



Clinical Analysis of Nasal Bone Fracture in Patients Who Have Previously Undergone Dorsal Augmentation Using Silicone Implants: A Pilot Study



Sik Namgoong¹ · Jong-Phil Yang¹ · Seung-Kyu Han¹ · Seong-Ho Jeong¹ · Eun Sang Dhong¹

Received: 16 April 2019 / Accepted: 19 May 2019 / Published online: 6 June 2019

© Springer Science+Business Media, LLC, part of Springer Nature and International Society of Aesthetic Plastic Surgery 2019

Abstract

Background There are no studies about the treatment of nasal bone fractures in patients with dorsal augmentations using silicone implants. We aimed to describe the characteristics of nasal bone fracture in patients who underwent rhinoplasty and compare the difference between closed reduction and conservative treatment of nasal bone fractures in patients with a history of rhinoplasty.

Methods Between January 2013 and June 2018, a total of 463 patients were admitted to our center for nasal bone fracture; 17 patients with nasal bone fractures who underwent rhinoplasty were included, of which, five underwent closed reduction in the nasal bone and 12 underwent conservative treatment. Three of 12 patients who were initially treated conservatively underwent a secondary rhinoplasty for esthetic improvements. All patients were classified according to fracture site and the presence of a nasal septal fracture—in accordance with the modified Murray classification—and were analyzed for the correlation between fracture type and disease course.

Results The nasal bone fracture types per computed tomography findings were unilateral ($n = 13$), bilateral ($n = 4$), septal ($n = 1$), and M-type ($n = 1$). No significant differences in fracture site ($P > 0.05$) and the presence of a nasal septal fracture ($P > 0.05$) were found between the groups. Fracture type did not significantly differ among patients who underwent closed reduction, conservative

treatment without secondary rhinoplasty, and secondary rhinoplasty ($P > 0.05$).

Conclusions Despite risking traumatic capsular rupture, implant removal is seldom required and closed reduction is recommended if visible deviations are present; otherwise, only conservative treatment is recommended.

Level of Evidence IV This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266.

Keywords Nasal bone fracture · Augmentation rhinoplasty · Silicone implant · Disease course

Introduction

Nasal bone fracture is the most common fracture of the facial bone. The nasal bone is a plate-like structure located directly beneath the skin layer that can be palpated easily owing to the presence of few fat layers. Since it is symmetrical, small changes in the nasal bone, such as depression or deviation, can be easily recognized. Although often considered minor, a nasal bone fracture can be a serious injury if not recognized and treated timely. Management of such an injury depends on whether the fracture is nondisplaced, displaced, open, or associated with a complication that requires a more aggressive approach.

Recently, augmentation rhinoplasty using an alloplastic material has been commonly performed in Asian countries [1]. An increasing number of patients with nasal bone fractures undergo augmentation rhinoplasty with silicone implants [2]. The nose can be easily deformed even by a minor fracture, and inadequate treatment can result in poor

✉ Eun Sang Dhong
prsdhong@kumc.or.kr

¹ Department of Plastic Surgery, Korea University College of Medicine, Korea University Guro Hospital, 148 Gurodong-Gil, Guro-Ku, Seoul 08308, South Korea

cosmetic outcomes and functional disorders [3]. Compared with the symptoms of a simple nasal bone fracture, those from nose injury may differ in individuals who have undergone augmentation rhinoplasty. The incidence of complications after augmentation rhinoplasty with silicone implants significantly varies in the literature, ranging from approximately 4–36% [4, 5]. Silicone implants may cause infection, calcification, capsule formation, or bone erosion, making the nasal bone susceptible to trauma [6]. When calcification occurs in a silicone implant, the implant hardens under the skin and soft tissue, thereby increasing the risk of developing complications [7]. As calcification progresses, the nose may appear deviated owing to contractive distortion, and the silicone implant may become palpable through the skin. Furthermore, even if the silicone implants are removed during the operation, capsules and thickened tissues may remain and affect nasal bone reduction.

To date, numerous classification systems for nasal bone fractures have been proposed. In 1986, Murray et al. [8] reported a 7-step classification based on pathological findings of fractures. In 2000, Rohrich and Adam [9] went one step further and suggested the use of appropriate surgical procedures according to the 7-step classification.

Several studies have reported about the diagnosis and treatment of nasal bone fractures. However, only few studies have analyzed the characteristics of nasal bone fracture in patients who underwent rhinoplasty. Furthermore, the difference between closed reduction and conservative treatment of nasal bone fracture in patients with a history of rhinoplasty has not been evaluated. We hypothesized that disease course, including inflammation and nasal deformity, may be different in individuals who have undergone augmentation rhinoplasty. In this report, we focused on analyzing the disease course and type of nasal bone fracture in patients with a history of augmentation rhinoplasty that used a silicone implant. The primary objective of this study was to describe the characteristics of nasal bone fractures in patients who underwent dorsal augmentation and thus to compare the difference between closed reduction and conservative treatment of nasal bone fractures in patients with a history of rhinoplasty.

Methods

Patients

The study protocol was approved by the institutional review board (IRB Approval No. 2018GR0061). The medical records of patients who had nasal bone fracture with a history of augmentation rhinoplasty were retrospectively assessed.

In this study, we analyzed collected data from 463 patients [337 men and 126 women; mean age, 36.8 ± 17.8 years (range 5–89 years)] treated for nasal bone fractures at our medical center between January 2013 and June 2018. Among the 463 patients, those who met the following inclusion criteria were included in the study: (1) age > 19 years; (2) diagnosed as having an acute nasal bone fracture; (3) had a history of augmentation rhinoplasty using a silicone implant; (4) underwent one of the following treatment methods: closed reduction or conservative treatment; (5) followed up for > 3 months; and (6) underwent computed tomography (CT) or plain radiography and clinical photography for the assessment of prognosis. Patients were excluded from this study if they had a nasal bone fracture history with or without surgical correction, a history of augmentation rhinoplasty using another silicone implant (i.e., Gore-Tex), concomitant multiple facial fractures at the orbital or zygoma area, or ongoing treatment or were lost to follow-up (Fig. 1). Of the 463 patients, 17 met the inclusion criteria.

Study Protocol and Evaluation

Physical and radiological examinations, including facial three-dimensional CT scanning, and both lateral nasal bone and reverse Waters' view radiographies, were performed in all patients after trauma. The surgeon performed closed reduction under general anesthesia in the patients who presented with nasal deviation. After reduction, Nasopores (Polyganics B.V., Utrecht, The Netherlands) was applied bilaterally for postoperative preservation, and hemostasis and packing materials were removed on the third postoperative day. In addition, the Denver Splint (Shippert Medical Technologies, Centennial, CO) was worn for 2 weeks postoperatively to protect the nose from external shock and to maintain its shape. Nasal lateral view and Waters' view radiographs were obtained 1 day after the operation.

All facial three-dimensional CT scans were reviewed to assess for the characteristics of nasal bone fractures in the patients who had previously undergone augmentation rhinoplasty, by using the modified Murray classification, which is used to classify the severity of fractures (Table 1) [10]. The patients were classified according to fracture severity (types I–III). Type II was subdivided into types IIA, IIAs, IIB, and IIBs in accordance with the modified Murray classification. We defined types I and IIA as mild fractures and types IIB to III as severe fracture. The patients were also classified according to fracture site and the presence of a nasal septal fracture, which are significantly associated with postoperative prognosis (Fig. 2).

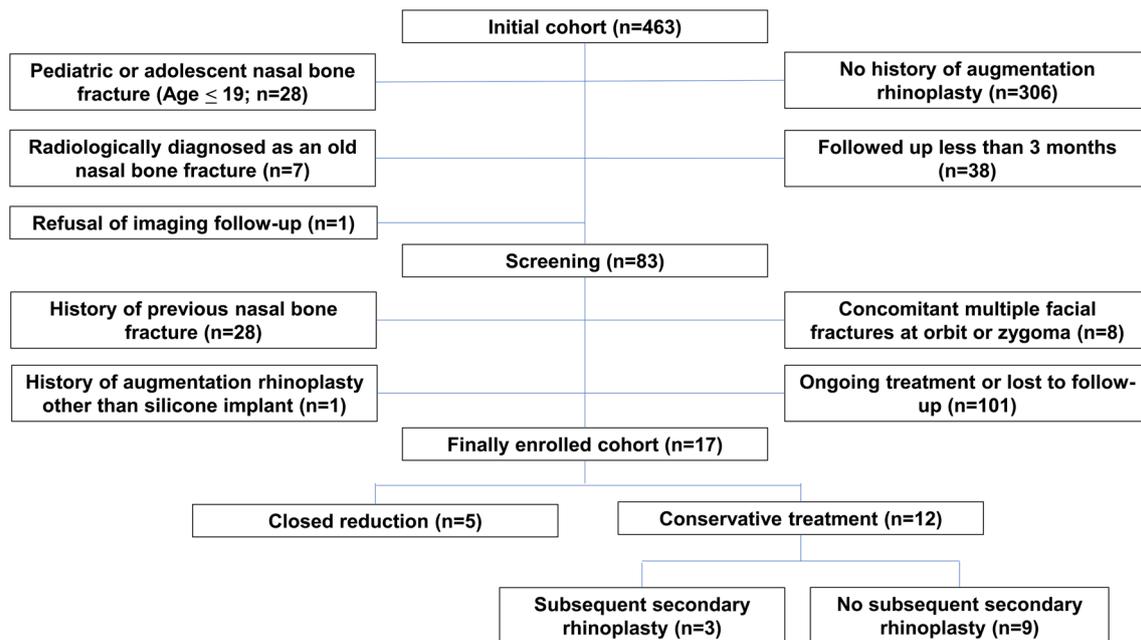


Fig. 1 Flowchart of the patients included in the study (n = number of patients)

Table 1 Modified Murray classification

Type	Characteristic of the fracture
I	Simple without displacement
II	Simple with displacement/without telescoping
IIA	Unilateral
IIAs	Unilateral with septal fracture
IIB	Bilateral
IIBs	Bilateral with septal fracture
III	Comminuted with telescoping or depression

Statistical Analyses

All data were expressed as mean \pm standard deviation. Mann–Whitney U tests were used to compare quantitative variables, and Fisher exact tests were used to analyze categorical variables. A P value < 0.05 was considered statistically significant. All statistical analyses were performed using the Statistical Package for the Social Sciences version 20.0 software for Windows (SPSS, Inc., Chicago, IL).

Results

Among the 17 patients who presented with nasal bone fracture after augmentation rhinoplasty, 6 were men and 11 were women. Five of the 17 patients underwent closed reduction of the nasal bone, and 12 received conservative

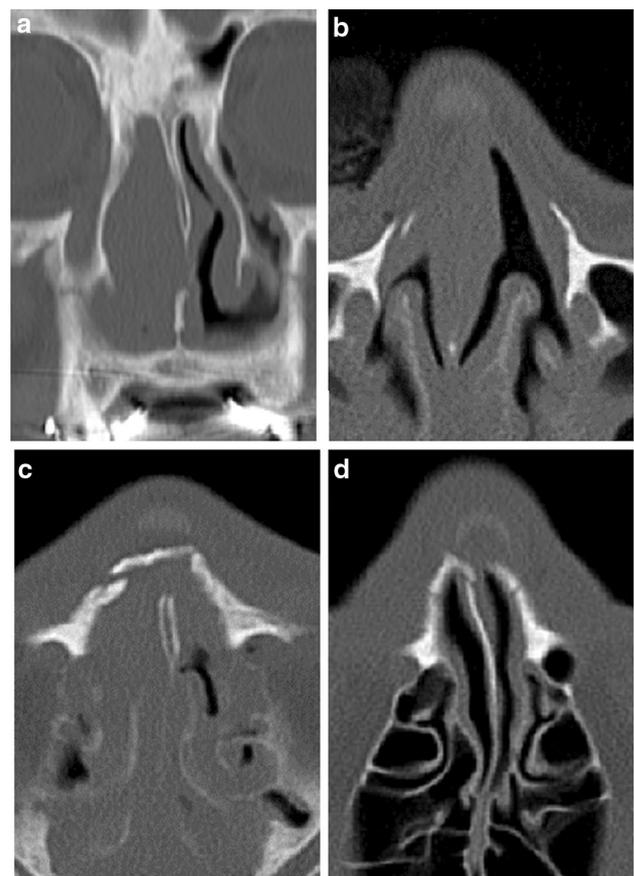


Fig. 2 Classification of nasal bone fractures according to fracture site and the presence of a nasal septal fracture. **a** Septal fracture, **b** unilateral fracture, **c** bilateral fracture, and **d** M-type fracture

treatment. Of the 12 patients who received conservative treatment, 3 patients underwent a subsequent secondary rhinoplasty at least 12 months after the nasal bone fracture.

All patients enrolled were classified according to fracture site and the presence of a nasal septal fracture in accordance with the modified Murray classification based on preoperative CT images. The patterns of nasal bone fractures classified according to the findings from the CT scans were unilateral fracture ($n = 13$), bilateral fracture ($n = 4$), septal fracture ($n = 1$), and M-type fracture ($n = 1$). None of the patients showed any signs of infection after the treatment. No statistically significant difference was observed in terms of fracture site ($P > 0.05$) and the presence of a nasal septal fracture ($P > 0.05$) between the 2 groups (Table 2). According to the modified Murray classification, 13 (76%) of 17 patients presented with type I and IIA fractures. Among the patients who underwent closed reduction, 4 out of 5 patients presented with type I and IIA fractures, whereas 1 out of 5 patients presented with type III fractures. In addition, among the patients who underwent conservative treatment without secondary rhinoplasty, 7 (78%) had type I and IIA fractures. Among the 12 patients who were treated conservatively, 3 patients underwent secondary rhinoplasty due to patient dissatisfaction. Moreover, 2 out of 3 patients who underwent secondary rhinoplasty had initially presented with type I and IIA fractures. No statistically significant difference was

observed in terms of fracture type among the patients who underwent closed reduction, conservative treatment without subsequent secondary rhinoplasty, and conservative treatment with subsequent secondary rhinoplasty ($P > 0.05$; Table 3).

Figures 3, 4, and 5 show the clinical photographs and axial CT views at various time points. Figures 3 and 4 show the CT findings before and after closed reduction. Both cases had a unilateral right-side fracture and depression after trauma but no deviation of the nasal bone and destruction of silicone implant 2 months after closed reduction. Three of 12 patients who were initially treated conservatively underwent subsequent secondary rhinoplasty eventually due to the patients' dissatisfaction or desire for esthetic improvement. One patient who received subsequent secondary rhinoplasty did not present with a hump nose or any other deformities immediately after trauma. However, the patient presented with a hump nose 6 months after conservative treatment; therefore, he underwent rhinoplasty using autologous cartilage to remove the hump and, additionally, to obtain the desired shape (Fig. 5). Another patient presented with calcification around the implant that was found to be the Medpore implant (Porex Surgical) inserted at the antero-caudal septum before trauma. The Medpore implant was removed, and the patient underwent secondary rhinoplasty using autologous cartilage. The other patient presented with

Table 2 Comparison of the characteristics of fractures between nasal bone fracture patients who previously underwent augmentation rhinoplasty and closed reduction in nasal bone fracture or conservative treatment

Variables	Closed reduction ($n = 5$)	Conservative treatment ($n = 12$)	P
Age (years)	40.2	37.17	0.72
Sex			0.28
Male	3	3	
Female	2	9	
Septal fracture			0.52
Yes	1	1	
No	4	11	
Location of fracture			1.0
Unilateral	4	9	
Bilateral	1	3	
M-type fracture			1.0
Yes	0	1	
No	5	11	
Deformity after treatment			0.26
Yes	0	4	
No	5	8	
Infection after treatment			1.0
Yes	0	0	
No	5	12	
Subsequent secondary rhinoplasty			0.52
Yes	0	3	
No	5	9	

Table 3 Comparison using the modified Murray classification

Treatment group	Mild fracture type		Severe fracture type				Total	Mild fracture-type cases/total cases (%)	P
	Type I	Type IIA	Type IIAs	Type IIB	Type IIBs	Type III			
Closed reduction	1	3	0	0	0	1	5	80	1
Conservative treatment									
Without subsequent secondary rhinoplasty	4	3	0	2	0	0	9	78	
With subsequent secondary rhinoplasty	2	0	0	0	0	1	3	67	
Total number of patients	7	6	0	2	0	2	17	17	

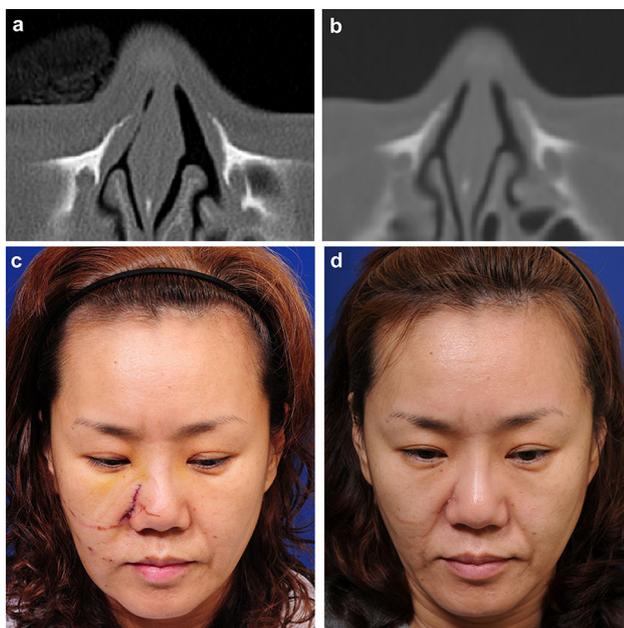


Fig. 3 Case 1. Patient with a deviated nose after trauma. **a, c** Computed tomography (CT) scan and clinical photograph after trauma and before closed reduction. **b, d** CT scan and clinical photograph 2 months after closed reduction. No deviation and destruction of the silicone implant were observed

capsular contracture and complained about nasal length and thus underwent secondary rhinoplasty using autologous cartilage.

Discussion

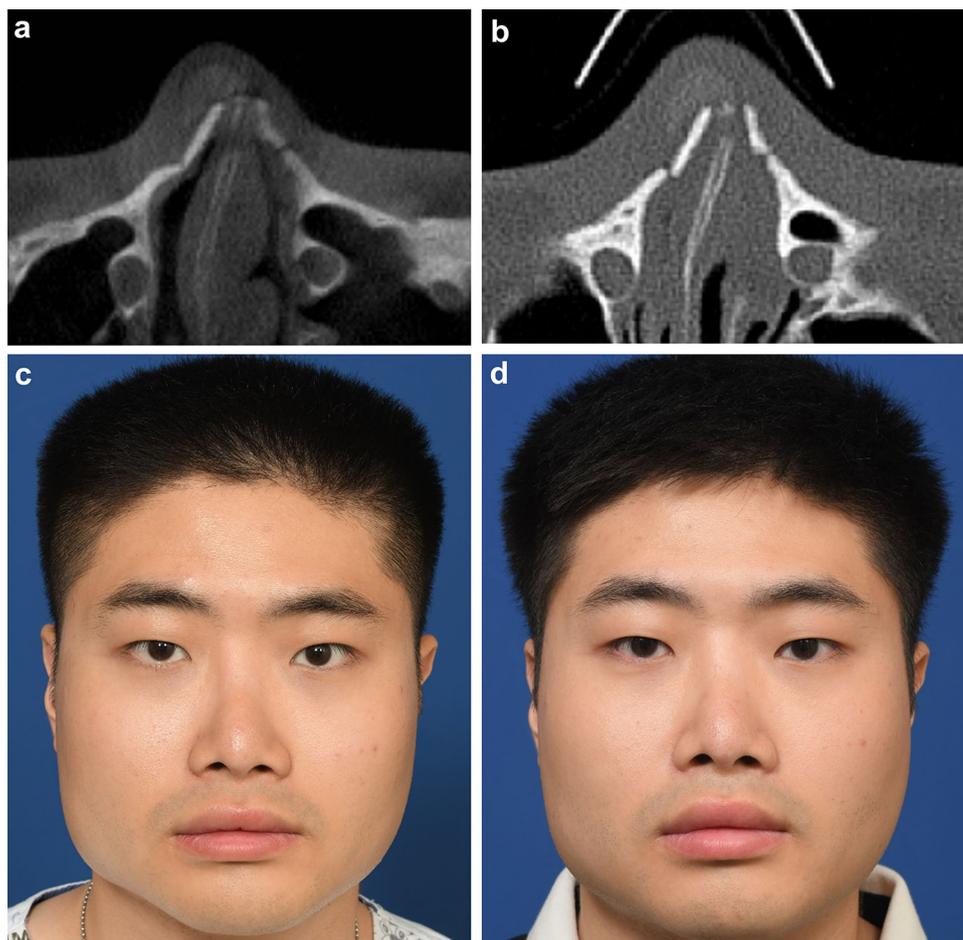
Contracted noses resulting from capsular contracture of alloplastic implants secondary to rhinoplasty are quite common in Asians [11–13]. The demand for correction of these secondary deformities is currently increasing [12, 13]. Most plastic surgeons in Korea limit the use of

alloplastic implants extending to the nasal tip [14]. However, in real-world clinical settings, numerous patients present with nose deformities due to the inadequate use of alloplastic implants [13].

Patients who had previously undergone augmentation rhinoplasty were dissatisfied with the previous shape of their noses; in these patients, it is extremely difficult to achieve a satisfying reduction result after a nasal bone fracture. Numerous studies have focused on the proper management of nasal bone fractures [15–20]; however, only a few reports have been published about nasal bone fractures in patients who had previously undergone augmentation rhinoplasty [21]. Furthermore, data about the clinical characteristics and outcomes of patients who have previously undergone augmentation rhinoplasty are limited.

Three previous studies reported on nasal bone fractures in patients who had previously undergone augmentation rhinoplasty [1, 21, 22]. The first report focused on the characteristics of nasal trauma in patients who had previously undergone augmentation with implants [1]. The authors classified nasal trauma into five groups and reported that the most common type of injury was simple deviations of the implant without fracture and extrusion [1]. This study did not report the clinical outcomes of these patients. The second study reported a new classification method for fractured nasal bones in patients who had previously undergone augmentation rhinoplasty with silicone implants and patient satisfaction after treatment [22]. The authors proposed a management model using their classification method [22]. In patients with high- or total-level fractures, silicone implants were removed owing to the lack of supporting strength and the interaction between the fracture and artificial support. However, data about the clinical characteristics and outcomes of patients who had previously undergone augmentation rhinoplasty are limited. The third study focused on the satisfaction of patients

Fig. 4 Case 2. Patient with a deviated nose after trauma. **a**, **c** Computed tomography (CT) scan and clinical photograph after trauma. **b** CT scan 4 days after closed reduction. No deviation and destruction of the silicone implant were observed, while the reduction of right sided nasal wall was seen, **d** clinical photograph 2 months after closed reduction. No deviation and destruction of the silicone implant were observed



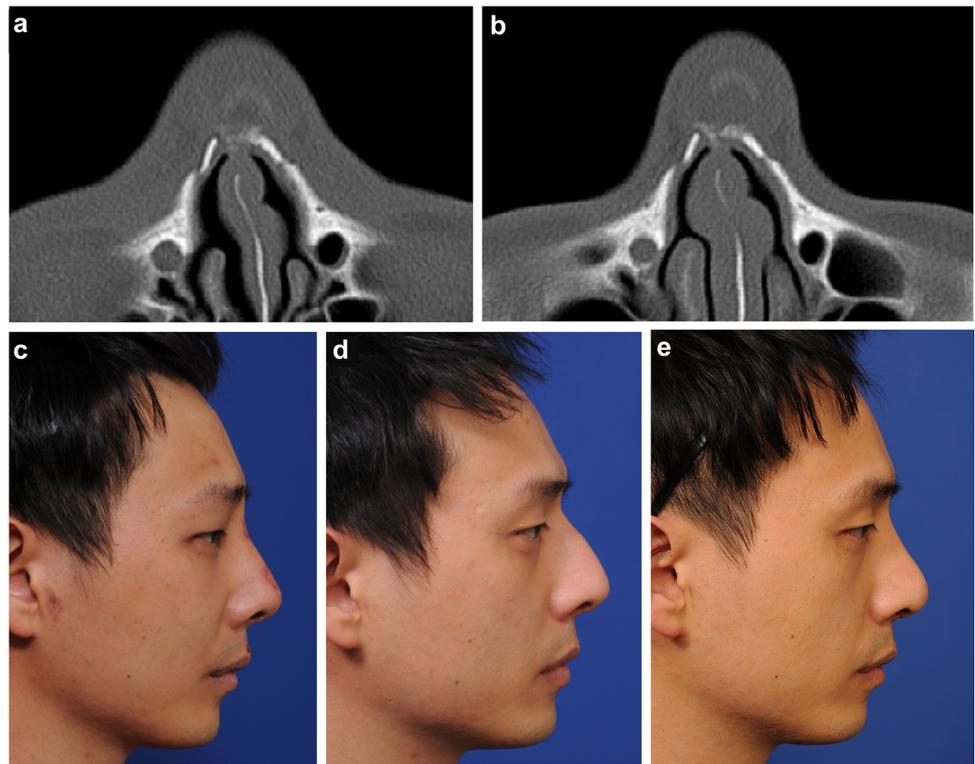
who had previously undergone rhinoplasty and their satisfaction after closed fracture reduction [21]. In this study, no difference in post-reduction satisfaction was observed between patients with nasal bone fracture who did not undergo and those who underwent rhinoplasty. No data are available about patients who had conservative treatment.

We focused on analyzing the disease course and type of nasal bone fracture in patients who had undergone a previous rhinoplasty. Most patients showed no implant extrusion, infection, or severe implant disfigurement (e.g., deviation or rotation). In this present study, we hypothesized that traumatic capsular rupture, which might cause capsular contracture and result in nasal deformity, would occur in nasal bone fractures in patients who previously underwent a rhinoplasty. However, the deformity and infection were not as bad as we expected. In addition, no statistically significant difference in fracture severity according to the modified Murray classification was observed between the groups. We assumed that the degree of fracture did not significantly affect the deviation and deformity because the fracture was masked by the camouflage effect of the implant.

There are crucial issues that should not be missed when examining a patient with acute nasal bone fracture who previously underwent dorsal augmentation using an alloplastic implant. Bilateral osteotomy is frequently conducted before the insertion of the alloplastic implant when augmentation rhinoplasty is performed, particularly for complicated cases of esthetic rhinoplasty. Therefore, the stability of the nasal bone should be examined thoroughly when evaluating nasal bone fractures to not misinterpret acute fracture lines. In addition, it is difficult to find that the dorsal implant remained ideally in the midline in the long-term follow-up; the finding of a laterally skewed alloplastic implant should not be misinterpreted as the consequence of nasal bone fractures in the interpretation of the patient CT results. On the contrary, the dorsal implant deviation should be determined based on the photographs of the patient taken before nasal bone fracture.

The present study has some limitations. As this was an exploratory retrospective pilot study, a formula was not used to calculate the sample size. The small sample size ($n = 17$) may not be sufficient to statistically analyze the effect of nasal bone fracture in patients who previously underwent augmentation rhinoplasty with silicone

Fig. 5 Case 3. Patient with a hump nose after trauma. **a** Computed tomography (CT) scan after trauma, **b** CT scan 6 months after M-type nasal bone fracture, without closed reduction. No deviation and destruction of the silicone implant were observed, **c** immediately after trauma, **d** 6 months after trauma, **e** 6 months after secondary rhinoplasty



implants. Although augmentation rhinoplasty using silicone implants is prevailing in Asia, recruiting a sufficient number of members in the cohort who met the inclusion and exclusion criteria, which were elaborately designed to overcome the limitation from the small sample size, required a long time. In addition, sufficient follow-up time is needed to determine precisely the effect of nasal fracture in patients who previously underwent augmentation rhinoplasty with silicone implants. Our study was conducted on the basis of a large population ($n = 463$) with nasal bone fractures between January 2013 and June 2018. We have narrowed down the cohort by excluding patients who might influence the results of our study, such as those with short-term follow-up or concomitant facial bone fracture at the orbital or zygoma area and a history of augmentation other than silicone implants such as Gore-Tex. Further, well-designed prospective studies with a larger sample size and longer follow-up might be needed to obtain statistically significant results.

In addition, postoperative assessment using a CT scan was not available to all the enrolled patients. CT scanning has a better sensitivity and specificity than plain radiography, which was previously used for the diagnosis and evaluation of nasal bone fractures [23, 24]. However, despite these advantages, performing a postoperative CT scan is difficult owing to problems in national insurance coverage; thus, it is performed only in patients with severe deformities and those who need additional surgery.

Despite these aforementioned limitations, this study might be the first to describe the characteristics of nasal bone fractures in patients who underwent dorsal augmentation. Thus, it is the first to compare the difference between closed reduction and conservative treatment of nasal bone fractures in patients with a history of rhinoplasty. In addition, it introduces a reconstructive strategy for plastic surgeons who frequently encounter nasal bone fractures, which are the most common facial bone fractures, in this day and age when silicone implant augmentation prevails, particularly for Asian rhinoplasty.

Conclusions

Despite concerns about traumatic capsular rupture that might cause capsular contracture, none of the patients in this study developed infection or severe implant disfigurement without regard to closed reduction. Therefore, implant removal is not recommended, and closed reduction is necessary if visible deviations are present. Otherwise, only conservative treatment should be recommended for nasal bone fractures in patients who have previously undergone augmentation rhinoplasty.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest to disclose and no financial support.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration, and its later amendments or comparable ethical standards and all patients provided written informed consent prior to enrollment.

Informed Consent Informed consent was obtained from all individual participants included in this study.

References

- Choi SM, Choi HJ, Kim CH, Ahn HS, Kang SG, Jung SG (2008) Characteristics of nasal trauma in the implanted nasal prosthesis. *J Korean Soc Plast Reconstr Surg* 35:597–602
- Ondik MP, Lipinski L, Dezfoli S, Fedok FG (2009) The treatment of nasal fractures: a changing paradigm. *Arch Facial Plast Surg* 11:296–302
- Chen C-T, Hu T-L, Lai J-B, Chen Y-C, Chen Y-R (2010) Reconstruction of traumatic nasal deformity in Orientals. *J Plast Reconstr Aesthet Surg* 63:257–264
- Graham BS, Thiringer JK, Barrett TL (2001) Nasal tip ulceration from infection and extrusion of a nasal alloplastic implant. *J Am Acad Dermatol* 44:362–364
- Tham C, Lai Y-L, Weng C-J, Chen Y-R (2005) Silicone augmentation rhinoplasty in an Oriental population. *Ann Plast Surg* 54:1–5
- Jung DH, Kim BR, Choi JY, Rho YS, Park HJ, Han WW (2007) Gross and pathologic analysis of long-term silicone implants inserted into the human body for augmentation rhinoplasty: 221 revision cases. *Plast Reconstr Surg* 120:1997–2003
- Zeng Y, Wu W, Yu H, Yang J, Chen G (2002) Silicone implant in augmentation rhinoplasty. *Aesthet Plast Surg* 49:495–499
- Murray J, Maran A, Busuttill A, Vaughan G (1986) A pathological classification of nasal fractures. *Injury* 17:338–344
- Rohrich RJ, Adams WP Jr (2000) Nasal fracture management: minimizing secondary nasal deformities. *Plast Reconstr Surg* 106:266–273
- Hwang K, You SH, Kim SG, Lee SI (2006) Analysis of nasal bone fractures; a six-year study of 503 patients. *J Craniofac Surg* 17:261–264
- Hong ST, Kim DW, Yoon ES, Kim HY, Dhong ES (2012) Superficial mastoid fascia as an accessible donor for various augmentations in Asian rhinoplasty. *J Plast Reconstr Aesthet Surg* 65:1035–1040
- Hwang NH, Dhong ES (2018) Septal extension graft in Asian rhinoplasty. *Facial Plast Surg Clin N Am* 26:331–341
- Suh MK, Ahn ES, Kim HR, Dhong ES (2013) A 2-year follow-up of irradiated homologous costal cartilage used as a septal extension graft for the correction of contracted nose in Asians. *Ann Plast Surg* 71:45–49
- Kim HS, Park SS, Kim MH, Kim MS, Kim SK, Lee KC (2014) Problems associated with alloplastic materials in rhinoplasty. *Yonsei Med J* 55:1617–1623
- Ogino A, Onishi K, Nakamichi M, Okaneya T (2018) Navigation-assisted nasal bone osteotomy for malunited fracture. *J Craniofac Surg* 29:156–158
- Lu GN, Humphrey CD, Kriet JD (2017) Correction of nasal fractures. *Facial Plast Surg Clin N Am* 25:537–546
- Kim ST, Jung JH, Kang IG (2017) Is surgical navigation useful during closed reduction of nasal bone fractures? *J Craniofac Surg* 28:e208–e210
- Jeon M, Kim Y (2018) Correlation between the existing classifications of nasal bone fractures and subjective patient satisfaction. *J Craniofac Surg* 29:1825–1828
- Lim H, Kang KR, Koh SH, Jung SW, Jung S (2017) Postoperative changes after closed reduction of nasal fracture. *J Craniofac Surg* 28:1649–1653
- Hwang K, Yeom SH, Hwang SH (2017) Complications of nasal bone fractures. *J Craniofac Surg* 28:803–805
- Yoon T, Kim Y (2016) Postoperative Satisfaction in nasal bone fracture patients who had rhinoplasty. *J Craniofac Surg* 27:1707–1710
- Jeon SP, Kang SJ, Kim JW, Kim YH, Sun H (2013) New nasal fracture classification for patients with silicone implants. *J Plast Surg Hand Surg* 47:363–367
- Nishioka H, Kondoh S, Yuzuriha S (2018) Convex bone deformity after closed reduction of nasal bone fracture. *J Plast Reconstr Aesthet Surg* 71:85–89
- Lee IS, Lee JH, Woo CK, Kim HJ, Sol YL, Song JW, Cho KS (2016) Ultrasonography in the diagnosis of nasal bone fractures: a comparison with conventional radiography and computed tomography. *Eur Arch Otorhinolaryngol* 273:413–418

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.