be treated with prophylactic antibiotics. If infection occurs, cultures should be obtained immediately and antibiotics selected to match the sensitivity of the microorganism(s). Adequate drainage is important, and packing should be used sparingly.

External and internal deformities

If residual deformity and/or nasal obstruction persists after closed reduction of nasal fractures, open reduction should be performed as soon as possible. The fragments are carefully mobilized and then properly reduced and stabilized in position.

Patients who desire a reduction rhinoplasty when a posttraumatic deformity is being corrected will require a controlled septorhinoplasty. The ideal period for such corrective surgery is usually 3 to 6 months after injury, once all swelling has disappeared and the bones have been completely stable (Facer, 1981; Farrior, 1984; Goldman, 1964; Schultz and DeVillers, 1974).

In children, the timing of revisional surgery is somewhat controversial. When the deformity is minimal, the surgery can be delayed until the child is 15 or 16 years of age, when facial growth is nearly complete. This is a conservative approach with little chance for additional damage to growth centers. However, if significant deformity or dysfunction exists, early precise intervention is indicated (Goode and Spooner, 1972). Kane and Kane (1978) have reported that repositioning techniques in children do no harm. Bernstein (1973) and Pirsig (1977) have reported minimal problems in the development of the nose as long as the surgery is conservative and removal of tissue is minimal.

Farrior (1984) has characterized the deformity following nasal trauma (Fig. 42-18). Common sequelae include a relative hump, a wide nasal dorsum, depression of the nasal dorsum, depression of the cartilaginous tip, deviation of the nose, splaying of the tip, saddle deformity, and columella retraction. Whether one can develop a true hump from a fracture or from altered growth centers is a matter of conjecture. Septal deflections, spurs, and complex angulations can also occur. With previous mucosal lacerations, one can expect some synechiae and intranasal scarring. Most late deformities and dysfunction must be handled with standard septorhinoplasty and soft-tissue techniques.