



Multidisciplinary Assessment and Management of Nasal Septal Fracture Across Nursing, Dentistry, Pharmacy, Laboratory, and Emergency Care-An Updated Review

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Abstract

Background: Nasal septal and nasal bone fractures represent the most common injuries within maxillofacial trauma due to the exposed anatomical position of the nasal framework and its limited structural resistance to external forces. These injuries frequently coexist with other facial fractures and may result in both functional airway compromise and aesthetic deformity. Given the anatomical complexity and clinical variability, their management requires a multidisciplinary approach.

Aim: This review aims to provide an updated and comprehensive synthesis of nasal septal fracture management, emphasizing multidisciplinary involvement across nursing, dentistry, pharmacy, laboratory medicine, and emergency care. It also highlights current evidence regarding diagnosis, imaging, treatment strategies, complications, and preventive measures.

Methods: A narrative review approach was adopted based on previously published literature and clinical studies addressing nasal fracture epidemiology, pathophysiology, diagnostic evaluation, and management principles. Emphasis was placed on integrating clinical guidelines and multidisciplinary healthcare perspectives relevant to trauma care pathways.

Results: Findings indicate that nasal fractures are predominantly caused by interpersonal violence, motor vehicle accidents, sports trauma, and falls, with demographic variation by age and sex. Clinical assessment remains central to diagnosis, while CT imaging is reserved for complex cases. Management ranges from conservative observation to closed reduction and delayed reconstructive surgery. Septal hematoma, septal perforation, and saddle nose deformity remain key complications. Early intervention improves outcomes, while delayed treatment increases the likelihood of deformity and revision surgery. Multidisciplinary collaboration improves detection, treatment accuracy, and long-term functional and cosmetic results.

Conclusion: Nasal septal fractures require early recognition and structured multidisciplinary management to optimize outcomes. Integration of emergency care, surgical specialties, and allied health services is essential to reduce complications and improve patient recovery.

Keywords: Nasal fracture, septal fracture, maxillofacial trauma, closed reduction, septal hematoma, multidisciplinary care, nasal reconstruction.

Introduction

Fractures involving the nasal framework represent the most frequent injuries within the maxillofacial region, a pattern largely attributed to the exposed anatomical position of the nose and the relatively delicate structure of its osseous components [1]. Within this context, nasal septal fractures commonly coexist with fractures of the nasal bones, with reported associations ranging from 42% to 96% of cases, highlighting the close anatomical and biomechanical relationship between these structures

[1][2]. Such injuries carry both functional and aesthetic implications, as disruption of the nasal architecture may compromise airway patency while simultaneously altering external nasal contour, thereby affecting both respiratory efficiency and facial harmony. The integrity of the nasal structure is maintained through a composite framework consisting of bone, cartilage, and overlying soft tissue. The paired nasal bones form the primary osseous support of the nasal dorsum and articulate superiorly with the frontal bone while extending laterally to meet the frontal

processes of the maxillae. These articulations occur along the nasofrontal and nasomaxillary suture lines, which serve as critical junctions in maintaining structural continuity. Notably, the thickness of the nasal bones is not uniform, with increased density observed superior to the level of the medial canthi, a feature that contributes to regional variations in fracture susceptibility [3]. The nasal septum plays a central role in both structural support and functional airflow regulation, comprising a posterior bony segment and an anterior cartilaginous component. The bony portion is formed superiorly by the perpendicular plate of the ethmoid bone and inferiorly by the vomer, which together create a rigid partition. These elements integrate with the quadrangular cartilage, which constitutes the anterior segment of the septum and provides essential support to the nasal dorsum. This cartilage extends from the keystone area to the supratip region, serving as a pivotal element in maintaining the projection and stability of the nasal profile [3].

The keystone area represents a critical anatomical zone within the mid-nasal vault, characterized by the junction between the quadrangular cartilage and the ethmoid bone, typically spanning a distance of 10 to 15 mm just inferior to the rhinion. This region functions as a central support hub, where multiple structural components converge to stabilize the middle third of the nose. At this level, the upper lateral cartilages articulate with the caudal margins of the nasal bones while simultaneously attaching to the dorsal border of the cartilaginous septum. This intricate arrangement underscores the interdependence of nasal structures, where disruption in one component can propagate instability throughout the nasal framework. Anchorage of the nasal septum is achieved through firm attachments to the surrounding skeletal structures. Anteriorly, it is secured to the nasal spine, while posteriorly it connects to the nasal crest formed by the maxillary and palatine bones. These anchoring points provide foundational stability and maintain septal alignment under physiological conditions. The vascular supply of the nasal septum is notably rich and derives from both the internal and external carotid arterial systems. Contributions from the internal carotid circulation include the anterior and posterior ethmoid arteries, whereas the external carotid system supplies the region through branches such as the sphenopalatine artery, the greater palatine artery from the maxillary artery, and the superior labial artery. This extensive vascular network supports tissue viability but also predisposes the region to significant bleeding in the event of trauma [1][2][3].

Etiology

Nasal bone fractures arise from a range of traumatic mechanisms, reflecting both environmental exposure and behavioral risk factors. The anatomical prominence of the nose makes it particularly vulnerable to direct impact, which explains the high frequency of such injuries in clinical practice. On a

global scale, interpersonal violence, motor vehicle accidents, sports-related trauma, and accidental falls are consistently identified as the leading causes of nasal fractures. These mechanisms differ in their dynamics, with direct frontal or lateral forces commonly producing varying patterns of injury depending on the intensity and angle of impact. Geographical variation plays a notable role in the distribution of etiological factors. In North America, for instance, motor vehicle accidents have been reported to surpass interpersonal violence as the primary cause of nasal bone fractures, indicating the significant contribution of high-velocity trauma in this region [4]. The kinetic energy involved in vehicular collisions often results in more complex injury patterns, potentially involving both the nasal bones and adjacent facial structures. In pediatric populations, the etiology demonstrates distinct patterns influenced by lifestyle and activity levels. Sporting activities and motor vehicle accidents are the predominant causes, although the relative contribution of each varies across studies and settings [4][5]. Children and adolescents are particularly susceptible during recreational activities, where protective measures may be inconsistent or absent. An interesting observation within sports-related injuries is the higher incidence of nasal fractures in ball-related sports such as soccer, basketball, baseball, and rugby when compared to combat sports like wrestling and martial arts [4]. This may be attributed to the unpredictable trajectory and velocity of balls, as well as the frequency of accidental collisions between players. In contrast, combat sports often emphasize controlled techniques and the use of protective gear, which may reduce the likelihood of direct nasal trauma. Collectively, these findings highlight the multifactorial nature of nasal bone fracture etiology and underscore the importance of context-specific prevention strategies.

Epidemiology

Nasal bone and septal fractures demonstrate a clear epidemiological pattern characterized by marked demographic and temporal variations. A consistent finding across clinical studies is the significantly higher prevalence of these injuries among males compared to females. This disparity is largely attributed to increased exposure of males to high-risk environments, including interpersonal violence, contact sports, and occupational hazards, in addition to a greater propensity for risk-taking behaviors. These factors collectively contribute to a higher likelihood of facial trauma in the male population, thereby influencing the overall incidence distribution of nasal fractures. The peak occurrence of nasal bone fractures is observed during the second and third decades of life, a period typically associated with heightened physical activity, social engagement, and increased exposure to traumatic events [6][7]. From a broader epidemiological perspective, trends in the United States indicate a progressive rise in the incidence of nasal bone and other facial fractures since

the year 2000. This upward trajectory may reflect multiple contributing factors, including changes in lifestyle patterns, increased participation in high-impact activities, and evolving societal dynamics that influence injury risk. Despite this rise in incidence, the rate of surgical intervention for fracture repair has remained relatively stable over the same period. This divergence between incidence and operative management suggests a shift in clinical practice patterns and injury characteristics. One plausible explanation for the stable repair rates is the increasing prevalence of non-displaced or minimally displaced fracture patterns, which often do not necessitate surgical intervention. Additionally, there has been a discernible trend toward more conservative, nonoperative management strategies, particularly in cases where functional and aesthetic outcomes can be adequately preserved without surgical correction. Furthermore, advancements in diagnostic imaging, particularly the expanded use of computed tomography (CT), have enhanced the accuracy of fracture detection and characterization. This has led to improved diagnostic precision, enabling clinicians to more effectively differentiate between fractures requiring intervention and those amenable to conservative management. In some cases, CT imaging has also contributed to the identification of minor fractures that may not have been clinically diagnosed in earlier periods, thereby influencing both diagnostic and treatment decision-making processes [7].

Pathophysiology

The pathophysiology of nasal bone and septal fractures is primarily governed by the direction, magnitude, and energy transfer of traumatic forces applied to the nasal framework. The most frequent mechanism involves a direct frontal or lateral impact to the nose, which generates compressive and shearing forces that exceed the structural tolerance of the nasal bones and septal cartilage [8]. Due to the central and protruding position of the nose on the facial skeleton, it is particularly susceptible to such external forces, resulting in a wide spectrum of fracture patterns. The morphological presentation of nasal fractures varies considerably depending on the intensity and vector of the applied force. Fractures may be unilateral or bilateral, and their structural configuration can range from nondisplaced cracks to markedly displaced or depressed segments. In some cases, incomplete or greenstick fractures occur, particularly in younger individuals where bone elasticity allows partial structural failure without complete separation. At the opposite end of the spectrum, high-impact trauma may result in comminuted fractures, characterized by multiple fragmented bone segments and significant disruption of anatomical continuity [9]. The injury process is not limited to the nasal bones alone but frequently extends to adjacent anatomical structures. The lateral nasal cartilages and septal cartilage are

commonly involved, leading to distortion of the internal nasal architecture. Damage to the septal cartilage is particularly clinically significant, as it may compromise both structural support and airway patency. Disruption of these cartilaginous frameworks can result in septal deviation, nasal obstruction, and long-term deformity if not appropriately managed. In cases of severe, high-energy trauma, the force transmission may extend beyond the nasal complex to involve the surrounding midfacial skeleton. Such injuries can produce complex fracture patterns, including Le Fort fractures and naso-orbito-ethmoid (NOE) complex fractures. These patterns reflect extensive disruption of facial buttresses and are associated with significant functional and aesthetic consequences. The involvement of multiple anatomical planes underscores the interconnected nature of facial skeletal structures and highlights the progressive nature of injury severity as energy transmission increases [9].

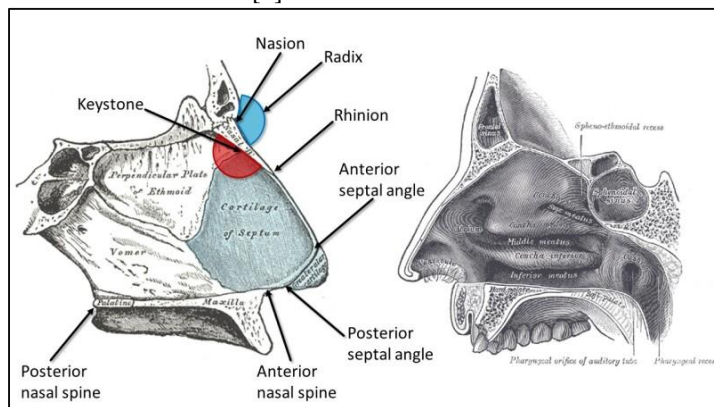


Fig. 1: Nasal Anatomy.

History and Physical

The initial evaluation of patients presenting with maxillofacial trauma must adhere to the principles of advanced trauma care, beginning with a structured primary survey that prioritizes life-threatening conditions. The assessment focuses on the airway, breathing, circulation, neurological status, and environmental exposures, ensuring immediate identification and stabilization of critical injuries. Only after these urgent concerns have been addressed should a comprehensive history and secondary physical examination be undertaken, as delayed recognition of systemic compromise may significantly affect clinical outcomes in facial trauma cases. A detailed understanding of the mechanism of injury is fundamental in the assessment of nasal and maxillofacial trauma. The nature, direction, and energy of the applied force provide essential diagnostic clues regarding the extent and pattern of injury. High-energy mechanisms, particularly motor vehicle collisions, are strongly associated with more severe facial injuries and a higher likelihood of multiple concurrent fractures. The direction of impact plays a pivotal role in determining fracture

morphology. Lateral forces typically produce asymmetrical deformities, characterized by inward displacement on the side of impact and compensatory outward displacement on the contralateral side. In contrast, direct anterior impacts to the nasal dorsum commonly result in bilateral splaying of the nasal bones, producing outfractures that significantly alter nasal contour and structural integrity [10]. An accurate assessment of the patient's premorbid nasal appearance is an essential component of clinical evaluation. Clinicians should obtain a detailed history from both the patient and, when available, family members to determine baseline nasal symmetry, shape, and function prior to injury. This comparison is critical for distinguishing acute traumatic changes from pre-existing anatomical variations or deformities. Functional assessment should include inquiry into nasal airflow, with particular attention to unilateral or bilateral obstruction, which may indicate underlying mucosal edema, septal deviation, or structural disruption of the nasal septum [11]. Additionally, prior history of nasal trauma or surgical intervention must be thoroughly documented, as previous alterations to nasal anatomy may influence both the complexity of current injuries and the selection of appropriate management strategies, as well as alter the risk profile for intervention.

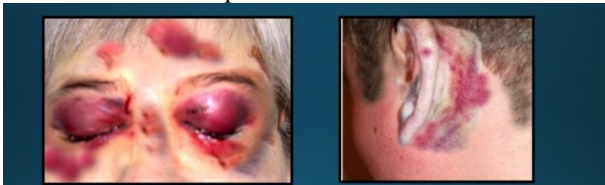


Fig. 2: Skull Base Fracture.

The clinical history should also focus on identifying features suggestive of more extensive craniofacial involvement. Symptoms such as telecanthus, diplopia, visual disturbances or loss of vision, clear nasal discharge, malocclusion, facial weakness, and sensory deficits in the facial region may indicate complex fractures involving adjacent anatomical structures such as the orbit, maxilla, or cranial base. The presence of these findings necessitates a high index of suspicion for associated midfacial or skull base injuries and warrants further radiological evaluation. Physical examination of the patient must be comprehensive and systematic, encompassing the entire head and neck region. This includes inspection and palpation of the skin, ocular structures, auricular regions, oral cavity, and intranasal anatomy. A focused examination of the external nose and internal nasal cavity should be performed under adequate illumination using a headlamp in conjunction with a nasal speculum or endoscopic visualization when available. External inspection should assess for soft tissue injuries, lacerations, and exposure of underlying bony or cartilaginous structures. Any deviation, instability, or mobility of the nasal pyramid should be carefully documented, as these findings are indicative of structural disruption. An increase in

intercanthal distance following trauma is particularly significant and may suggest a naso-orbito-ethmoid fracture, which is associated with disruption of the medial orbital support structures [10]. Palpation of the nasal tip is essential to evaluate cartilaginous support and detect loss of structural integrity. The nasal dorsum should be examined for contour abnormalities, including saddle nose deformity, which may indicate significant septal damage or displacement of supporting structures. Intranasal examination is a critical component of the assessment, with particular emphasis on the early identification of septal hematoma. This condition typically presents as a fluctuant, red or bluish swelling along the nasal septum and usually becomes clinically apparent within 24 to 72 hours following injury [12]. Failure to promptly recognize and manage a septal hematoma can result in cartilage necrosis and subsequent deformity. Clinical suspicion should remain high in cases where nasal obstruction persists despite the use of topical vasoconstrictors and removal of intranasal clots [11]. Further intranasal evaluation should document septal deviation, dislocation, mucosal lacerations, and any evidence of structural disruption. The presence of clear rhinorrhea, particularly when associated with a positive halo sign, should raise concern for cerebrospinal fluid leakage, indicating a potential breach in the skull base [11]. Such findings represent a significant complication requiring urgent investigation and multidisciplinary management to prevent infectious and neurological sequelae.



Fig. 3: Naso-Orbito-Ethmoid Fracture.
Evaluation

The diagnostic evaluation of nasal bone and septal fractures is primarily guided by clinical assessment, with imaging and laboratory investigations reserved for selected indications based on the severity and complexity of the injury. In cases of simple nasal bone fractures, radiological imaging is generally not required, as diagnosis can be reliably established through a thorough clinical examination. The characteristic external deformity, localized tenderness, and functional symptoms such as nasal obstruction are often sufficient to confirm the diagnosis without the need for additional imaging modalities. Historically, plain radiography was utilized in the assessment of nasal fractures; however, its diagnostic utility has significantly declined in contemporary practice due to limited sensitivity and poor correlation with clinical findings. As a result, plain film X-rays are now rarely employed in the evaluation of nasal trauma. In contrast, computed tomography (CT) of the facial bones without intravenous contrast has emerged as the gold standard imaging modality when there is suspicion of more extensive maxillofacial injury. CT imaging provides superior spatial resolution and detailed visualization of both bony and soft tissue structures, enabling accurate identification of fracture patterns, displacement, and associated injuries. It is particularly valuable in complex trauma cases where involvement of adjacent facial structures is suspected, as demonstrated in nasal septal fractures visualized on CT imaging without contrast [11]. Magnetic resonance imaging (MRI) may be indicated in specific clinical scenarios, particularly when neurological symptoms are present. MRI is superior in evaluating soft tissue injuries, intracranial extension, and potential complications involving the brain or cranial nerves. Its role is therefore complementary rather than primary in the assessment of nasal fractures, being reserved for cases where central nervous system involvement is a concern.

More recently, ultrasonography has been explored as a non-invasive and radiation-free diagnostic tool for nasal bone fractures. Although it offers advantages such as bedside availability and real-time assessment, current evidence indicates that its diagnostic accuracy remains inferior to that of CT scanning. Consequently, its use is not widely adopted as a definitive imaging modality in maxillofacial trauma evaluation [13]. Laboratory investigations are not routinely required in the assessment of isolated nasal fractures. However, they may be indicated in specific clinical contexts. A complete blood count and coagulation profile should be considered in patients presenting with significant epistaxis, substantial blood loss, or those with known coagulopathies or anticoagulant therapy. These tests assist in evaluating hemodynamic stability and identifying underlying hematological abnormalities that may complicate management. In cases where there is persistent clear

nasal discharge following trauma, further biochemical analysis is warranted to exclude cerebrospinal fluid (CSF) leakage. Fluid samples can be tested for the presence of β 2-transferrin or β -trace protein, both of which are highly specific markers for CSF. The identification of these proteins confirms the presence of a dural breach and necessitates prompt further investigation and specialist management due to the risk of intracranial infection and other serious complications.

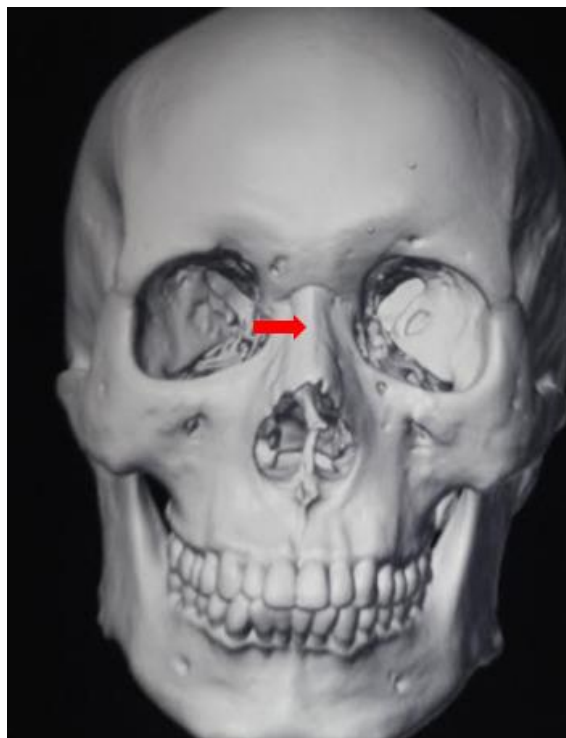


Fig. 4: Nasal bone.

Treatment / Management

The management of nasal fractures necessitates a structured and stepwise approach that begins with stabilization of acute complications and progresses toward restoration of both functional and anatomical integrity of the nasal framework. The initial phase of treatment is primarily directed toward the control of epistaxis and the prompt management of any associated cutaneous or mucosal lacerations. Hemorrhage control represents a critical priority in early intervention, as nasal trauma frequently disrupts the highly vascularized mucosal surfaces of the nasal cavity. Epistaxis in the context of nasal fractures is most commonly managed through conservative measures. Digital compression of the nasal alae, with concurrent pressure applied to the anterior septum, is typically sufficient to achieve hemostasis in many cases. This technique targets the Kiesselbach plexus, which represents the most frequent site of nasal bleeding due to its dense vascular anastomotic network. In situations where bleeding persists despite initial conservative measures, escalation of treatment

may be required. Chemical cauterization or thermal coagulation can be employed to achieve localized vessel occlusion. Additionally, anterior or posterior nasal packing may be utilized to provide mechanical tamponade and stabilize ongoing hemorrhage. In cases of severe or refractory epistaxis, more advanced interventions such as endoscopic ligation of the sphenopalatine or anterior ethmoidal arteries may be indicated. Alternatively, angiographic embolization offers a minimally invasive option for controlling life-threatening hemorrhage by selectively occluding the responsible vascular supply. Comprehensive management principles for epistaxis are further elaborated in dedicated clinical resources.

Following hemodynamic stabilization, the decision-making process regarding fracture management is guided by the presence or absence of functional impairment and cosmetic deformity. Patients who demonstrate no significant nasal obstruction or external deformity may be managed conservatively. Observation remains an appropriate strategy in such cases, with adjunctive supportive measures including head elevation to reduce edema and the application of cold compresses to limit inflammatory swelling. The dynamic nature of post-traumatic edema necessitates reassessment after several days, as nasal deviation or deformity may become more apparent once swelling subsides. For this reason, re-evaluation within 3 to 5 days is recommended to ensure accurate assessment of the final nasal contour [14]. When fractures result in functional compromise or aesthetic distortion, closed reduction of nasal bone and septal injuries is indicated. This procedure aims to restore anatomical alignment and preserve nasal airway function. Closed reduction may be performed under local anesthesia with or without sedation; however, general anesthesia is frequently preferred due to improved airway control, enhanced patient comfort, and optimal operative conditions for precise manipulation. From a surgical perspective, general anesthesia also minimizes patient movement and distress, thereby facilitating more accurate realignment of displaced nasal structures [10]. When local anesthesia is utilized, regional nerve blocks are employed to achieve adequate analgesia. These include infraorbital nerve blocks, dorsal nasal nerve blocks, and nasociliary nerve blocks, each targeting specific sensory distributions within the nasal and midfacial region. Care must be taken to avoid the use of epinephrine in this anatomical region due to the risk of vasospasm affecting the retinal circulation [15]. When combined with topical anesthetic agents such as lidocaine or cocaine applied via cotton pledgets, these techniques provide effective analgesia, with studies demonstrating comparable pain control between local and general anesthesia modalities [16].

The optimal timing for closed reduction remains a subject of clinical debate. Some practitioners advocate for early intervention within 5

to 7 days post-injury to minimize fibrous healing and facilitate easier repositioning of fractured segments. Others recommend delaying intervention until complete resolution of edema, typically within 1 to 2 weeks, to allow for more accurate assessment of the underlying deformity [10][11]. However, delayed intervention beyond two weeks has been associated with reduced patient satisfaction due to the increased likelihood of residual deformity and suboptimal cosmetic outcomes [17]. Delays in management also increase the risk of callus formation, which may impede successful realignment of bony fragments. In such scenarios, more invasive techniques such as endonasal or percutaneous osteotomies may be required to mobilize healed fracture segments. The use of computed tomography guidance to assist in osteotomy placement along established fracture lines has been described as an effective strategy for delayed or secondary correction, even months to years following the initial injury [18]. Closed reduction techniques typically involve the insertion of specialized instruments, such as Boies or Sayre elevators, into the nasal cavity to elevate and reposition displaced bony structures. Following reduction, an external nasal splint is applied to maintain alignment and provide structural support during the healing phase. Septal reduction can be performed using similar instruments, including Sayre elevators or Asch forceps, which allow for controlled medial repositioning of deviated septal cartilage. When closed techniques fail to achieve adequate correction of septal deviation or obstruction, early operative septoplasty may be considered, with evidence supporting improved functional outcomes in selected cases [19]. Post-reduction stabilization may include the use of intranasal splints or packing to maintain septal alignment. However, these adjuncts are generally reserved for cases in which septoplasty has been performed, as routine use following closed reduction is often unnecessary. Septoplasty in the acute setting is approached cautiously, particularly when there is extensive mucosal disruption, as this increases the risk of postoperative septal perforation [19]. When performed, septoplasty is typically approached via a hemitransfixion incision along the membranous septum, allowing access to the underlying cartilaginous and bony structures. Elevation of mucoperichondrial flaps enables exposure of fracture lines and facilitates selective removal of deviated segments while preserving critical structural components of the septum.

Reconstruction of the nasal septum, particularly within the structural L-strut, requires careful preservation of dorsal and caudal support to maintain nasal stability. Cartilage grafting techniques are frequently employed to reinforce weakened or fractured segments. Spreader grafts are positioned along the dorsal septum to restore internal nasal valve function, while septal batten or extension grafts provide support to the caudal septum [see Image.

Spreader Grafting]. In cases involving extensive comminution or loss of septal support, extracorporeal septoplasty may be required, wherein the septal cartilage is reconstructed outside the nasal cavity and subsequently reinserted [see Image. Extracorporeal Septal Reconstruction Using Native Quadrangular Cartilage]. These advanced reconstructive approaches are essential in restoring both functional airway patency and aesthetic nasal contour in complex trauma cases. Definitive reconstruction, such as open septorhinoplasty, is generally deferred in the acute phase due to the high risk of compromised tissue vascularity and infection. Early surgical manipulation of traumatized cartilage may lead to devascularization, increasing the likelihood of graft failure, resorption, or extrusion. For this reason, delayed septorhinoplasty, typically performed 3 to 6 months following the initial injury, is considered the preferred approach for comprehensive structural reconstruction [20].

Differential Diagnosis

The clinical evaluation of suspected nasal fractures requires careful exclusion of associated and more complex injuries involving the surrounding maxillofacial and cranial structures. Due to the central anatomical position of the nose within the facial skeleton and its close relationship with adjacent bony and soft tissue structures, isolated nasal fractures may be accompanied by more extensive injuries that significantly alter both management and prognosis. Therefore, a systematic approach to differential diagnosis is essential to ensure accurate identification of all associated injuries and to guide appropriate therapeutic intervention. One of the most important conditions to consider in the differential diagnosis is the naso-orbito-ethmoid (NOE) complex fracture. This injury represents a severe form of midfacial trauma in which the fracture extends posteriorly from the nasal bones into the ethmoid air cells and involves the medial orbital structures. A defining clinical feature of NOE fractures is traumatic telecanthus, characterized by an abnormal increase in the intercanthal distance due to disruption of the medial canthal tendon attachments. This finding is highly suggestive of structural instability within the medial orbital wall and should prompt further radiological evaluation to assess the full extent of injury. These fractures are frequently associated with high-energy trauma and are commonly observed in the context of Le Fort type III fractures, where extensive midfacial disjunction occurs. The involvement of multiple facial buttresses in these injuries reflects significant force transmission and necessitates a multidisciplinary approach to management [20][21].

Orbital fractures also represent a critical differential consideration in patients presenting with nasal trauma. Clinical signs such as periorbital edema and ecchymosis may indicate underlying orbital involvement, particularly when associated with

functional deficits. Orbital floor fractures, in particular, may result in sensory disturbances due to injury to the infraorbital nerve, leading to hypesthesia of the cheek, upper lip, and lateral nasal region. In addition, entrapment of extraocular muscles, most commonly the inferior rectus muscle, can result in restricted ocular motility, diplopia, and vertical gaze limitation. These functional impairments are clinically significant and require prompt identification to prevent long-term ocular complications. The presence of ocular symptoms in the context of nasal trauma should therefore raise strong suspicion for associated orbital fractures and necessitate urgent ophthalmological assessment. Another critical condition within the differential diagnosis is skull base fracture, which typically results from high-energy traumatic forces transmitted through the craniofacial skeleton. These injuries are often associated with significant morbidity due to their proximity to intracranial structures. Patients with skull base fractures may present with characteristic clinical signs, including bilateral periorbital ecchymosis, commonly referred to as "raccoon eyes," which reflects anterior cranial fossa involvement. Additionally, postauricular ecchymosis, known as "Battle sign," may be observed in cases involving the middle cranial fossa and mastoid region. These external manifestations are important diagnostic indicators of underlying basilar skull injury and should prompt immediate further investigation [21].

Skull base fractures are clinically significant not only due to their structural implications but also because of their association with serious complications. Patients are at increased risk of cerebrospinal fluid (CSF) leakage due to dural tears, which may present as clear rhinorrhea or otorrhea. The presence of a CSF leak significantly increases the risk of intracranial infection, including meningitis. Furthermore, these patients may have concomitant spinal injuries due to the high-energy mechanisms typically involved, necessitating a comprehensive trauma evaluation to exclude associated vertebral fractures. In summary, the differential diagnosis of nasal fractures extends beyond isolated nasal bone injury and encompasses a spectrum of complex facial and cranial fractures. Conditions such as naso-orbito-ethmoid fractures, orbital fractures, and skull base fractures must be carefully considered and systematically excluded. Accurate differentiation is essential, as these injuries carry distinct clinical implications and require specialized management strategies. Early recognition through thorough clinical examination and appropriate imaging is critical in reducing the risk of missed diagnoses and optimizing patient outcomes in maxillofacial trauma care [20][21].

Prognosis

The overall prognosis of nasal fractures is generally favorable, particularly when timely and appropriate management is implemented. Most patients achieve satisfactory functional recovery following reduction of nasal bone and septal injuries, with restoration of adequate airway patency and acceptable cosmetic outcomes. However, the degree of success following surgical or non-surgical intervention is variable and depends on multiple factors, including the severity of the initial trauma, the presence of associated septal injury, the timing of intervention, and the precision of fracture reduction. Despite generally positive outcomes, residual nasal deformity remains a relatively common complication following closed reduction procedures. Reported rates of persistent deformity vary widely in the literature, ranging from approximately 9% to as high as 50% of cases [14][20][21][22]. This variability reflects differences in injury severity, patient selection, timing of intervention, and surgical technique. In many cases, subtle asymmetry, dorsal irregularities, or septal deviation may persist despite technically successful reduction, highlighting the inherent limitations of closed management in complex nasal injuries. The prognosis is significantly influenced by early and accurate management of associated nasal septal fractures or deviations. Prompt recognition and appropriate treatment of septal injuries at the time of initial trauma are associated with improved functional and aesthetic outcomes [2]. Failure to address septal instability in the acute phase may result in long-term structural compromise, leading to chronic nasal obstruction, septal deviation, or external nasal deformity. Consequently, early intervention plays a critical role in optimizing long-term results and minimizing the need for secondary corrective procedures.

In cases where residual deformity or persistent nasal obstruction occurs, secondary surgical intervention such as septorhinoplasty may be required. These reconstructive procedures aim to restore both form and function by correcting structural abnormalities of the nasal framework. The necessity for revision surgery is influenced by several factors, including the severity of the initial deformity and whether pre-existing nasal abnormalities were present prior to injury. Patients with baseline nasal deviation or obstruction prior to fracture are more likely to require subsequent corrective surgery, as trauma may exacerbate underlying anatomical irregularities [23]. From a clinical perspective, the decision-making process regarding definitive surgical intervention is also influenced by patient activity level and risk of reinjury. In individuals engaged in high-risk activities, such as contact or combat sports, surgeons often exercise caution when considering early open rhinoplasty. In such cases, surgical correction is typically deferred until the patient has discontinued participation in these activities. This conservative approach is intended to reduce the risk of recurrent

nasal trauma, which could compromise surgical outcomes and necessitate further revision procedures. Delaying definitive reconstruction allows for stabilization of nasal tissues and reduces the likelihood of graft displacement, structural failure, or recurrent deformity. In summary, while nasal fractures generally have a good prognosis with appropriate management, outcomes are not uniformly predictable. Residual deformity and functional impairment remain significant considerations, particularly in cases involving septal injury or delayed treatment. The need for revision surgery is not uncommon and is influenced by both injury-related and patient-related factors. Careful assessment, timely intervention, and individualized treatment planning are essential to achieving optimal long-term functional and aesthetic outcomes in patients with nasal fractures.

Complications

Complications following nasal bone and septal fractures represent a significant clinical concern due to the complex anatomical structure of the nasal framework and its critical role in both functional respiration and facial aesthetics. Despite appropriate reduction and management, residual nasal deformity remains one of the most frequently encountered sequelae. The degree of deformity varies widely among patients and may manifest as subtle asymmetry, persistent deviation of the nasal dorsum, or more pronounced structural collapse. These outcomes are influenced by the severity of the initial injury, the precision of fracture reduction, and the presence of associated septal damage. Even with optimal intervention, complete restoration of pre-injury nasal architecture is not always achievable, underscoring the inherent limitations of fracture management in this anatomically intricate region. Among the more functionally significant complications, saddle nose deformity and septal perforation are particularly notable. These conditions may arise as direct consequences of traumatic septal injury, septal hematoma formation, or iatrogenic damage during surgical intervention such as septoplasty. Saddle nose deformity results from structural collapse of the cartilaginous support system, leading to loss of dorsal nasal height. Septal perforation, on the other hand, may result from ischemic necrosis of the septal cartilage following untreated hematoma or extensive mucoperichondrial disruption. Both conditions may coexist and contribute to long-term functional and aesthetic impairment [23].

Olfactory dysfunction is another important complication, occurring in approximately one-third of patients sustaining nasal bone fractures. This impairment may present as hyposmia or anosmia and is often related to trauma involving the olfactory neuroepithelium located in the superior nasal septum and superior or supreme turbinates [24]. In some cases, olfactory disturbances may also result from surgical manipulation or postoperative scarring affecting the olfactory pathways. Although some patients

experience partial recovery over time, persistent dysfunction may significantly impact quality of life. Management of septal hematoma is critical in preventing long-term complications. Septal hematomas typically result from trauma, including direct nasal injury or iatrogenic causes during nasoseptal procedures, although spontaneous occurrence may be seen in patients with underlying bleeding disorders. Early identification and prompt intervention are essential, as delayed treatment allows the accumulation of blood to clot, complicating evacuation and increasing the risk of adverse outcomes [25]. If left untreated, septal hematomas can rapidly progress to cartilage necrosis due to pressure-induced ischemia, often within 24 hours. In addition, secondary infection may develop within 72 hours, particularly when mucosal integrity is compromised, allowing bacterial invasion from nasal flora. The progression of untreated hematoma to abscess formation significantly increases the risk of permanent structural damage, including septal perforation and saddle nose deformity [12]. Therapeutic management of septal hematoma requires timely surgical drainage under appropriate anesthesia. Local anesthesia using topical agents such as lidocaine or cocaine, supplemented by infiltrative anesthesia when necessary, is commonly employed. In pediatric or uncooperative patients, general anesthesia may be required. Visualization of the hematoma is achieved using nasal speculums or endoscopic assistance. Smaller collections may be effectively treated by needle aspiration, particularly when intervention occurs early before clot organization. Larger or organized hematomas necessitate incision and drainage, typically via a horizontal approach along the most fluctuant area. In some cases, partial excision of mucoperichondrium is performed to prevent premature closure and reaccumulation of blood. Post-drainage management often includes placement of drains, splints, or quilting sutures to eliminate dead space and prevent recurrence. Care must be taken in bilateral cases to avoid overlapping incisions, which may result in full-thickness septal defects and subsequent perforation.

Septal perforation represents a challenging complication with a broad spectrum of clinical presentations. Small perforations may remain asymptomatic, whereas larger defects can lead to significant morbidity. Symptoms commonly include nasal crusting, recurrent epistaxis, nasal obstruction, and whistling during respiration, with smaller perforations more frequently associated with audible airflow disturbances. The management approach is determined by defect size and symptom severity. Perforations measuring up to 1 to 1.5 cm may be amenable to closure using local flaps combined with interposition grafts composed of cartilage, fascia, or synthetic materials [26][27][28]. Larger perforations

often require more complex reconstructive strategies, including obturator placement or regional and free flap techniques such as inferior turbinate flaps, facial artery musculomucosal flaps, pericranial flaps, or radial forearm free tissue transfer [29][30][31][32]. Saddle nose deformity represents another significant long-term complication resulting from collapse of the quadrangular cartilage and loss of dorsal nasal support. This deformity is characterized by a concave depression between the nasal root and tip, resulting in both functional and aesthetic impairment [33]. Structural collapse of the upper lateral cartilages contributes to narrowing of the internal nasal valves, which are critical regions for airflow resistance regulation. Consequently, patients may present with both cosmetic deformity and clinically significant nasal obstruction. Mild deformities may be corrected using onlay grafts or minimally invasive techniques such as crushed cartilage or dermal fillers [34][33][35]. In contrast, severe deformities require comprehensive reconstructive procedures aimed at restoring the structural integrity of the nasal framework. These may include extracorporeal septoplasty with reconstruction of the L-strut, particularly in cases with extensive septal destruction.

In advanced cases where native septal cartilage is insufficient due to prior trauma or surgery, alternative graft sources such as costal cartilage or calvarial bone are utilized. Costal cartilage provides robust structural support but may be associated with warping, whereas split calvarial bone grafts offer rigid dorsal reconstruction and can be used to reestablish nasal projection while supporting the upper lateral cartilages [36][37]. These reconstructive strategies highlight the complexity of managing post-traumatic nasal complications and emphasize the importance of individualized surgical planning to achieve both functional restoration and aesthetic balance.

Postoperative and Rehabilitation Care

Postoperative management following nasal bone and septal fracture reduction is a critical determinant of long-term functional and aesthetic outcomes. After surgical or closed reduction procedures, external and internal nasal splints are commonly applied to maintain structural alignment and stabilize the nasal framework during the early phases of healing. These splints are typically removed within 1 to 2 weeks, depending on the extent of injury and the stability of the reduction. Their removal marks an important stage in recovery, as it allows reassessment of nasal contour and airway function. In cases where nasal packing is utilized to control bleeding or support septal alignment, prophylactic oral antibiotics are frequently prescribed to reduce the risk of infectious complications, including toxic shock syndrome. However, the routine use of antibiotics in this context remains a subject of clinical debate, with differing opinions regarding their necessity in

uncomplicated cases [38]. Postoperative care also includes strict avoidance of strenuous physical activity or any form of exertion that may increase the risk of reinjury or disrupt the healing nasal structures. Patients are advised to refrain from contact sports, heavy lifting, and activities that could expose the nose to trauma during the acute healing phase. Maintaining adequate intranasal moisture is essential for optimal mucosal recovery. Nasal saline sprays are commonly recommended to prevent crusting, reduce irritation, and promote epithelial healing within the nasal cavity. In addition, close clinical follow-up is required to monitor healing progress and identify early signs of complications such as persistent deformity, septal deviation, or nasal obstruction. In some cases, secondary or revision surgical intervention may be necessary if functional or cosmetic outcomes are suboptimal. Comprehensive postoperative rehabilitation therefore plays a fundamental role in ensuring long-term success following nasal fracture management [38].

Consultations

The management of nasal bone and septal fractures often requires a multidisciplinary approach to ensure optimal patient outcomes. Early involvement of specialists with expertise in facial trauma is essential, particularly in cases involving complex fractures or associated facial injuries. Otolaryngologists, oral and maxillofacial surgeons, and plastic surgeons are the primary specialists responsible for the evaluation and treatment of these injuries due to their advanced understanding of nasal anatomy and reconstructive techniques. Early consultation with these specialists facilitates accurate diagnosis, appropriate classification of injury severity, and timely intervention. In addition, their involvement is crucial in determining the most suitable treatment modality, whether conservative management, closed reduction, or surgical reconstruction. Early specialist input also reduces the likelihood of missed injuries, particularly septal hematomas or complex midfacial fractures that may not be immediately apparent during initial assessment. In emergency settings, timely referral from emergency physicians or primary care providers to facial trauma specialists is a key component of effective patient care. Early interdisciplinary communication ensures that patients receive appropriate management during the critical early stages following injury, thereby improving both functional and aesthetic outcomes. Furthermore, coordinated care between specialties supports long-term follow-up and facilitates decision-making regarding potential secondary corrective procedures when necessary [38][39].

Patient Education

Preventive strategies for nasal fractures are fundamentally aligned with broader principles of facial trauma prevention and focus on minimizing exposure to high-risk environments and activities. The use of seat belts in motor vehicles remains one of the

most effective measures in reducing facial injuries during collisions. Similarly, the use of protective helmets with facial shields is strongly recommended for individuals engaged in high-speed or high-risk activities such as motorcycling, skiing, and cycling, as these devices significantly reduce the incidence and severity of facial trauma. In sports-related settings, the use of appropriate facial protective equipment is essential, particularly in contact and ball-related sports. Although many sports such as rugby, cricket, baseball, basketball, and soccer do not universally mandate facial protection, they are consistently associated with a high incidence of nasal fractures [39][40][41]. Increased awareness and adoption of protective gear in these activities can substantially reduce injury rates. Behavioral modification also plays a significant role in injury prevention. Avoidance of interpersonal violence and reduction of alcohol consumption are important strategies, as intoxication is frequently associated with both aggressive behavior and accidental falls [42]. In older adults, ground-level falls represent a major cause of nasal fractures. Preventive measures in this population include environmental modifications such as removal of tripping hazards, improved home lighting, and careful selection of medications that minimize side effects such as dizziness, hypotension, and impaired balance [43]. Patient education following nasal fracture is equally important in preventing long-term complications and ensuring realistic expectations. Patients should be informed about the potential for residual deformity or persistent nasal obstruction even after successful reduction. Clear communication regarding treatment limitations and expected outcomes helps improve satisfaction and adherence to postoperative instructions. Additionally, timing of intervention is critical, as reduction should ideally be performed once acute edema has subsided, allowing for more accurate assessment and correction of underlying structural deviation.

Pearls and Other Issues

Several key clinical principles are essential in the evaluation and management of nasal bone and septal fractures. Nasal bones are recognized as the most frequently fractured structures within the maxillofacial skeleton due to their prominent anatomical position and relative fragility. A significant proportion of patients with nasal bone fractures also sustain concomitant septal injuries, which may be overlooked unless specifically assessed during clinical examination. Failure to identify septal involvement can lead to long-term complications, including nasal obstruction and deformity. Routine imaging is not indicated in isolated nasal bone fractures unless there is suspicion of more extensive facial or cranial injury based on clinical findings. Overuse of imaging in uncomplicated cases should be avoided to reduce unnecessary radiation exposure and healthcare costs. Closed reduction of nasal fractures yields optimal cosmetic outcomes when performed within two weeks

of injury. However, delaying intervention for several days, typically 3 to 5 days, may be beneficial to allow reduction of edema and improved visualization of deformity. In selected cases, acute septoplasty may be performed for severe septal deviation or fracture, provided there is no significant mucosal disruption. This approach can improve both airway function and structural alignment when appropriately indicated. Definitive reconstructive procedures, such as septorhinoplasty for persistent deformity or obstruction, should be delayed for 3 to 6 months following injury. This delay allows adequate tissue healing and stabilization of nasal structures, thereby improving surgical outcomes [40][41].

Enhancing Healthcare Team Outcomes

Nasal bone fractures represent common traumatic injuries with the potential for long-term functional and aesthetic consequences if not appropriately managed. Optimal outcomes are achieved through a coordinated, multidisciplinary approach involving emergency physicians, primary care providers, and specialists in facial trauma. Initial recognition of injury severity and early referral to experienced surgeons are critical steps in the management pathway. Emergency and primary care clinicians play a pivotal role as the first point of contact for patients with nasal trauma. Their ability to identify concerning clinical features, such as septal hematoma, significant deformity, or signs of associated facial fractures, directly influences the speed and accuracy of specialist referral. Early communication with otolaryngology, oral and maxillofacial surgery, or plastic surgery teams ensures timely intervention, which is associated with improved functional and cosmetic outcomes. Early closed reduction performed by trained specialists can reduce the likelihood of long-term complications and may prevent the need for more extensive reconstructive procedures. Furthermore, coordinated follow-up care among healthcare professionals allows for ongoing assessment of healing, early detection of complications, and timely planning of revision surgery when necessary. This collaborative model of care enhances patient outcomes by integrating acute management with long-term reconstructive planning and rehabilitation [40].

Conclusion:

Nasal septal fractures represent frequent but clinically significant injuries that require structured assessment and coordinated management. Their impact extends beyond cosmetic deformity to include airway obstruction and long-term functional impairment. Early recognition of associated injuries such as septal hematoma, orbital trauma, or skull base involvement is essential to prevent complications and reduce morbidity. Clinical outcomes depend on timely diagnosis, appropriate selection of imaging, and accurate classification of fracture severity. Closed

reduction remains the mainstay of treatment in uncomplicated cases, while delayed reconstructive procedures are required for persistent deformity or functional deficit. The timing of intervention plays a critical role in determining both cosmetic and functional results. A multidisciplinary healthcare approach enhances patient care by integrating emergency services, surgical expertise, nursing support, laboratory diagnostics, and rehabilitation planning. Preventive strategies and patient education further reduce recurrence and improve recovery outcomes. Overall, optimal management relies on early intervention, structured follow-up, and individualized treatment planning to achieve functional restoration and facial symmetry.

References:

1. Rhee SC, Kim YK, Cha JH, Kang SR, Park HS. Septal fracture in simple nasal bone fracture. *Plast Reconstr Surg.* 2004 Jan;113(1):45-52.
2. Arnold MA, Yanik SC, Suryadevara AC. Septal fractures predict poor outcomes after closed nasal reduction: Retrospective review and survey. *Laryngoscope.* 2019 Aug;129(8):1784-1790.
3. Oneal RM, Beil RJ. Surgical anatomy of the nose. *Clin Plast Surg.* 2010 Apr;37(2):191-211.
4. Hwang K, Ki SJ, Ko SH. Etiology of Nasal Bone Fractures. *J Craniofac Surg.* 2017 May;28(3):785-788.
5. Desrosiers AE, Thaller SR. Pediatric nasal fractures: evaluation and management. *J Craniofac Surg.* 2011 Jul;22(4):1327-9.
6. Yu H, Jeon M, Kim Y, Choi Y. Epidemiology of violence in pediatric and adolescent nasal fracture compared with adult nasal fracture: An 8-year study. *Arch Craniofac Surg.* 2019 Aug;20(4):228-232.
7. VandeGriend ZP, Hashemi A, Shkoukani M. Changing trends in adult facial trauma epidemiology. *J Craniofac Surg.* 2015 Jan;26(1):108-12.
8. Stranc MF, Robertson GA. A classification of injuries of the nasal skeleton. *Ann Plast Surg.* 1979 Jun;2(6):468-74.
9. Lu GN, Humphrey CD, Kriet JD. Correction of Nasal Fractures. *Facial Plast Surg Clin North Am.* 2017 Nov;25(4):537-546.
10. Fattahi T, Salman S. Management of Nasal Fractures. *Atlas Oral Maxillofac Surg Clin North Am.* 2019 Sep;27(2):93-98.
11. Hoffmann JF. An Algorithm for the Initial Management of Nasal Trauma. *Facial Plast Surg.* 2015 Jun;31(3):183-93.
12. Sanyaolu LN, Farmer SE, Cuddihy PJ. Nasal septal haematoma. *BMJ.* 2014 Nov 04;349:g6075.
13. Lee IS, Lee JH, Woo CK, Kim HJ, Sol YL, Song JW, Cho KS. Ultrasonography in the diagnosis of

- nasal bone fractures: a comparison with conventional radiography and computed tomography. *Eur Arch Otorhinolaryngol.* 2016 Feb;273(2):413-8.
14. Rohrich RJ, Adams WP. Nasal fracture management: minimizing secondary nasal deformities. *Plast Reconstr Surg.* 2000 Aug;106(2):266-73.
 15. Zide BM, Swift R. How to block and tackle the face. *Plast Reconstr Surg.* 1998 Mar;101(3):840-51.
 16. Jana S, Guha R, De KS, Adhikari B, Das P. Nasal Bone Fracture Reduction Under Local Anaesthesia: A Holistic Approach to Nasal Blocks and a Comparison with General Anaesthesia. *Indian J Otolaryngol Head Neck Surg.* 2024 Feb;76(1):358-364.
 17. Sharma SD, Kwame I, Almeyda J. Patient aesthetic satisfaction with timing of nasal fracture manipulation. *Surg Res Pract.* 2014;2014:238520.
 18. Wick EH, Whipple ME, Hohman MH, Moe KS. Computer-Aided Rhinoplasty Using a Novel "navigated" Nasal Osteotomy Technique: A Pilot Study. *Ann Otol Rhinol Laryngol.* 2021 Oct;130(10):1148-1155.
 19. Younes A, Elzayat S. The role of septoplasty in the management of nasal septum fracture: a randomized quality of life study. *Int J Oral Maxillofac Surg.* 2016 Nov;45(11):1430-1434.
 20. Wang W, Lee T, Kohlert S, Kadakia S, Ducic Y. Nasal Fractures: The Role of Primary Reduction and Secondary Revision. *Facial Plast Surg.* 2019 Dec;35(6):590-601.
 21. James JG, Izam AS, Nabil S, Rahman NA, Ramli R. Closed and Open Reduction of Nasal Fractures. *J Craniofac Surg.* 2020 Jan/Feb;31(1):e22-e26.
 22. Basheeth N, Donnelly M, David S, Munish S. Acute nasal fracture management: A prospective study and literature review. *Laryngoscope.* 2015 Dec;125(12):2677-84.
 23. Li K, Moubayed SP, Spataro E, Most SP. Risk Factors for Corrective Septorhinoplasty Associated With Initial Treatment of Isolated Nasal Fracture. *JAMA Facial Plast Surg.* 2018 Dec 01;20(6):460-467.
 24. Hwang K, Yeom SH, Hwang SH. Complications of Nasal Bone Fractures. *J Craniofac Surg.* 2017 May;28(3):803-805.
 25. Kass JI, Ferguson BJ. Videos in clinical medicine. Treatment of hematoma of the nasal septum. *N Engl J Med.* 2015 May 28;372(22):e28.
 26. Pedroza F, Patrocinio LG, Arevalo O. A review of 25-year experience of nasal septal perforation repair. *Arch Facial Plast Surg.* 2007 Jan-Feb;9(1):12-8.
 27. Kridel RWH, Delaney SW. Discussion: Acellular Human Dermal Allograft as a Graft for Nasal Septal Perforation Reconstruction. *Plast Reconstr Surg.* 2018 Jun;141(6):1525-1527.
 28. Ozturan O, Yenigun A, Senturk E, Eren SB, Aksoy F. Endoscopic Endonasal Repair of Septal Perforation with Interpositional Auricular Cartilage Grafting via a Mucosal Regeneration Technique. *Otolaryngol Head Neck Surg.* 2016 Oct;155(4):714-7.
 29. Xu M, He Y, Bai X. Effect of Temporal Fascia and Pedicle Inferior Turbinate Mucosal Flap on Repair of Large Nasal Septal Perforation via Endoscopic Surgery. *ORL J Otorhinolaryngol Relat Spec.* 2016;78(6):303-307.
 30. Waters CM, Zanation AM, Thorp BD, Shockley WW, Clark JM. Repair of Septal Perforation with Endoscopic-Assisted Pericranial Flap Harvest and Open Rhinoplasty Approach. *Facial Plast Surg Aesthet Med.* 2020 May/June;22(3):225-226.
 31. Heller JB, Gabbay JS, Trussler A, Heller MM, Bradley JP. Repair of large nasal septal perforations using facial artery musculomucosal (FAMM) flap. *Ann Plast Surg.* 2005 Nov;55(5):456-9.
 32. Mobley SR, Boyd JB, Astor FC. Repair of a large septal perforation with a radial forearm free flap: brief report of a case. *Ear Nose Throat J.* 2001 Aug;80(8):512.
 33. Gadkaree SK, Weitzman RE, Fuller JC, Justicz N, Gliklich RE. Review of literature of saddle nose deformity reconstruction and presentation of vomer onlay graft. *Laryngoscope Investig Otolaryngol.* 2020 Dec;5(6):1039-1043.
 34. Kim DW, Toriumi DM. Management of posttraumatic nasal deformities: the crooked nose and the saddle nose. *Facial Plast Surg Clin North Am.* 2004 Feb;12(1):111-32.
 35. Gurlek A, Askar I, Bilen BT, Aydogan H, Fariz A, Alaybeyoglu N. The use of lower turbinate bone grafts in the treatment of saddle nose deformities. *Aesthetic Plast Surg.* 2002 Nov-Dec;26(6):407-12.
 36. Cheney ML, Gliklich RE. The use of calvarial bone in nasal reconstruction. *Arch Otolaryngol Head Neck Surg.* 1995 Jun;121(6):643-8.
 37. Furlan S. Correction of saddle nose deformities by costal cartilage grafts--a technique. *Ann Plast Surg.* 1982 Jul;9(1):32-5.
 38. Ishii LE, Tollefson TT, Basura GJ, Rosenfeld RM, Abramson PJ, Chalet SR, Davis KS, Doghramji K, Farrior EH, Finestone SA, Ishman SL, Murphy RX, Park JG, Setzen M, Strike DJ, Walsh SA, Warner JP, Nnacheta LC. Clinical Practice Guideline: Improving Nasal Form and Function after Rhinoplasty Executive Summary. *Otolaryngol Head Neck Surg.* 2017 Feb;156(2):205-219.
 39. Hwang K, Kim JH. Effect of Restraining Devices on Facial Fractures in Motor Vehicle Collisions. *J Craniofac Surg.* 2015 Sep;26(6):e525-7.

40. Perkins CS, Layton SA. The aetiology of maxillofacial injuries and the seat belt law. *Br J Oral Maxillofac Surg.* 1988 Oct;26(5):353-63.
 41. Manninen IK, Klockars T, Mäkinen LK, Blomgren K. Epidemiology and aetiology of sport-related nasal fractures: Analysis of 599 Finnish patients. *Clin Otolaryngol.* 2023 Jan;48(1):70-74.
 42. Lee K, Olsen J, Sun J, Chandu A. Alcohol-involved maxillofacial fractures. *Aust Dent J.* 2017 Jun;62(2):180-185.
- Clyburn TA, Heydemann JA. Fall prevention in the elderly: analysis and comprehensive review of methods used in the hospital and in the home. *J Am Acad Orthop Surg.* 2011 Jul;19(7):402-9.