Aesthetic Plastic Surgery
DOI: 10.1007/s00266-002-4307-5

Management of Nasal Trauma

Stephen W. Perkins, M.D., F.A.C.S., and Steven H. Dayan, M.D.

Indianapolis, IN, USA

Online publication: 21 November 2002

Correspondence to: Stephen W. Perkins, M.D., F.A.C.S.

Nasal bones are the most commonly fractured bones in the face and the third most commonly fractured bones in the body [5]. The nose, the most projected feature of the face, is the leading structure encountered in a traumatic event [5,20]. It is estimated there are, on average, 51,200 nasal fractures per year in the United States [11]. However, there are probably more incidences, as many patients with nasal fractures do not seek treatment [19] or treatment may go unreported. In a severely traumatized patient with life-threatening injuries, it is not unusual for a nasal fracture to be unrecognized [7]. Additionally, nasal fractures may not be specifically diagnosed when it occurs in conjunction with other fractures of the face [7]. Infant or childhood nasal trauma is notorious for being overlooked, leading to adolescent and adult nasal deviation [10] and/or airway obstruction [5,7]. Commonly, the patient who is seeking cosmetic or functional rhinoplasty has experienced a previously unnoticed or forgotten traumatic event in which the nasal bones or cartilages were damaged. Unfortunately, even when a nasal fracture is diagnosed, the mechanism of injury is often not well understood, leading to an inadequate treatment plan. This results in a less than ideal reduction and an unsatisfactory outcome. Possibilities of complications may ensue including the difficult to correct twisted nose deformity.

Incidence and Injury Pattern

Most facial fractures afflict people between the ages of 15 and 40 years and are three times more likely to occur in males [5]. Nasal and facial fractures in adults are commonly reported to be the result of motor vehicle accidents (MVA), sports injury, altercations, or falls [5,17]. The variability in frequency may depend on the urban location in which the study has been performed [1]. The mechanism by which the injury occurred and the patients awareness may affect the manner in which it is reported. Patients who have sustained nasal fracture during altercations will have a 15–20% chance of reporting a second nasal trauma [14]. These patients' lifestyles afford a particular susceptibility to repeated facial trauma.

Additionally, these patients may be quick to recognize and report a nasal trauma. Interestingly, it has been noted that previous rhinoplasty patients are at an increased risk for nasal fractures, especially males, within one year of the procedure [11]. It seems intuitive that the still settling post-rhinoplastic nose is vulnerable to outside forces and this information needs to be conveyed to the patient. Fortunately, it has been our experience that the post-rhinoplastic patient rarely ignores a nasal injury and reliably seeks medical attention.

Injuries to the nose that occur during an altercation (e.g. a fist) tend to not injure other facial features [5]. Once the patient seeks medical attention, the practioner is allowed to concentrate on diagnosing the nasal injury. Conversely, motor vehicle accidents tend to result in severe nasal fractures that are frequently associated with additional maxillofacial injuries. Twenty percent of patients who have sustained facial skeleton injuries have multiple facial bone fractures [6]. When high impact trauma fractures the bones of the midface, the also nose tends to be injured. It is estimated that 28% of patients who sustain midfacial fractures experience an associated nasal fracture [6]. In this situation, the nasal fracture may be neglected resulting in a missed diagnosis.

Children's noses are mostly cartilaginous and possess small nasal bones that are softer and more compliant, absorbing little of the energy from the force [31]. However, they are not immune to nasal fractures. It is well known that birth trauma can result in nasal septal deviation. It is estimated that the incidence of nasal septal deformities ranges between 1.25% – 23% of all newborns [24]. A forceps-assisted or a breech delivery are often associated with the injury, but intrauterine forces may also be responsible for neonatal cartilage deformities [9]. Fortunately, these deviations can be treated easily, expeditiously, and without complication in the early neonatal period, preventing long term sequelae.

Similar to adults, older children and adolescents are also injured as a result of sports injury, MVA, and falls, however, also included are playground assaults and injuries from animals [5]. It is important to not disregard abuse as a cause of childhood nasal trauma [2]. Also of particular importance in pediatric patients are sports related injuries, one of the most preventable causes of nasal fractures. Fifty percent of pediatric facial fractures are secondary to sports-related injury, and 65% of these patient will experience a nasal fracture. Softball, a popular recreational sport enjoyed by both males and females, is the most likely cause of sports related nasal fracture in children [23]. This has led to The U.S. Consumer Protection Safety Commission June of 1996 official recommendations for protective face gear on batting helmets.

Following nasal trauma, children are especially susciptible to septal hematoma and its subsequent complications. The cartilages of the nose tend to buckle and twist rather than fracture, producing a separation between the perichondrium and the cartilage resulting in a hematoma [31]. This can occur in the absence of nasal bone fractures, with minimal signs and symptoms of nasal trauma [21]. Unfortunately, childhood nasal trauma is often unappreciated, manifesting as external and internal nasal deformities in adult life.

Mechanism of Injury

The nasal bones are the most fragile of the external facial bones, having the least amount of tolerance to an impact force [12]. The resultant fracture of the nose can be suprisingly predictable based on the forces of injury. Most common nasal fractures are due to a lateral force [6,22]. Murray studied the pathophysiology of fractured nasal bones in fresh cadaver heads. He concluded that 24–50 kilopascals of lateral force results in two fracture lines that run parallel on the ipsilateral thin nasal bone along the dorsum meeting at the junction of the thick and thin bones. In this type of injury the nose may appear deviated, however it is only an illusion caused by a depression of the unilateral bony fragment (Fig. 1). This type of injury carries a good prognosis for restoration and a normal airway (Fig. 2) [30]. On the other hand, a deviating fracture of the nose occurs with lesser lateral force (16–66 kilopascals) and a greater frontal force (114–312 kilopascals) (Fig. 3). A relatively greater force is needed from a frontal impact to produce a fracture because the nasal bones are buttressed by the frontal process of the maxilla, the nasal spine and the perpendicular plate of the ethmoid [7]. The inciting factor leading to the deviation is the combination of fractures to both nasal bones, the cartilaginous, and bony septum. A c-shaped fracture in the septum results in deviation of the nasal bones to greater than one width of the nasal bridge. The septal fracture extends from just under the dorsum of the nose inferiorly and posteriorly through the perpendicular plate of the ethmoid and curving anteriorly to the inferior cartilaginous septum near the maxillary crest and the vomerine angle. This type of fracture can occur with as little as 50 kilopascals of combined frontal and lateral force. A c-shaped fractures of the septum may also accompany a large force from any direction that results in comminution of the nasal bones. Nasal trauma associated with septal fractures require a more extensive repair process.

The nasal septum acts to absorb the shock of the trauma. Depending on the degree of force, the septum may rebound, dislocate or fracture. This mechanism may serve as a protective measure preventing fracture of the nasal bones. However, this sacrifice often leads to septal injury irregardless of nasal bone injury. This is especially true in children who have small nasal bones anchored to a highly cartilaginous nasal framework. Frequently, the inferior end of the septum becomes dislodged from its groove and is deflected obliquely into the nasal cavity. As a result, the ala and nostril on the deflected side are widened, while the opposite side is flattened and narrowed. Additionally, the tip loses support, drops, and the columella becomes retracted and/or distorted [7].

High impact frontal forces which occur in a MVA, can produce comminuted and compound nasal fractures. Damage may occur to the thick portion of the nasal bones and surrounding bony framework. A nasal orbital ethmoid (NOE) fracture is a complicated fracture of the nasal bones associated with damage to the supporting orbital structures, adjacent facial bones, and possibly damage to the cribiform plate and/or intracranial injury. It is important to differentiate this type of fracture from an isolated nasal bone fracture. This is usually not difficult because the patient with NOE fractures has additional and differing signs that may include telecanthus, epiphora, periorbital emphysema, and a flattened nasofrontal root. The management and work-up of NOE injuries varies from that of isolated nasal bone fracture and is beyond the scope of this chapter.

Diagnosis

Diagnosing a nasal fracture is primarily a clinical exercise. Following the acute nasal injury, a patient may experience episatxis, pain, edema, ecchymoses, nasal obstruction, and subconjuctival hemorrhage. More specific signs for nasal fracture include crepitus, mucosal lacerations, fractured, or dislocated septum, obvious concavity, and depressions of the nasal bones. Occasionally a patient will experience a compound nasal fracture at which time the diagnosis is more apparent.

In the acute injury, as in every trauma patient, a complete physical exam is mandatory. This is usually completed by the time the specialist has been consulted. Never-the-less, be cognizant of the possibility for CSF leaks, orbital fractures, cervical spine, or skull base fractures [3,16,28]. Palpate the external nasal structures. Feel for step deformities, crepitus, sharp edges, or bony mobility. If hours have passed from the time of the injury, evidence of fracture may be hidden secondary to the masquerading effects of edema.

Intranasal exam should be performed after decongesting the nasal cavities. Topical adrenaline, neosynepherine, or oxymetazoline are effective, and cocaine adds the benefit of anesthesia. Identify mucosal tears, exposed cartilage, and/or bone. Pay particular attention to the septum especially in the patient with complaints of nasal obstruction, the most common symptom of a hematoma [2]. A red or blue bulge from the septum into the the airway is suspicious for a hematoma. This may be unilateral or bilateral following a fracture in the cartilage. Hematomas usually involve the cartilaginous portion and can be seen with anterior rhinoscopy; but be certain to examine the posterior septum. If a hematoma is suspected, a helpful maneuver is to palpate the intranasal mass with a cotton swab. If it is compressible, a fine needle aspiration is often diagnostic.

In the pediatric patient (who is particularly susceptible to septal hematoma), the cartilaginous structure of the nose tends to buckle and twist, rather than fracture, and produces separation of the perichondrium from the septal cartilage without tearing the mucosa. A potential space is developed in which avulsion of a small vessel supplying the perichondrium results in a septal hemtoma [31]. The septum and nose are straight in most children and any deviation should be considered significant [18]. It is important to realize in the pediatric patient, that substantial mucosal or septal trauma can occur without signs of external trauma. A history of nasal injury is reason enough for intranasal exam [21]. General anesthesia should be considered to complete a thorough examination as children are usually less compliant.

Radiographic diagnosis of nasal fracture may be controversial in the emergency department, insurance office, or during litigation, but it has been well-established by most physicians treating nasal fractures as an unnecessary exam. In 1939 Fomon, although recognizing the unsatisfactory diagnostic capabilities from roentgenography of the nose, advised that they should be obtained before, after, and during treatment for legal reasons [7]. Since then numerous reports and studies have documented the unreliability of this exam. Additionally, old fractures frequently heal by fibrous union, therefore permanently visible on x-ray examination. In pediatric patients, x-rays are even of less value because the

nasal bones are not fused and the nasal skeleton is primarily cartilage [13]. Illum, instituting a call to action, felt that it is our respsoniblilty as physicians to inform and correct the impression of those who believe that x-rays reveal the whole truth [14]. CT scans have greater sensitivity and specificity for nasal fracture, but their cost, radiation exposure, and lack of impact on management do not justify their use in diagnosing isolated nasal fractures. However, CT scans can be a valuable tool when managing the patient with extensive maxillofacial trauma. In the patient with isolated nasal trauma, photographic documentation can serve all the purposes that were accomplished with radiographs. Photographs provide a tangible record from which patient education and surgical planning can be derived.

Patients will frequently present with chronic sequalae of a previous nasal fracture, including nasal obstruction, nasal septal deviation, saddle nose deformity, and a dependent nasal tip that lacks support. Many patients with nasal bone irregularities can trace back to an identifiable traumatic event. Often these patients did not seek medical attention at the time of the injury or were incompletely treated. Examination of these patients follows the same principles used in the acutely injured patient, however the treatment differs.

Treatment of Nasal Fractures

Often the greatest controversy surrounding nasal fractures is in the mangement and repair. This does not have to be confusing if one understands the mechanism of the injury, the patient's expectations, and tailors a treatment plan specific to the individual. Not suprisingly, the most important determination of whether or not an immediate reduction was successful is based on the patient's attitude. Both Illum and Owen have demonstrated a majority of their patients were satisfied with their results despite the physician's criticism of a less than perfect result [14,22]. Nonetheless, many patients and physicians alike considered the results obtained from reduction in the early post-traumatic period to be inadequate [29]. Failure rates in obtaining a complete reduction have been estimated to occur 30–50% (Fig. 4) [4,19]. These patients frequently go on to develop long-term sequale of nasal fracture. To completely correct the deformity, a second operation may be necessary (Fig. 5). In the patient requesting the perfect result, it may be appropriate to wait six to eight weeks following the traumatic event and perform a septorhinoplasty. This eliminates an extra procedure and allows for direct access to nasal structure in which exact adjustments can be made within virgin planes, devoid of edema.

There are two windows of opportunity to obtain the best result in early reduction of nasal fracture, the first being immediately posttraumatic within the first two to three hours prior to significant edema. Following this period of time, edema has settled in, camouflaging the nasal fracture, thereby making aesthetic judgments more difficult. The second opportunity occurs five to ten days after injury when the effects of local soft tissue trauma has begun to resolve and bony units are still mobile. This is prior to the beginning of fibrous union of the fractured bones which occurs in the two to three week period. Once fibrous union begins, manipulation becomes more difficult. Reduction in the early period can be performed equally well under local or general anesthesia [22]. The choice of anesthetic method should be determined by the patient's tolerance.

Closed Versus Open Repair

One technique does not work better than another, rather they both are successful proven methods for achieving nasal reduction when used appropriately. Closed reduction is defined as repositioning portions of displaced nasal bones with manipulation. Closed reduction in its simplest form can be performed with digital forces. Other methods include the aid of a Boies elevator, Asch and Walsham forceps, or the back of a scalpel handle. It is easily performed in an outpatient or office setting.

Many authors practice a graduated approach to nasal fracture reduction, beginning with a closed approach, and if unsuccessful, progressing to a open approach [13,29]. However, if the diagnosis and mechanism of injury are clear, a direct approach to the appropriate open or closed technique may be taken. A complete nasal bone fracture sustained from a lateral force without a septal fracture resulting in a unilateral concavity, is most amenable to successful reduction utilizing a closed technique. Digital manipulation may be all that is required. However, if the nasal bone is locked under the ascending process of the maxillae, then a better outcome is obtained using an elevating instrument. Following decongestation, local anesthesia, and evacuation of blood clots, a Boies elevator can be placed under the concave nasal bone. Be certain the elevator is not inserted too deep, as it may lay under the nasal process of the frontal bone and will be of no value. The motion is upward and outward with the opposite hand on the nasal dorsum molding the bone into proper position. Often the bone and the septum will snap into position. An external nasal splint and light intranasal packing of antibiotic coated telfa or gauze-stuffed finger cots should maintain the proper reduced position. Oral antibiotics are necessary in the interim and nasal packs can be removed after three days.

If a closed reduction is unsuccessful, as it often can be, an open reduction or delayed treatment is necessary. The high failure rate of closed reduction is usually secondary to inadequate management of the nasal septum. Septal fractures may be overlooked by the treating physician. In a well thought out study investigating trauma to cadaver heads and then followed up with a prospective clinical study, Murray attributed the high failure rate of closed reduction to a c-shaped fracture occurring in the bony and cartilaginous septum. If closed reduction is performed without addressing the septal fracture, the displaced interlocking segments of the septum eventually drag the mobile nasal bones back toward their displaced position.

Therefore, it can be concluded that if a septal fracture is diagnosed, closed reduction is not adequate treatment and an open approach is necessary. An open reduction involves exposing the septum and/or correcting deviations with osteotomies. Usually correction of the septum can be approached through a hemitransfixation incision or through existing mucosal lacerations. Initial attempt should be made to reduce the septal components. Limited resection of overlapping segments may be necessary, followed by suture fixation with 4–10 catgut in a mattress fashion. If the inferior septum is deviated off the maxillary spine, it is helpful to excise an inferior strip of cartilage providing for a swinging door septum that can be replaced in the midline and sutured to the maxillary perieosteum. Following stabilization of the septum, adequate nasal bone reduction can be accomplished with confidence. Intranasal septal splints for seven to ten days are necessary to maintain the midline position. Commercially available silastic splints or

radiographic film cut outs have been used successfully. Nasal packing and oral antibiotics are also required during this time period.

Occasionally, patients will present with a laceration through the skin, affording the surgeon direct access to the bony deformity. It may be helpful to slightly and judiciously extend the laceration with a small incision allowing for an easier reduction. When practicing proper plastic surgical techniques, these lacerations will heal discreetly. In the isolated nasal fracture, wire and miniplate fixation has not been necessary. These tools are better reserved for the patient with more extensive maxillofacial trauma.

Although some have considered performing cosmetic septorhinoplasty at the same time of fracture reduction in the acutely injured nose, we have found this to be less than optimal [25,29]. There are many variables involved in the healing process, further complicated by irregular and comminuted fractured bones and cartilages that can not be controlled. Following correction, reparative process and fibrosis can cause shifts in the nasal structures. Additionally, there is the lack of detailed preoperative consultation and thought process that are required by both the surgeon and patient. In the patient who has contemplated an aesthetic improvement prior to the injury and is adamantly requesting a cosmetic septorhinoplasty, in addition to reduction, it is not unreasonable to delay treatment for six to eight weeks. The treatment then follows the steps usually performed in managing patients presenting with the crooked or twisted nose deformity [33]. Surgeons who routinely achieve successful results in these difficult to correct deformities can expect the same satisfying outcome when treating the recently fractured nose.

In the pediatric patient, closed reduction is the technique of choice. In order to perform a thorough examination and a complete reduction, general anesthesia is usually desirable. Most deviations can be treated with digital manipulation or, if this is unsuccessful, with the aid of a small blunt instrument providing elevation. Unfortunately in children, the endpoint of reduction is not as obvious as in adults. The cartilaginous elements of the pediatric nose do not snap back into place as do the adult nasal bones. However, every effort should be made to avoid an open approach. The concern is that disruption of the nasal skeleton will have long-term effects on the growth and development of the nose and possibly the maxilla. Whether or not disruption of the human pediatric septal growth centers affect the development of the nose is not clear. Certainly there is evidence to support the importance of growth centers in animal models [27]. Although unresolved, every effort should be made to avoid an open technique. Rarely, in the pediatric patient the tools of an open approach may be necessary to correct a severely deviating fracture not manageable by a closed reduction. Stucker felt that if a closed reduction is unsuccessful, then a conservative open approach is justified [31]. He recommended using a 2-mm osteotome to align the nose along with a conservative septorhinoplasty. He stressed the importance of maintaining intact mucoperichondrial flaps and to reset minimal cartilage (if at all). This rationale is in accordance with rabbit studies revealing surgery on the septum affected nasal growth, whereas no deleterious effect on nasal growth was caused by osteotomies [26]. Following reduction, a light nasal splint and packing is usually necessary. Close followup should be maintained, as the child is at increased risk for developing delayed nasal deviation and nasal obstruction.

Septal Hematoma

Septal hematomas develop when there is shearing of the intact mucopeirichondruim against the nasal septum with avulsion of a small vessel supplying the septum [2]. This occurs following septal absorption of a forceful impact. Blood accumulates between the mucoperichondrium and the cartilaginous septum. Occasionally, and especially in children, it can also separate the mucoperiosteum from the bony septum [25]. Because cartilage does not contain its own vascular supply, the intervening hematoma blocks the cartilage from nutrients derived from the surrounding perichondrium. If not evacuated, breakdown of cartilage can develop in as little as three to four days [8]. This can lead to fibrosis and long-term loss of support to the nasal dorsum and tip. The long-term structural defect is manifested as a saddle nose deformity and columellar retraction. A delay in the evacuation of the hematoma can lead to the feared complication of a nasal septal abcess. The breakdown of cartilage and blood is an excellent culture media for bacteria to flourish. Organisms most commonly identified are *Staphylococcus aureus, Streptococcus pnuemonia, Group A beta hemolytic Streptococcus* and *Haemopholus influenza.* Although rare, if the abscess is not treated in a timely fashion, this can lead to more severe complications such as meningitis, cerebral abscess, and cavernous sinus thrombosis [2]. Children with a highly cartilaginous nasal skeleton are particularly susceptible and have an increased incidence of septal hematomas. It is important to realize that in children, even minor injury can lead to a hematoma without the external signs of trauma. Therefore, any history of nasal injury in a child warrants an intranasal examination. If a hemaotoma is diagnosed, it needs to be treated quickly and mindfully. An attempt can be made to evacuate the blood via large bore needle aspiration. Often, the hematoma is organized and an incision in the mucosa is necessary to remove the clot. A drain has not been found to be necessary unless there is the presence of an abscess, in which case a penrose drain can be efficacious. Septal flaps can be reapproximated with a quilting 4–0 catgut suture. Oral antibiotics and nasal packing for three to four days is required. Following removal of the packs, close followup is necessary as reaccumulation of fluid is not uncommon [2]. A high index of suspicion for a hematoma along with prudent management once it is diagnosed, is essential to preventing acute complications and long term structural defects.

Long-Term Outcome

The commonly identified sequalae of a neglected nasal fracture (or a partially reduced nasal fracture) is a twisted or crooked nose deformity associated with residual depressions and surface irregularities. These patients often present without having received medical attention and recount a history of progressive changes following a traumatic event, although there are a significant number of patients who did received treatment, albeit unsuccessfully. Despite expert primary treatment, many patients will seek reconstructive surgery. Not uncommonly, the patient with a persistent deformity will experience progressive nasal obstruction. The offending trauma which has led to the twisted deformity usually has created a deviated or dislocated nasal septum and disrupted the traditional nasal support mechanism [7,32,33]. Furthermore, this deformity can result in loss of support and lead to internal and external nasal valve collapse.

Although seemingly easy to correct, the deviated nose is the most challenging of all septorhinoplasty procedures [32]. Tardy recognized that a traumatized nose possess bent and angualated cartilages with scarred and obliterated tissue planes. He stressed the importance of correcting the septal deformity as the

initial event along with the significance of performing complete osteotomies [32]. Too often the initially corrected twisted nose deviates back to its displaced position because of an inadequately treated septum or greensticked osteotomies. Toriumi appreciated the importance of addressing the middle vault. Often simply freeing the upper lateral cartilages from the septum allows the structures to reorient themselves in the midline [33]. If this proves unsuccessful, middle-third deviation can be effaced with a planoconvex spreader graft fixated to the concave side of the nasal septal deformity. If a deviation persists despite best efforts to correct the septum, upper lateral cartilages, and nasal bones, onlay grafts of autologous cartilage will balance residual asymmetries.

Loss of septal support leading to saddling and collumellar retraction is treated with a graduated approach (Fig. 6). Minor saddling can be corrected with onlay cartilage grafts (Fig. 7). Autologus cartilage is ideal — rib, septal, or auricular have been used for many years with long-term success. Recent positive experiences have been reported with radiated homologus rib graft [15]. Synthetic materials have generally been discouraged but Gortex™ continues to be a safe and reliable alternative implant material when restricted to the dorsum. Severe saddling with complete loss of dorsal support may best be approached through an external collumellar incision with total nasal septal reconstruction and significant augmentation [32].

Conclusion

Nasal fracture is one of the most common injuries in society. Nasal trauma can result in the frequently unappreciated septal injury. Essential to the proper management is thorough external and internal nasal examination, especially in children who may demonstrate few obvious signs of nasal trauma. Radiographs offer little assistance to nasal fracture work up. Prudent treatment of nasal septal hematoma can prevent complications such as septal abscess and collapse of nasal support mechanisms. Treatment for the fractured bone can be performed acutely following the injury, subacutely, or in a delayed fashion. Whether a closed or open approach is utilized depends upon the correct diagnosis and the individuals' desires and expectations. Poorly treated or neglected nasal fractures lead to progressive twisted nose deformities, saddling, and nasal obstruction. Although a challenging defect to repair, successful and long-term correction can be achieved with time honored principles. Proper diagnosis in addition to understanding the mechanics and treatment rationale of nasal fractures are essential skills required of all rhinoplastic surgeons.

References

1. Bailey B (1993) Nasal fractures. In: B Bailey (ed), Head and neck surgery — otolaryngology., J.B. Lippincott, Philadelphia, pp 991-1007

2. Canty PA, Berkowitz RG (1996) Hematoma and abscess of the nasal septum in children. Arch Otol 122:1373-1376 [PubMed]

3. Davidson JS, Birdsell DC (1989) Cervical spine injury in patient with facial skeletal trauma. J Trauma 29:1276-1278

[PubMed]

4. Dickson MG, Sharpe DT (1986) A prospective study of nasal fractures. J Laryngol Otol 100:543-541 [PubMed]

5. Dingman , Reed O (1964) The nose. In: O Reed, and P Natvig (eds), Surgery of facial fractures., W.B. Saunders, Philadelphia and London, pp 267-294

6. Dingman RO, Converse JM (1977) The clinical management of facial injuries and fractures of the facial bones. In: JM Converse (ed), Reconstructive plastic surgery., W.B. Saunders, Philadelphia, pp 599-747

7. Fomon S (1939) The nose. In: S Fomon (ed), Surgery of injury and plastic repair., Williams and Wilkins, Baltimore, pp 614-831

8. Fry H (1967) The importance of the septal cartilage in nasal trauma. Br J Plas Surg 20:392-402 [PubMed]

9. Gray LP (1972) Early treatment of septal deformity and associated abnormalities. Modern trends in disease of the ear, nose and throat. Ellis Maxwell, London, p 219

10. Grymer L, Gutierrez C, Stoksted P (1985) Nasal fractures in children: influence on the development of the nose. J Laryng Otol 99:735-739 [PubMed]

11. Guyuron B, Zarandy S (1994) Does rhinoplasty make the nose more susceptible to fracture? Plast Reconstr Surg 93:313-317 [PubMed]

12. Hampson D (1995) Facial injury: a review of biomechanical studies and test procedures for facial injury assessment. J Biomech 28:1-7 [PubMed]

13. Holt GR (1978) Immediate open reduction of nasal septal injuries. Ear Nose Thr J 57:54-67 [PubMed]

14. Illum P (1986) Long-term results after treatment of nasal fractures. J Laryng Otol 100:273-277 [PubMed]

15. Kridel RWH, Konior RJ (1993) Irradiated cartilage grafts in the nose. Arch Otol 119:24-31 [PubMed]

16. Lewis VL, Manson P, Morgan RF, et al. (1985) Facial injuries associated with cervical fractures: recognition, patterns and management. J Trauma 25:90-93 [PubMed]

17. Logan M, Driscoll K, Masterson J (1994) The utility of nasal bone radiographs in nasal trauma. Clin Radiol 49:192-194 [PubMed]

18. Moran W (1977) Nasal trauma in children. Otolaryngol Clin North Am 10:95-101 [PubMed]

19. Murray N, Maran A, Mackenzie J, et al. (1984) Open v closed reduction of the fractured nose. Arch Otol 110:797-802 [PubMed]

20. Nahum A (1975) The biomechanics of maxillofacial trauma. Clinics in Plastic Surgery 2:59-64 [PubMed]

21. Olsen KD, Carpenter RJ, Kern E (1980) Nasal septal injury in children. Arch Otol 106:317-320 [PubMed]

22. Owen GO, Parker AJ, Watson DJ (1992) Fractured-nose reduction under local anaesthesia. Is it acceptable to the patient. Rhinol 30:89-96 [PubMed]

23. Perkins SW, Sklarew EC: Sports related facial trauma in children. Presented at conjoint session of AAO-HNS, AAFPRS. AAO-A. Kansas City, Mo. Sept 1991

24. Podoshin L, Gertner R, Fradis M, et al. () Incidence and treatment of deviation of nasal septum in newborns Ear Nose Throat J 70:485-487 [PubMed]

25. Renner GJ (1991) Current issues in head and neck trauma. Otol Clin North Am 24:195-213 [PubMed]

26. Rhys Evans PH, Brain DJ (1981) The influence of nasal osteotomies and septum surgery on the growth of the rabbit snout. J Laryngol Otol 95:1109-1119 [PubMed]

27. Sarnat BG, Wexler MR (1966) Growth of the face and jaws after resection of the septal cartilage in the rabbit. Am J Anat 118:755-768 [PubMed]

28. Slupchynskyj S, Berkower AS, Byrne D (1992) Association of skull base and facial fractures. Laryngoscope 102:1247-1250 [PubMed]

29. Staffel JG (1998) Nasal fracture. In: GA Gates (ed), Current therapy in otolaryngolgy head and neck surgery., Mosby, St. Louis, pp 133-134

30. Stranc MF, Robertson GA (1979) A classification of injuries of the nasal skeleton. Ann Plas Surg 2:468-474 [PubMed]

31. Stucker FJ, Bryarly RC, Shockley WW (1984) Management of nasal trauma in children. Arch Otol 110:190-192 [PubMed]

32. Tardy ME (1997) Rhinoplasty the art and the science. W. B. Saunders, Philadelphia

33. Toriumi DM, Ries WM (1993) Innovative surgical management of the crooked nose. Facial Plas Surg Clin North Am 1:63-77 [PubMed]

Figures

Figure 1
Figure 1 (large scale)

Fig. 1. Unilateral depressed nasal bone fracture giving the illusion of a deviating nasal fracture.

Figure 2
Figure 2 (large scale)

Fig. 2. Unilateral nasal bone fracture carries a good prognosis for repair.

Figure 3
Figure 3 (large scale)

Fig. 3. Deviating fracture of nose is secondary to a greater frontal force which also often results in a septal fracture.

Figure 4
Figure 4 (large scale)

Fig. 4. Patient who underwent an unsuccessful closed reduction in the immediate post-traumatic period.

Figure 5
Figure 5 (large scale)

Fig. 5. Proper alignment is often achieved following a delayed secondary repair.

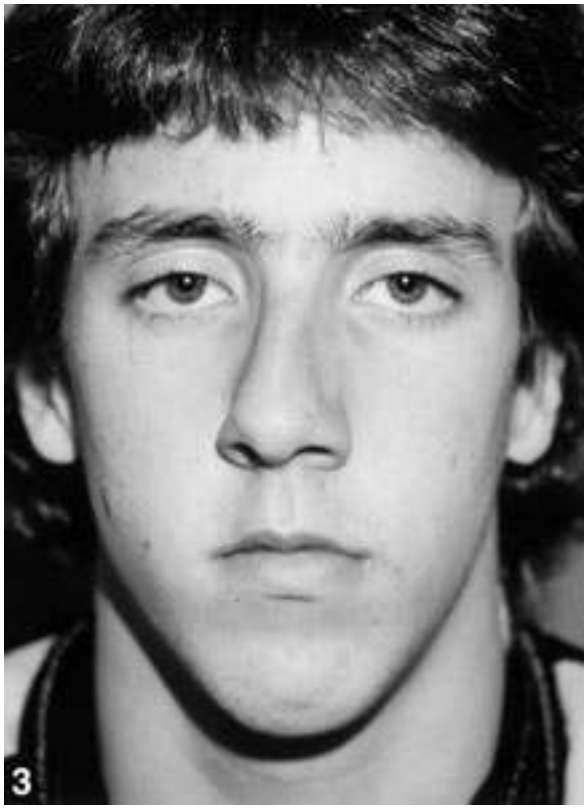
Figure 6
Figure 6 (large scale)

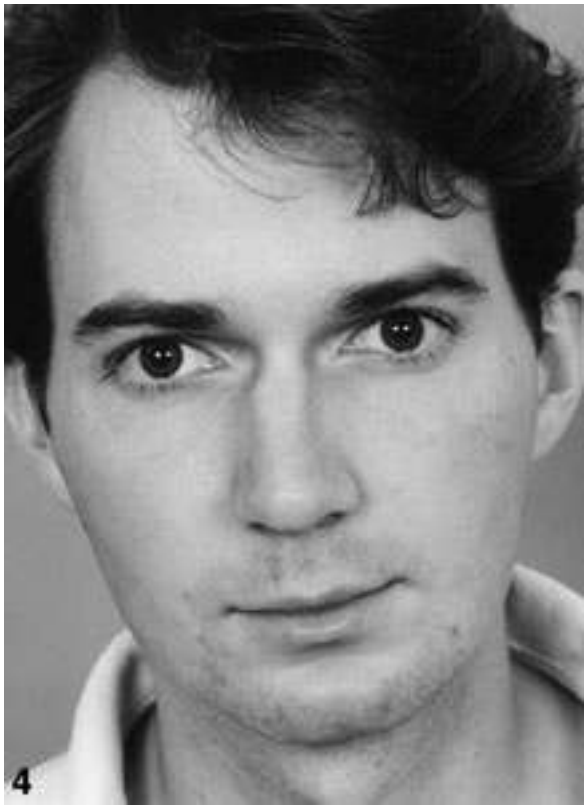
Fig. 6. (**A**,**B**) Septal resorption following trauma leads to a saddle nose deformity.

Figure 7
Figure 7 (large scale)

Fig. 7. (**A**,**B**) Saddle nose deformities can be corrected with autolougus cartilage grafting.


2


3


4


5


6A


B


7A
B