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Efficacy of closed reduction of nasal fractures – a retrospective analysis with focus on factors affecting functional and aesthetic outcomes

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Abstract

Background

Nasal bone fractures are the most common type of facial bone fractures. While the nasal anatomy and closed reduction techniques of nasal fractures are well described, there is a paucity of data reporting on the need for revision rhinoplasty. The objective of this study was an analysis of factors affecting the outcome and need for revision rhinoplasty in patients who underwent closed reduction for nasal bone fracture

Methods

From 2010 to 2020, a total of 417 consecutive patients underwent closed nasal reduction. Medical files of the patients were reviewed retrospectively. The rate of rhinoplasty after fracture consolidation was determined. Factors influencing the need for revision rhinoplasty were assessed using univariable and multivariable logistic regression analyses.

Results

47 patients (11.3%) required revision rhinoplasty after fracture healing. Patients who had suffered an additional septum fracture were more likely to undergo rhinoplasty. The risk of the need for open revision rhinoplasty after fracture healing was increased for patients complaining of airway obstruction at the time of cast removal after closed reduction.

Conclusion

A certain number of patients will require secondary revision rhinoplasty after closed reduction of a nasal fracture. Subjective airway obstruction at the time of cast removal after closed reduction is a predictor for revision rhinoplasty. Prospective studies are required to support the findings of this investigation.

Key Words

Nasal fracture, closed reduction, revision rhinoplasty, outcomes

Introduction

Nasal bone fractures are the most common type of facial bone fractures [1]. They are caused by different trauma mechanisms including traffic accidents, assault, external trauma from other objects or falls [2]. Accurate initial treatment after diagnosis including closed reduction if indicated is essential to prevent deformity and functional impairment [3]. Numerous guidelines have been described to refine and optimize acute nasal trauma management, but restoration of pretraumatic form and function remains a challenge [4]. The need for secondary revision rhinoplasty for postreduction nasal deformity is said to range from 14 to 50 percent [5]. Post-traumatic septo-rhinoplasty can be challenging and the result may not always be predictable, which makes optimizing the initial treatment key in decreasing the need for secondary surgery. While the nasal anatomy and closed reduction techniques of nasal fractures are well described [5], there is a paucity of data reporting on the need for revision rhinoplasty and potentially confounding factors. The objective of this study was an analysis of factors affecting the outcome and need for revision rhinoplasty in patients who underwent closed reduction for nasal bone fracture.

Patients and Methods

From 2010 to 2020, a total of 417 consecutive patients received a closed nasal reduction at our department after having suffered a nasal fracture. Medical files of the patients were reviewed retrospectively and analyzed for patient demographics, fracture characteristics, patient work up, surgical intervention and outcome. The fractures of patients who received a computed tomography as part of their diagnostic work up were staged according to the nasal fracture classification proposed by Rohrich and Adams [6]. The areas targeted during revision rhinoplasty were assessed.

Closed nasal reduction technique

All patients received an administration of i.v. antibiotics (usually a 2nd generation cephalosporin) preoperatively. Otrivin soaked swabs were placed in each nostril, and left in place for 5-10 minutes. Reduction was performed using an elevator instrument and anteriorly directed traction. Reduction of the lateral nasal walls was achieved by lateral rotation of the elevator device and continued traction, external digital palpation verified proper reduction. In case of a septal injury reduction of the septum was achieved using Ash forceps. Proper reduction was verified clinically (straight alignment, palpation, both digital and with the elevator). After reduction silicone splints (without "airway") were inserted in patients with septal affection, these were secured to the septum with – a U-suture through the septum with PDS 4-0 with a straight needle. Patients without a septal fracture received gauze tamponades only. An external thermoplastic nasal splint was used on all patients

Outcomes of interest

The rate of rhinoplasty after fracture consolidation was determined. Factors influencing the need for revision rhinoplasty were analyzed.

Statistical analysis

Descriptive statistics included frequencies and proportions for categorical variables. Means, medians, and ranges were reported for continuously coded variables. The Chi-square tested the statistical significance in proportions differences. The t-test and Kruskal-Wallis test examined the statistical significance of means and median differences. Univariable and multivariable logistic regression models tested the relationship between the need for rhinoplasty and several variables, namely age, sex, time between trauma and closed reduction, open versus closed fractures, concomitant septal fracture, concomitant other facial fracture, initial cosmetic disturbance, airway obstruction, time of gauze, splint and cast removal, premature gauze or cast removal by the patient, secondary fractures. R software environment for statistical computing and graphics (version 3.4.3) was used for all statistical analyses. All tests were two sided with a level of significance set at $p < 0.05$

Results

Between 2010 and 2020, closed nasal reduction was performed in 417 consecutive patients with nasal bone fractures (306 male and 111 female patients) (table 1). One illustrative case can be found in figures 1 to 4. Median patient age was 30 years (interquartile range [IQR]: 23-45 years). Overall, 371 (89 %) patients had a closed fracture while 46 (11 %) patients had open fractures. One third of all patients (139 patients, 33.3 %) suffered from an associated nasal septum fracture. A Septal deviation visible in the CCT and/or clinically was present in 135 patients (32.4%) and a dislocation of the septum was noted in 59 patients (14.1%). Concomitant facial fractures were seen in 56 patients (13.4%). At the time of initial presentation, a visible nasal deformity was noted in 415 (99.5%) patients. 190 (45.6%) complained of an

additional subjective airway obstruction. 279 (66.9%) patients received a CCT. These fractures were staged according to Rohrich and Adams (table 2).

Most nasal fractures were sustained by an assault mechanism (147 patients, 35.3%). 285 patients (68.3%) received a computed tomography throughout their initial diagnostic workup. For 132 patients (31.7%), the diagnosis was based on x-rays.

46 patients (11%) had a history of at least one prior nasal fracture. In addition to closed reduction of the nasal bones, open septum surgery was performed on 7 patients (1.7%). Septal splints were placed in 42 patients (10%). All other patients received gauze tamponades only.

Closed reduction was performed in average 6 days posttraumatically (median, IQR 4-9). Gauze removal took place at 2 days postoperatively (median, IQR 2-3). The cast was removed after 7 days (median, IQR 7-8). If Doyle splints were placed, they were removed 14 days postoperative (median, IQR 8-14). 61 patients (14.6%) removed the gauze themselves before the scheduled appointment and 72 patients (17.3%) removed the cast themselves before the planned visit.

At the time of cast removal 52 patients (12.5%) complained of airway obstruction, that had not been present prior to the trauma. For 47 patients (11.3%) an indication for rhinoplasty surgery was documented after fracture healing. 32 of these patients underwent revision rhinoplasty at our institution. Average follow up time was 37 weeks. For patients requiring revision rhinoplasty, the end date for nasal fracture follow-up was defined as the date where the indication for rhinoplasty was made. Revision rhinoplasty was performed 398 (range 214-592) days after initial reduction. The indication for rhinoplasty was made to address persisting airway obstruction only in 10 cases and to address both airway obstruction and persisting cosmetic deformity in 18 cases. In 4 cases solely a cosmetic deformity needed to be addressed. In these case deformities were deemed as such when a visible deviation or hump was

present that had not present prior to the trauma. In these cases patients were asked to demonstrate pre trauma photographs to get a better understanding of the posttraumatic deformity. Preoperatively an additional evaluation by an ENT surgeon was sought in 16 cases. The target areas addressed during revision rhinoplasty are documented in table 3. In the majority of patients the septum (87.5%) and the outer nose (81.3%) were addressed. In the postoperative regime gauze tamponades were removed after 24 hours in 12 patients, 3 patients had gauze removal after 2-5 days. 17 patients received foam cubes only. Septal splints were left in place for 5 - 7 days in 6 patients and for 10-14 days in 17 patients. Casts were removed after 5 - 7 days in 9 patients and after 10-14 days in 19 patients.

Patients who had suffered an additional septum fracture were more likely to undergo rhinoplasty (48.9% vs. 31.4%, p=0.02) The same was true for patients with septal deviation (51.1% vs. 30%, p= 0.006). Having suffered a previous nasal fracture made it more likely that there would be a need for open rhinoplasty after fracture healing (21.3% vs. 9.7%, p=0.01). Patients who complained of an airway obstruction at the time of cast removal were significantly more likely to require rhinoplasty surgery (34% vs. 9.7%, p<0.001).

No specific stage according to Rohrich and Adams was found to be a predictor for future need of revision rhinoplasty (table 2).

In multivariable logistic regression models evaluating the risk of the need for open rhinoplasty after fracture healing (see table 4) airway obstruction at the time of cast removal was an independent predictor of the need for open rhinoplasty after fracture healing (Odds ratio [OR]: 4.79, p=0.0004).

Discussion

Closed treatment of nasal bone fractures has been described in detail for centuries [7]. The restoration of form and function is the goal of closed nasal reduction [5]. Even though this surgical intervention is considered a straightforward procedure, the incidence of post-reduction nasal deformity requiring open revision rhinoplasty is as high as 14 to 50 percent, according to Rohrich and Adams [6].

In our study, we analyzed which factors might be attributed to a higher risk of a residual post-reduction nasal deformity resulting in the need for revision rhinoplasty. Our analysis yielded several interesting findings.

First, median patient age was 30 years and most nasal fractures were sustained by an assault mechanism (147 patients, 35.3%). Other studies have quoted assault as a cause for nasal bone fractures with a percentage as high as 60% [8]. Regarding age, other centers have reported similar data [9]. Neither patient age nor trauma mechanism had an effect on the need for later revision rhinoplasty in our study. The majority of patients were male. This has been attributed to the higher incidence of interpersonal violence between males [10].

Second, 46 patients (11%) had a history of at least one prior nasal fracture. These patients were more likely to require revision rhinoplasty. Previous nasal injury and potentially pre-existing deformity could complicate closed reduction as the technique is based on visual examination [5].

Third, we saw that patients with an associated nasal septal fracture and a visible septal deviation were more likely to undergo revision rhinoplasty. A thorough assessment of the nasal septum is considered the most important step in determining aesthetic and functional outcomes in nasal fractures [11]. Ash forceps are used for septal reduction and the septum is splinted post-reduction. 29.5% (41) of our patients with a septal fracture received silicon splints the remainder was treated with

gauze packing only. However, visual inspection might not suffice to fully assess the post-reduction septal alignment and splinting techniques might be insufficient to maintain reduction resulting in a later need for revision rhinoplasty.

Fourth, in our cohort, 14.6% of patients removed the gauze packing prematurely or took off their cast prematurely in 17.3% of cases. This, however, did not have an impact on the likelihood of later revision rhinoplasty. Post-reduction external splinting by means of a nose cast or a thermoplastic dressing is generally considered necessary [12]as a protection towards outside forces but reduction per se is not held by a cast thus premature removal seems to have no significant influence on overall outcomes.

However it needs to be considered that as Farber et al [5] stated that one week after closed reduction, the nasal bones remain mobile. In fact some colleagues will manage any deviation or collapse with external manipulation of the nose with localized application of pressure until symmetry is reestablished. This approach is not performed in our department so its potentially beneficial effect towards avoiding the need for revision rhinoplasty could not be addressed.

Fifth, patients who complained of an airway obstruction at the time of cast removal were significantly more likely to end up requiring revision rhinoplasty surgery as described above. At our department, casts are generally removed seven days post-reduction and we typically wait 3 months post trauma before the indication for secondary rhinoplasty is made. Taking our findings concerning airway obstruction into consideration, it might be beneficial to discuss an increased risk for the need of secondary rhinoplasty with the patient already at the time of splint removal if airway obstruction is present. But of course airway obstruction at this point might also still be due to swelling.

There are several limitations to this study. It is a retrospective study and thus may be prone to observer bias. The conclusions will need to be supported by prospective data for greater impact. Additionally, as we are presenting consecutive cases, patients were operated on by different surgeons. These adhere to a department standard concerning the intra- and postoperative regime, but minor deviations based on personal preference might have been made. Additionally, it is possible that in some cases proper reduction might not have been achieved, consequently leading to residual airway obstruction or aesthetic deformity. This could of course not be identified in this retrospective analysis. And it has to be noted that the success of closed reduction was assessed clinically only. A CCT scan would have provided an objective assessment of the reduced nasal bones but would not have been justified in our opinion in this young (median patient age was 30 years (interquartile range [IQR]: 23-45 years)) patient cohort. A purely clinical assessment by definition is prone to observer bias. However, it is common practice for the reduction of isolated fractures of the nasal bone. Also objective measurements of nasal appearance and function especially in the form of a patient reported outcome measurement like e.g. the 10-Item Standardized Cosmesis and Health Nasal Outcomes Survey (SCHNOS) [13] for these patients at the time of injury and at the final postoperative assessment are not available for this patient cohort, leading to a partly subjective assessment by the treating surgeon. A detailed assessment of the relative bony vs cartilaginous contributions to the nasal skeleton was not performed for this cohort. This might have been a factor that contributed to the need for revision and in itself could have been a significant contributor to closed reduction failure. Also, the pretraumatic nasal configuration of patients who ended up requiring revision rhinoplasty was not available thus minor, asymptomatic airway obstructions might have been present pretraumatic (with the patient not aware of them) and were only aggravated by the

fracture. Lastly, some patients were lost to follow-up and may have undergone revision rhinoplasty elsewhere..

Conclusion

Even though closed reduction of nasal fractures is frequently considered a straightforward procedure, a significant number of these patients will require secondary revision rhinoplasty. Associated nasal septal fractures may present a risk factor for the need for secondary revision surgery. Subjective airway obstruction at the time of cast removal after closed reduction was found to be predictive of revision rhinoplasty later on. Prospective studies are required to support the findings of this investigation.

Conflict of interest statement

All authors declare that there is no conflict of interest.

Ethical statement

Approval to perform the study was given by the Cantonal Ethics Committee of Zurich, Switzerland (Ethical approval ID 2020-00349). All patients gave written consent for data evaluation. Patients of which photographs are shown gave written consent to show full face photographs.

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none

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Figures

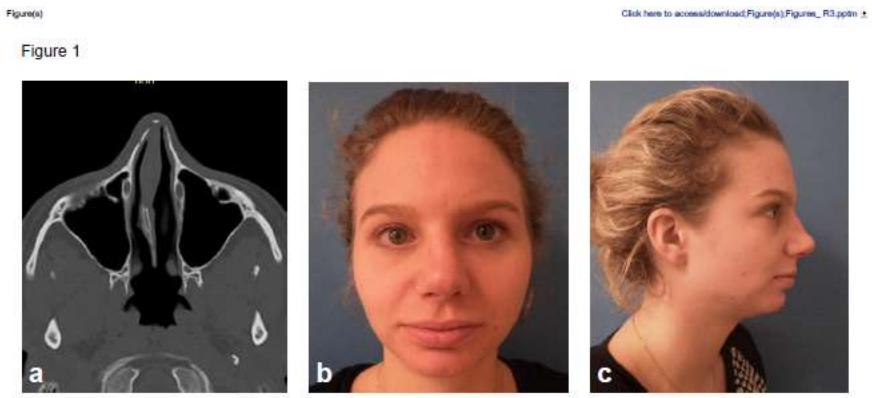

Figure 1

(a) While ice-skating this 27 year-old female patient fell and sustained a dislocated nasal fracture (b and c). Due to an obvious axial deviation the indication for closed reduction was given

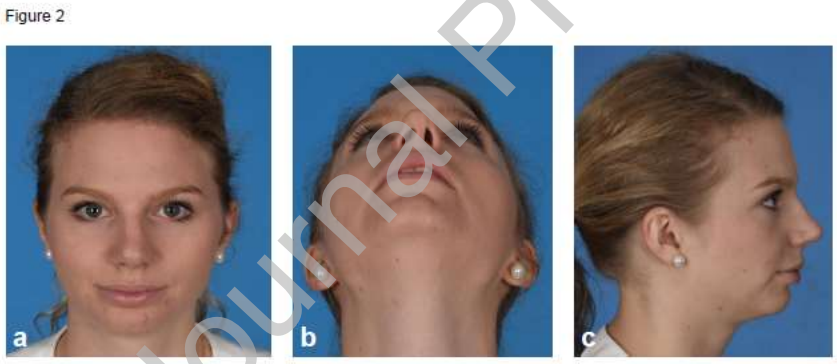

Figure 2

(a-c) In the post reduction course the patient complained of a persisting airway obstruction accompanied by an axial deviation leading to the indication for revision rhinoplasty.

Figure 3

Figure 3

(a-c) Results 12 months after open revision rhinoplasty with septoplasty septal extension grafts, spreader flaps, osteotomies, lateral overlay, spanning sutures and fdc.

Figure 4

Figure 4

(a-c) This 22-year old patient suffered a closed nasal fracture during a fall and underwent closed reduction for a visible axial deviation to the right. Six months post the reduction a deviation and airway obstruction persisted. At 12 months post reduction the patient underwent open revision rhinoplasty.

Figure 5

Figure 5

(a-c) Results 12 months after open revision rhinoplasty with paramedian, lateral and transverse osteotomies. Septoplasty was performed, spreader grafts were placed, transcutaneous, transosseus cerclage sutures were placed as well as tongue in groove and interdomal sutures and fdc was applied over the nasal dorsum. Doyle-Splints and a cast were worn for 2 weeks postoperatively.

Figure 6

Figure 6

Illustration summarizing this study's key points

Tables

Table 1: Patient variables and there effect on the need for revision rhinoplasty

Variable		Overall		Secondary RSP	p-value
			370 (88.7)	47 (11.3)	
Age (y)	Median	30	30	27	0.3
	IQR	23-45	23-45	20.5-43	
Sex, n (%)	female	111 (26.6)	97 (26.2)	14 (29.8)	0.7
	male	306 (73.4)	273 (73.8)	33 (70.2)	
Mechanism of trauma	assault	147 (35.3)	128 (34.6)	19 (40.4)	0.4
	polytrauma	7 (1.7)	5 (1.4)	2 (4.3)	
	slipping	116 (27.8)	106 (28.6)	10 (21.3)	
	sports	103 (24.7)	93 (25.1)	10 (21.3)	
	traffic	44 (10.6)	38 (10.3)	6 (12.8)	
Cosmetic deformity	No	2 (0.5)	2 (0.5)	0 (0)	1
	Yes	415 (99.5)	368 (99.5)	47 (100)	
Airway obstruction	No	225 (54)	204 (55.1)	21 (44.7)	0.3
	Yes	190 (45.6)	165 (44.6)	25 (53.2)	
Prior nasal fracture	No	271 (65)	248 (67)	23 (48.9)	0.01
	Yes	46 (11)	36 (9.7)	10 (21.3)	
Imaging modality, n (%)	CT	285 (68.3)	249 (67.3)	36 (76.6)	0.3
	x-ray	132 (31.7)	121 (32.7)	11 (23.4)	
Type of fracture, n (%)	closed	371 (89)	333 (90)	38 (80.9)	0.1
	open	46 (11)	37 (10)	9 (19.1)	
Associated septum fracture, n (%)	No	278 (66.7)	254 (68.6)	24 (51.1)	0.02
	Yes	139 (33.3)	116 (31.4)	23 (48.9)	
Impression fracture	No	259 (62.1)	232 (62.7)	27 (57.4)	0.7
	Yes	155 (37.2)	136 (36.8)	19 (40.4)	
Concomitant facial fractures	No	361 (86.6)	322 (87)	39 (83)	0.6
	Yes	56 (13.4)	48 (13)	8 (17)	
Septal hematoma	No	409 (98.1)	363 (98.1)	46 (97.9)	0.7
	Yes	8 (1.9)	7 (1.8)	1 (0.1)	
Septal deviation	No	282 (67.6)	259 (70)	23 (48.9)	0.006
	Yes	135 (32.4)	111 (30)	24 (51.1)	
Dislocation of the septum	No	358 (85.9)	321 (86.8)	37 (78.7)	0.2
	Yes	59 (14.1)	49 (13.2)	10 (21.3)	
Mucosal disruption	No	394 (94.5)	351 (94.9)	43 (91.5)	0.5
	Yes	23 (5.5)	19 (5.1)	4 (8.5)	
Time to reduction (d)	Median	6	6	6	0.9
	IQR	4-9	4-9	4-9	
Septal splint placement	No	375 (89.9)	337 (91.1)	38 (80.9)	0.05
	Yes	42 (10.1)	33 (8.9)	9 (19.1)	
Time to gauze removal (d)	Median	2	2	2	0.2
	IQR	2-3	2-3	2-3	
Premature gauze removal by patient	No	312 (74.8)	274 (74.1)	38 (80.9)	0.5
	Yes	61 (14.6)	56 (15.1)	5 (10.6)	
Time to cast removal (d)	Median	7	7	7	0.7
	IQR	7-8	7-8	7-9	
Premature cast removal by patient	No	331 (79.4)	297 (80.3)	34 (72.3)	0.1
	Yes	72 (17.3)	59 (15.9)	13 (27.7)	
Airway obstruction after cast removal	No	306 (73.4)	283 (76.5)	23 (48.9)	<0.001
	Yes	52 (12.5)	36 (9.7)	16 (34)	
Time to Doyle removal (d)	Median	14	14	9	0.4

	IQR	8-14	8-14.2	7-14	
Airway obstruction at last follow up	No	363 (87.1)	351 (94.9)	12 (25.5)	<0.001
	Yes	54 (12.9)	19 (5.1)	35 (74.5)	
Patient content with result at last follow up	No	64 (15.3)	27 (7.3)	37 (78.7)	<0.001
	Yes	353 (84.7)	343 (92.7)	10 (21.3)	

Table 2: Nasal fracture classification according to Rohrich and Adams and univariable logistic regression for revision rhinoplasty

Nasal fracture classification and univariable logistic regression for revision rhinoplasty					
Variable	number of patients with CCT	odds ratio	2.5 %	97.5 %	p-value
	279				
I. simple (unilateral)	15	Ref.			
II. simple (bilateral)	15	3.5	0.38	76	0.3
III. comminuted					
a. unilateral	23	2.9	0.38	61	0.3
b. bilateral	69	0.6	0.07	13	0.7
c. frontal	11	1.4	0.05	38	0.8
IV. complex (nasal bone & septal disruption)	62	1.7	0.28	34	0.6
a. assoc.septal hematoma	6	0.0	0.00	20	0.9
b. assoc.open nasal laceration	47	2.4	0.38	47	0.4
V. assoc NOE fracture/midface fracture	31	3.3	0.50	66	0.2

	Patients (%)
ENT involvement before revision rhinoplasty	16 (50)
Areas addressed during revision rhinoplasty	
Radix / Dorsum (glabella to lateral canthus, nasion, dorsum, hump)	15 (46.9)
Septum	28 (87.5)
Outer nose (nasal bone/sidewalls, ULC)	26 (81.3)
Tip (lobule, alar cartilages, tip defining points, supratip point, volume/definition/width, rotation/projection, shape and skin envelope)	20 (62.5)
Base (alar basis, nostrils, columella)	21 (65.6)
Other	13 (40.6)

Postoperative treatment	
Septal splint placement	23 (71.9)
Gauze tamponad placement	15 (46.9)
Cast placement	28(87.5)

Table 3: Features of revision rhinoplasty including targeted areas and postoperative regime

Logistic regression model for prediction of secondary rhinoplasty				
		2.5 %	97.5 %	
Associated septum fracture	1.79	0.71	4.44	0.21
Prior nasal fracture	2.01	0.74	5.07	0.15
Placement of a septal splint	1.33	0.30	5.24	0.69
Septal deviation	1.58	0.64	3.81	0.31
Subjective airway obstruction*	4.79	1.99	11.40	<0.001

***at time of cast removal

Table 4: Logistic regression model for prediction of revision rhinoplasty

Supplementary Material

Supplementary Table 1

Features of revision rhinoplasty including targeted areas and postoperative regime

Supplementary Table 2

Logistic regression model for prediction of revision rhinoplasty