A stepwise approach for the management of nasal bone fractures

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Abstract: This study introduces a novel nasal bone fracture classification system, presents a simple and clear algorithm for the management of nasal bone fracture, and evaluates the effectiveness of minimally invasive techniques for managing nasal bone fractures. Details were recorded for patients diagnosed with nasal fracture (n=240) and they were classified as: type I, closed, simple nasal bone fracture (unilateral and bilateral); type II, closed comminuted nasal bone fracture (unilateral and bilateral); type III, complex nasal bone fracture (with naso-orbito-ethmoidal fractures); and type IV, open nasal bone fracture (with external nasal skin lacerations). Three surgical techniques were used: closed reduction), open reduction, and transnasal fixation. Closed reduction was used for patients with closed simple fractures and closed unilateral comminuted fractures with good nasal contour (88.9%), percutaneous transnasal fixation was used for patients presenting with closed bilateral comminuted nasal bone fractures with good results (84.8%), and open reduction with direct fixation was used for patients with complex nasal fractures and patients with open fractures with good results (88.7%). Appropriate assessment and reduction of the nasal fracture is essential for optimal treatment. Thus, it is mandatory to determine the appropriate surgical technique based on the type of nasal fracture.
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Abbreviation: closed reduction (CR), open reduction (OR), transnasal fixation (TNF), and naso-orbito-ethmoidal (NOE)

1. Introduction

Nasal fractures represent approximately 40% of all facial fractures[1]. A nasal bone fracture may be unilateral or bilateral, simple or comminuted, and may also extend to involve the naso-orbito-ethmoidal (NOE) area or be associated with other facial fractures[2]. Diagnosis of a nasal fracture depends on the history of trauma; the results of an examination of the external nasal structure looking for depression, asymmetry, deviation, protuberances, or step-off deformities; examination of the intranasal structures to exclude any septal injuries; septal hematoma or airway obstruction; and radiological investigations, such as X-ray or CT scans, to assist in accurate diagnosis and to exclude or confirm the presence of any associated bony fractures[3]. Nasal fractures can be treated either immediately or after all the edema present has resolved, which may take 5–7 days and may extend to 2–3 weeks before significant healing occurs[4]. Treatment of such fractures ranges from using a simple, closed reduction technique to aggressive open reduction and internal fixation techniques[5]. Closed reduction is simple, easy, and can be performed under local anesthesia; however, accurate contouring may not be obtained, leading to posttraumatic nasal deformity that is difficult to correct. More aggressive, open reduction techniques were adopted to treat such fractures and avoid potential nasal deformity. However, if these aggressive reduction techniques were used regardless of fracture severity, patients could be overtreated from the perspectives of operative extent, time, and expense.

To avoid the malcorrection using the closed method and unneeded overtreatment using the open method, a transnasal fixation technique has been introduced as a minimally invasive technique for the treatment of such cases. Therefore, to determine the optimal treatment approach for nasal fracture, it is essential to determine the best reduction technique based on the pattern of fracture in each individual case[6].

The objectives of this study were to introduce a novel classification of nasal bone fractures, demonstrate a simple clear algorithm for the management of nasal bone fracture, and evaluate the effectiveness of minimally invasive techniques in the management of nasal bone fractures.

2. Materials and Methods

This study was conducted from March 2010 to January 2014 at two separate maxillofacial surgery units. This study was approved by the local Institutional Human Research and Ethics Committee

at each facility. Prior to study participation and surgery, written informed consent was provided by the patient if they were an adult or by the patient's parent or guardian if they were <18 years old.

The study included 240 patients who were diagnosed with nasal fracture. The following patient details were recorded: age, sex, cause of trauma, clinical presentation, type of fracture, associated injuries, the results of imaging studies (plain and CT radiological examinations), surgical procedures, operative data, patient follow-up, and any complications.

Based on the data collected, patients were classified as follows: Type I, closed simple nasal bone fracture (n=110), including patients with unilateral (n=56) or bilateral (n=74) lateralization or depression of the nasal bone that was not associated with overlying skin lacerations; Type II, closed comminuted nasal bone fracture (n=68), including patients with unilateral (n=35) or bilateral (n=33) comminuted nasal bone fracture that was not associated with overlying skin lacerations; Type III, complex nasal bone fracture (n=45), including patients with nasal bone fractures that extended to involve the NOE area but was not associated with overlying skin lacerations; and Type IV, patients with open nasal bone fracture (n=17), including any fracture that was associated with overlying skin lacerations.

Surgical techniques

Closed reduction

With this method, the fracture was reduced using Asch and Walsham forceps or with a periosteal elevator (Fig. 1). This change was aided by digital manipulation of the nasal bones. The septum was also evaluated and corrected as needed. Nasal packing may be used to prevent collapse and to control bleeding. An external nasal splint may be used to protect the reduced bones.

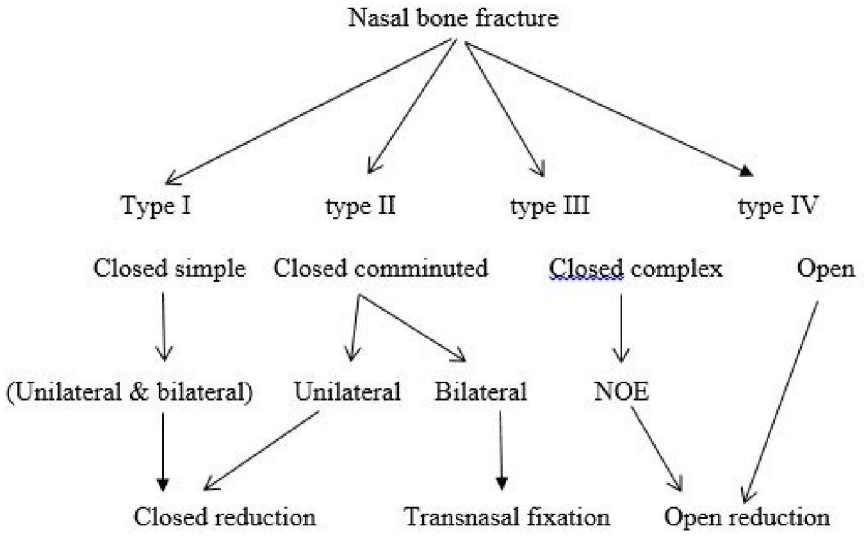
Open reduction

With this method, the fracture lines were exposed and directly reduced and fixed using plates and screws or by wires (Fig. 2) using a variety of approaches, such as a Lynch incision, open sky approach, coronal incision, or through existing lacerations.

Transnasal fixation[8]

The first step with this method was performing a closed reduction of the fractured nasal bone (Fig. 3). An 18 gauge needle was passed through the comminuted bone or through a hole drilled in the bone. A 26 gauge wire was passed through the lumen of the needle, and then the needle was withdrawn, leaving the wire in position. The wire was passed through two points: the root of the nose and an inferior point, depending on the support needed. A 5–7 mm portion of the needle cap or a small catheter was cut and used to support the reduced fracture segment on both the sides of the nasal region. The wire was tightened, but not too hard, to avoid pressure necrosis. This horizontal mattress fashioned of wiring with the rigid needle cap was used to maintain the contour and the projection of the nasal bridge.

Patients were treated according to the following algorithm, including CR, OR, and transnasal fixation.



All surgical procedures were performed under general anesthesia.

Type I: Both the unilateral and bilateral cases were treated by closed reduction.

Type II: All unilateral cases were treated by closed reduction. For bilateral cases, closed reduction alone was not sufficient to obtain a stable reduction; hence, transnasal fixation was used to obtain better results.

Type III: For cases associated with NOE fractures, closed reduction failed to provide satisfactory results for the first six cases; hence, these cases and the subsequent cases were treated using open reduction and direct fixation through a Lynch approach.

Type IV: Open nasal bone fractures were treated using open reduction and direct fixation through the skin lacerations.

3. Results

From March 2010 to January 2014, 240 consecutive patients with nasal bone fractures were treated. The study included 197 males (82.5%) and 52 females (21.5%). Their ages ranged from 6–70 years. The patients were assigned to one of the four groups according to their fracture type (Table 1). With Type I cases, both unilateral and bilateral cases were treated using the closed reduction technique. Good contours were obtained for 98 patients (89%). A major deformity was present in two patients and a minor deformity in 10 patients. Overall post-operative patient satisfaction was 98%.

Among the Type II cases (n=68), there were 35 unilateral and 33 bilateral cases. All the unilateral cases were treated by closed reduction with good and stable reduction. Good contour was obtained with 31/35 patients (88%). The remaining patients showed minor nasal deformity that was acceptable to the patients; hence, no further intervention was required. For the bilateral cases, closed reduction alone was not sufficient to obtain an intraoperative stable reduction; hence, percutaneous transnasal fixation was used to obtain a stable reduction and 29/33 patients (87.8%) showed good contour. Three patients had a minor deformity that was accepted by the patients. Only one patient in this group showed a major deformity in the form of persistent lateral nasal deviation. This patient underwent rhinoplasty 6 months later.

There were 45 cases with a Type III complex nasal bone fracture. Closed reduction with percutaneous transnasal fixation was attempted on six patients; however, all the patients showed collapse and major deformity with telecanthus 6 days after the operation when the transnasal wires were removed. All these patients underwent open reduction with direct fixation through a Lynch approach. Overall, 42 patients achieved good satisfactory results, whereas three patients had an ugly scar.

There were 17 Type IV cases with an open nasal bone fracture and skin lacerations over the fracture. Direct fixation was performed regardless of whether the fracture was unilateral or bilateral or whether or not it was comminuted. Good satisfactory results were obtained in 14/17 cases (82%). Two patients suffered an infection, whereas one patient had an ugly scar.

According to our algorithm, the following techniques were utilized. Closed reduction was used to treat patients with closed, simple nasal bone fractures (n=110, unilateral and bilateral) and closed, comminuted unilateral nasal bone fractures (n=35). Among the 145 patients who were treated with this technique, 129 (88.9%) showed good nasal contour, 14 (9.6%) had a minor deformity that they found acceptable, and only two (1.3%) had a major deformity. Percutaneous transnasal fixation was used to treat 33 patients who presented with closed, bilateral comminuted nasal bone fractures. Good results were obtained with 28 patients (84.8%), a minor deformity with four patients (12%), and only one patient (3%) had a major deformity. The technique of open reduction and direct fixation was used to treat patients with complex nasal bone fractures and patients with open fractures. Among the 62 patients treated with this technique, 45 had complex nasal fractures treated through a Lynch approach, whereas 17 had open fractures that were treated through the skin lacerations. Fifty-five patients (88.7%) hada good contour; 3 patients (5.4%) had an infection, and 4 patients (7.2%) had an ugly scar. Table 2.

Table 1: classification of nasal bone fractures.

Types	Type and description
Type I	Closed simple (unilateral and bilateral): lateralization or lateralization and depression of the nasal bone that was not associated with overlying skin lacerations.
Type II	Closed comminuted (unilateral and bilateral): comminuted nasal bone fractures that were not associated with overlying skin lacerations.
Type III	Closed complex: nasal bone fractures that extend to involve the naso-orbito-ethmoidal area but not associated with overlying skin lacerations.
Type VI	Any type that associated with overlying skin lacerations.

Table 2: results according to the treatment line.

Type of fracture	Number of patients	Line of treatment	Post-operative good nasal contour	Major deformity needing corrective rhinoplasty	Minor deformity accepted by the patient	Infection	Ugly scar	Overall patient satisfaction
I	110	CR	98	2	10			98%
II unilateral	35	CR	31	-	4			88.5%
II bilateral	33	TNF	29	1	3			96.9%
III	45	OR	42			-	3	93.3%
IV	17	OR	14			1	2	82.3%

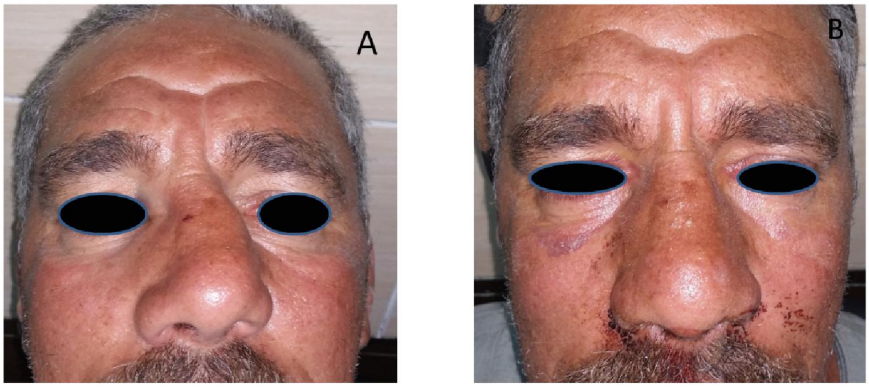


Fig. 1. A 46-year-old male with type I nasal fracture treated by closed reduction. (A) Pre-operative clinical photograph. (B) Post-operative clinical photograph. There were no postoperative complications and the patient showed satisfaction at follow-up.

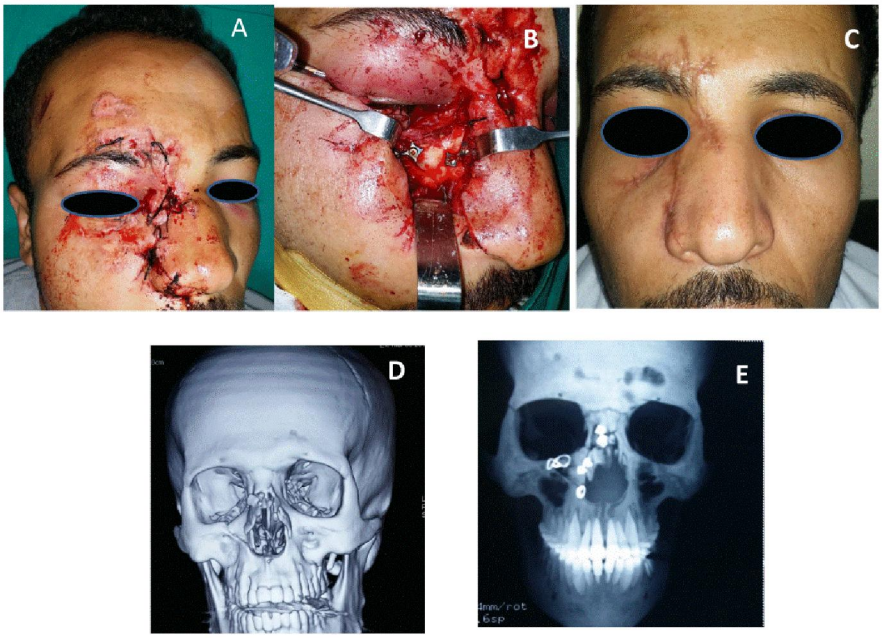


Fig. 2. Male patient, 27 years of age with type IV nasal fracture treated by open reduction and internal fixation. (A) Post-traumatic clinical photograph. (B) Intra-operative photos of reduction and fixation of the fracture bones with plates and screws (C) Follow-up photograph (D) Pre-operative three-dimensional CT scan of the patient. (E) Post-operative three-dimensional CT scan of the patient.

Fig. 3. Male patient, 12 years of age with type II bilateral nasal fracture treated by transnasal fixation. (A) Post-traumatic clinical photograph. (B) Intra-operative photos with the transnasal wire in position. (C) Post-operative clinical photograph. (D Follow-up photograph.

4. Discussion

Nasal bone fracture is the most common type of facial bone fracture[1]. Several classification systems have been described for nasal fractures; however, no uniform system is advocated or applied. Stranc and Robertson [7] classified nasal fractures into lateral, oblique, and frontal based on the direction of the force. We have presented a new, simple classification system that may provide additional treatment guidance (Table 1).

The closed reduction technique is most frequently used to treat these fractures[5]. This technique has several advantages, it is simple, and can be performed under local anesthesia; however, accurate contouring may not be obtained, and the nasal packing may result in overcorrection and widening of the nasal bridge. The nasal cast may become loose when the edema subsides and requires another cast. As a result, post-operative nasal deformity may occur[8]. In addition, in severely comminuted fractures or those associated with NOE fractures, the closed reduction technique is not sufficient and may lead to posttraumatic nasal deformity that is difficult to correct; thus, more aggressive techniques were adopted to treat these fractures and avoid nasal deformity. However, such aggressive techniques may be costly, require advanced facilities and more experienced staff, and can be associated with additional morbidity because it may cause a scar and affect the patient's facial aesthetic[9]. In an attempt to overcome the morbidity associated with the closed method and the complexity of the open method, some authors have described a minimally invasive method, percutaneous transnasal fixation[8].

Therefore, it is mandatory to determine the appropriate surgical technique according to the type of nasal fracture. Several algorithms for nasal fracture treatment were reported to provide the best results for each patient; however, most of these algorithms are difficult to apply. Based on the present trial conducted to overcome these difficulties, we provide a simple algorithm so that each patient can achieve esthetically and functionally superior results.

According to our algorithm, the closed reduction technique is used to manage closed, simple, unilateral and bilateral nasal bone fractures with good (89%) satisfactory results. For closed, unilateral comminuted nasal bone fractures, closed reduction was used with good (88%) satisfactory results. This finding is consistent with the results obtained by others who reported a success rate of 60%–90% with the closed reduction technique[3]. In closed, bilateral comminuted nasal bone fractures, we found that the closed reduction technique alone provides unsatisfactory results; at the same time, open reduction for these cases is costly with associated postoperative morbidity in the form of scars, which were not acceptable to

most patients. In such cases, we used a transnasal fixation technique that was introduced by Shridhar in 2012[8] with 84% of the patients achieving good results. This technique has the advantages of being easy, simple, less costly, no postoperative scars, and provides good results.

In cases with NOE, no technique other than open reduction and direct fixation is suitable to obtain good results. This finding is in agreement with that of others who stated that to achieve good results, one must emphasize early treatment, wide exposure through esthetic incisions, and reconstruction using rigid fixation and bone grafting where appropriate[9]. In cases with open fracture, the nasal bones are already exposed; hence, scars will be present; the best results are obtained by direct fixation.

In conclusion, appropriate assessment and reduction of the nasal fracture would be essential for the optimal treatment of thenasal fracture. It is mandatory to determine the appropriate technique according to the type of nasal fractures.

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