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Do closed reduction and fracture patterns of the nasal bone affect nasal septum deviation?

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Original Article

Background: Many severe nasal bone fractures present with septal fractures, causing postoperative septal deviation and negatively affecting the patients' quality of life. However, when a septal fracture is absent, it is difficult to predict whether surgical correction can help minimize nasal septal deviation postoperatively. This study determined whether performing closed reduction on even mildly displaced nasal bone fracture could deter the outcome of septal deviation.

Methods: We retrospectively reviewed the data of 116 patients aged 21–72 years who presented at the outpatient clinic and emergency room with fractures of nasal bones only without any involvement of the septum from January 2014 to December 2020. Patients were classified into three fracture type groups: A (unilateral), B (bilateral), and C (comminuted with depression). The degree of septal deviation was calculated by measuring the angle between the apex of the most prominent point and the crista galli in the coronal view on computed tomography images. The difference between the angles of the initial septal deviation and that of the follow-up was calculated and expressed as delta (Δ).

Results: Closed reduction tended to decrease the postoperative septal deviation in all fracture types, but the values were significantly meaningful only in type A and B fractures. In the surgical group, with type A as the baseline, type B showed a significantly larger Δ value, but type C was not significantly different, although type C showed a smaller Δ value. In the conservative group, with type A as the baseline, the other fracture types presented significantly lower Δ values.

Conclusion: For all fracture types, closed reduction significantly decreased the extent to which the nasal septum likely deviated. Therefore, when a patient is reluctant to undergo closed reduction, physicians should address the possible outcomes and prognosis of untreated nasal bone fractures.

Abbreviation: CT, computed tomography

Keywords: Bone fractures / Closed fracture reduction / Nasal bone / Nasal septum

INTRODUCTION

Septoplasty, along with rhinoplasty, is one of the most frequently performed aesthetic surgeries. The primary indication for septoplasty is nasal airway obstruction accompanied by a septal deformity causing difficulty in breathing, which in turn can lead to sleep apnea or other sleep disorders. These conditions usually do not pose a fatal threat but can interfere with patients' quality of life [1]. Septal deviation does not cause nasal obstruction by itself but it is a main contributing factor [2]. Often, when open septorhinoplasty is planned for a patient, regardless of the chief complaint, it is very common for a physician to encounter a patient with a history of nasal bone fracture [3]. One of the most frequent questions a surgeon might ask himself in a situation like this is that could the septal deviation have been prevented, if the nasal bone would have been treated surgically,

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making the septal correction procedure unnecessary?

The external anatomy of the nose plays a key role in the overall esthetics and function of the face, and deviation of the nasal septum is often neglected at the time of injury and during the treatment of nasal bone fractures. Rhee et al. [4] suggested that septal fractures should be properly treated using septoplasty or submucous resection along with combined nasal bone fractures to minimize postoperative deviation. However, it is unclear whether nasal bone fracture alone could affect septal deviation even in the absence of a septal fracture. When nasal bone fractures are not severe, most patients and surgeons do not recommend surgical correction. We assumed that the more complex the fracture pattern is, the more it will cause septal deviation during the bone remodeling process of bone union. This study aimed to determine whether the tiniest nasal bone fracture could deter the outcome of septal deviation.

METHODS

Study design and patients

We retrospectively reviewed the data of 116 patients aged 21 to 72 years who visited the outpatient clinic and emergency room presenting with only nasal bone fracture without any septal fracture from January 2014 to December 2020: The study sample included 59 men (50.86%) and 57 women (49.13%). The patients were divided into two groups: those who underwent closed reduction (surgical group) and those who did not (conservative group).

Hwang et al. [5] described the types of nasal bone fractures based on displacement patterns and the presence of septal fractures. However, our study primarily focused on fracture types in the absence of any septal fracture; therefore, we classified the fractures as follows: type A (unilateral), type B (bilateral), and type C (comminuted with depression) (Fig. 1). Fracture patterns were classified based on computed tomography (CT) scans, and the medical records and CT images of the patients were analyzed to determine the degree of nasal septal deviation. Type C fractures are based on the type 3 classification by Hwang et al. [5], which features comminuted fractures with telescoping or depression but only without any septal fracture (Fig. 2). The follow-up period was 6–8 months (mean, 7 months).

The exclusion criteria were as follows: patients aged ≥20 years; patients who had accompanying septal fractures and presented with other types of facial fractures, including maxillary and orbital fractures; and patients with any history of nasal bone fracture prior to our study were excluded. Patients who were ineligible for open reduction were also excluded.

All the patients were treated with closed reduction using a Boies elevator and Walsham forceps, when necessary. The nasal cavity was packed with a Vaseline gauze, and an external nasal splint was applied postoperatively. The splint was kept for a month after surgery.

CT image analysis

Facial CT was performed within a day or two after the trauma occurred. Follow-up CT was performed at least 6 months apart from the first one. The degree of septal deviation was calculated by measuring the angle between the apex of the most prominent point and the crista galli (Fig. 3) [6]. To ensure exact matching of the compared sections, we compared the scans side by side and chose the ones that looked as similar as possible. The second criterion was based on specific structures of facial bone anatomy such as the olfactory groove, the middle and inferior turbinates, the cribriform plate, the zygoma, and the maxilla: if one plane failed to include facial bone structures

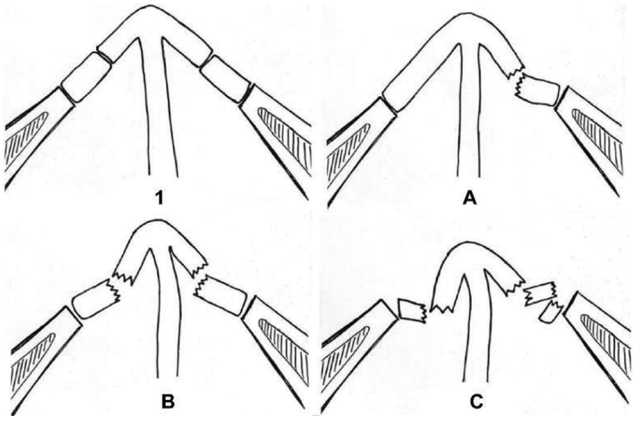

Fig. 1. Classification of nasal bone fractures in the study: type 1 (simple fracture without displacement of depression); type A (unilateral fracture); type B (bilateral fracture); type C (comminuted with telescoping or depression). Fracture types accompanying septal fracture were excluded.

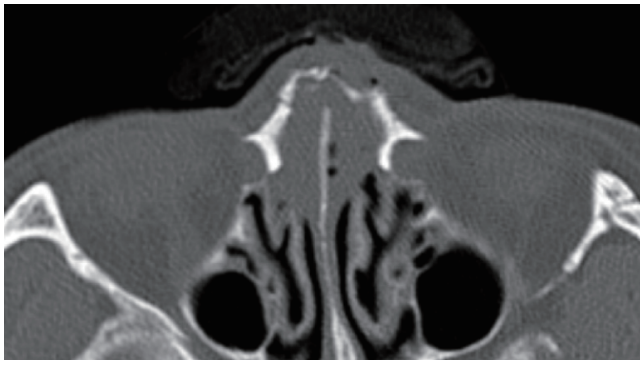

Fig. 2. Type C fracture type; it features comminuted nasal bone fracture without any septal fracture.

which were seen on the other plane, then the patient was excluded from the population, since these data could had created selection bias. After the planes were established, septal deviation was measured by three individual plastic surgeons. The average of the three measurements was extracted. The difference between the initial septal deviation angle and the follow-up angle was calculated and indicated as delta (Δ).

Statistical analysis

The *t*-test, chi-square test, and Fisher exact test were used to compare the demographic variables between the surgical and conservative groups. Preoperative and postoperative Δ value analyses were performed for each fracture type. Changes in septal deviation were compared among the three fracture type groups using analysis of variance. The results are expressed as medians with interquartile ranges. To analyze the relationship between the Δ value and fracture types, we performed multivariate linear regression analysis with a focus on the change in Δ values retrieved from two facial CT images, while other factors (sex and age) were adjusted. Comparisons were analyzed using the *post hoc* test. A paired *t*-test was used to evaluate the significant differences in septal deviation between the surgical and conservative groups for each fracture type. Simple and multivariate linear regression analyses were performed to evaluate the association between fracture type and Δ value of septal deviation. Multivariate linear regression analysis was used on Δ values to adjust variables (sex, interval time, and age) that were out of interest, with the main focus on identifying the extent to which each fracture type differed. This analysis was performed on the two groups addressed above. Data were analyzed using IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA). Statistical significance was set at $p < 0.05$.

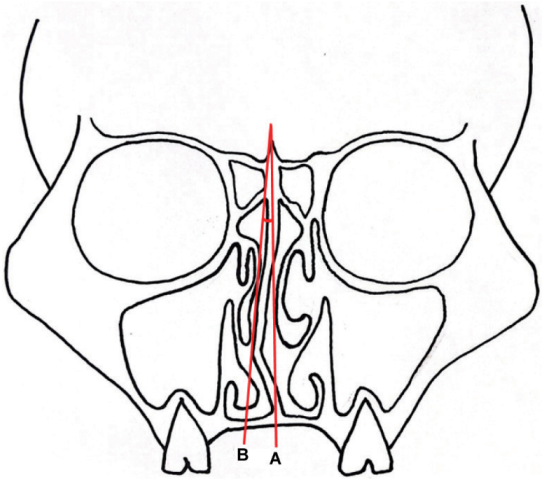

Fig. 3. Measuring septal deviation by calculating the angle between two lines. Line A: a line was drawn perpendicular to the hard palate from the crista galli. Line B: a line was drawn from the crista galli to the apex of the septal deviation.

RESULTS

The patients were divided based on fracture type and analyzed in the surgical and conservative groups. A total of 69 patients were allocated to the surgical group and 47 to the conservative group. Patient demographics were similar between the two groups at baseline, except for the Δ value. Age, sex, and fracture type were not found to be significant demographic factors (Table 1). All the patients showed initial and follow-up septal deviation confined to only one side of the facial midline. All the three fracture types showed smaller mean Δ values in the surgical group, although only the Δ values of types A and B were significantly lower (Table 2). This indicates that performing closed reduction in patients with nasal bone fracture significantly decreases postoperative septal deviation in certain types of fractures. Although postoperative septal deviation did not decrease

Table 1. Patient demographics and follow-up septal deviation in the surgical and conservative groups

Variable	Surgical group (n = 69)	Conservative group (n = 47)	*p*-value[c]
Sex			0.822
Male	34 (49.3)	25 (53.2)	
Female	35 (50.7)	22 (46.8)	
Age (yr)	35.9 ± 13.4	46.6 ± 15.0	
Fracture type			0.868
A	29 (42.0)	18 (38.3)	
B	21 (30.4)	14 (29.8)	
C	19 (27.5)	15 (31.9)	
Treatment interval time (day)	7.4 ± 3.3	-	
Initial septal deviation (°)	4.7 ± 3.1	5.0 ± 2.2	0.533
Follow-up septal deviation (°)[a]	5.6 ± 3.3	6.3 ± 2.2	0.221
Delta value[b]	1.0 ± 0.6	1.3 ± 0.4	0.001

Values are presented as number (%) or mean ± SD.
[a]The postoperative measurement of septal deviation was done on average 7 months period; [b]The change in septal deviation angle; follow-up septal deviation angle was subtracted from the initial septal deviation angle; [c]Analysis of variance or Fisher exact test for count data, statistically significant at $p < 0.05$.

Table 2. Mean delta value of septal deviation according to fracture types

Type	Conservative treatment (mean delta value)	Closed reduction (mean delta value)	*p*-value
A	1.65	1.31	< 0.05
B	1.02	0.37	< 0.05
C	1.13	1.08	0.60

Change in septal deviation angle; the preoperative septal deviation angle was subtracted from the postoperative septal deviation angle.

Table 3. Comparison among fracture types in each group using analysis of variance followed by *post hoc* test

Comparison between fracture types	Conservative treatment *p*-value	Close reduction *p*-value
A–B	<0.05	<0.05
C–A	<0.05	0.08
C–B	0.40	<0.05

Analysis of variance, statistically significant at $p<0.05$.

significantly in patients with type C fractures who underwent surgery, it tended to be smaller in the surgical group.

Comparisons of Δ values among the fracture types were also performed. Of the 47 patients who did not undergo surgery (conservative group), a significant difference was found among all the fracture types, except for types C and B. Of the 69 patients who received surgery (surgical group), a significant difference was found among all the fracture types as well, except for types C and A (Table 3).

In the surgical group, with type A as a baseline, type B showed a significantly larger Δ value, but type C was not significantly different, although type C showed a 0.23 smaller Δ value. The same linear regression analysis was performed for the conservative group. With type A as the baseline, the other fracture types presented significantly lower Δ values (Table 4).

Table 4. Adjusted linear regression analysis of delta value on fracture types compared to fracture type A

Fracture	Delta value (95% CI)	*p*-value
Surgical group		
Type A	Reference	
Type B	–0.93 (–1.20 to –0.66)	<0.05
Type C	–0.23 (–0.51 to 0.04)	0.09
Conservative group		
Type A	Reference	
Type B	–0.57 (–0.82 to –0.32)	<0.05
Type C	–0.54 (–0.78 to –0.29)	<0.05

Linear regression analysis, statistically significant at $p<0.05$.
CI, confidence interval.

DISCUSSION

Treatment modalities for nasal bone fractures vary since it is not a life-threatening medical condition, and patients tend to neglect the aesthetic outcomes of untreated nasal bone fractures. Moreover, patients may refuse closed reduction due to the fear of general anesthesia and the time-consuming burden of hospitalization [7]. Clinical experience shows that a significant number of patients visit outpatient clinics seeking septoplasty along with rhinoplasty. When a septal fracture is present at the time of the incident, it is easy to predict that there will definitely be deviation in the nasal septum postoperatively if left untreated. However, it is unclear whether nasal bone fracture alone affects the degree of septal deviation when the nasal septum is intact.

Our study demonstrates that closed reduction and different nasal bone fracture types affect the degree of septal deviation after trauma, even without any septal fracture. For all the fracture types, closed reduction significantly decreased the extent to which the nasal septum likely deviated. However, type C fractures, which feature depressed and comminuted nasal bones, are likely to cause septal deviation, regardless of surgical intervention. The nasal septum is located in the middle of the nasal cavity and represents the center of the nose. It is divided into a posterior part formed by the vomer and the perpendicular plate of the ethmoid bone and an anterior part represented by the quadrangular cartilage. Few studies have demonstrated that a deviated nasal septum affects the development of the nasal cavity and paranasal sinus and increases the interalveolar and maxillary rotation distances [8,9]. Moreover, considering how septal deviation can affect nasal bone morphology, we can seek a plausible answer to the question of how nasal bone morphology can affect nasal septal deviation [10]. Our results are consistent with this notion, in that type B fractures, which feature two sides of displaced bone fragments, more likely cause septal deviation than type A fractures. This can also be explained by the morphology of the nasal bone pyramid, which weakens both sides of the triangular wound and causes more collapse of the nasal septum, which acts as a pillar of the bony pyramid.

Kang et al. [11] demonstrated that bone remodeling after traumatic nasal bone fracture contributes to the reshaping and repositioning of the nasal bone pyramid in pediatric patients. While the same is not applicable in adults, a few studies have shown that nasal chondrocytes in adults have bone-forming capacity, although much less potent than in pediatrics [12]. We believe that the more severe the degree of nasal bone fracture, the more dynamic bone remodeling will be, thus reshaping the outline of the nasal bone pyramid.

Most patients who visited our clinic for open septorhinoplasty have a history of nasal bone fracture, regardless of whether they underwent closed reduction or not. One of the most common questions plastic surgeons face in the clinic is that would patients have been provided with a different result on the nasal septum, if he had performed closed reduction, thus making the whole septoplasty unnecessary? In addition, the conclusion we have arrived at is that septal deviation can be somewhat predictable, especially in patients with severe nasal bone fractures.

Our results demonstrate a significant reduction in the degree of septal deviation in patients who received a closed reduction of the nasal bone. The mechanism of this phenomenon is currently not known, but the results of our study can assist plastic surgeons in addressing patients with nasal bone fractures who are reluctant to undergo closed reduction. However, the degree of septal deviation does not always correlate with nasal symptoms, since numerous other factors such as the environment and allergic conditions also attribute to the onset of nasal airway obstruction [13]. We cannot predict if a change of septal deviation of 1° or 2°, will be significant in positively affecting nasal function. Nevertheless, it could definitely be a contributing factor. Since septal deviation can play a key role in postoperative nasal symptoms, it is plausible to avoid anatomical alterations via simple surgical correction. Therefore, we believe closed reduction of nasal bone fractures, regardless of the fracture type, can minimize secondary septoplasty afterward, thus saving time and money.

This study has some limitations. First, the treatment interval was not considered. Although the results of Kang et al. [14] showed that the treatment interval does not significantly alter surgical outcomes in pediatric patients, an extensive review of adults with various treatment intervals should add a new perspective to the study. In addition, pediatric patients were excluded from the study due to the small sample size and the complexity of the underdeveloped nasal septum. Adding a patient's age diversity and treatment interval into future studies could clarify this phenomenon concerning nasal septum development.

NOTES

Conflict of interest

Jae Ha Hwang and Kwang Seog Kim are editorial board members of the journal but were not involved in the peer reviewer selection, evaluation, or decision process of this article. No other potential conflicts of interest relevant to this article were reported.

Ethical approval

The study was approved by the Institutional Review Board of Chonnam National University Hospital (IRB No. CNUH-2022-137) and performed in accordance with the principles of the Declaration of Helsinki. The informed consent was waived because this study design is a retrospective review.

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