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ORIGINAL PAPER

Esthetic and functional result of crooked nose treatment; internal microperforating osteotomy and subtotal septal reconstruction

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Abstract

Crooked nose is mostly characterized by a deviation of both the bone and the cartilaginous parts of the nose. In order to obtain proper functional and improved esthetic results, both of these parts have to be corrected. The objective of this study is to evaluate the esthetical and the functional outcomes following correction procedures of the bone pyramid through internal microperforating technique and the cartilaginous part through subtotal septal reconstruction. The medical records of 158 patients who have undergone through primary septorhinoplasty for crooked nose treatment during the period of 21 June 2016 and 31 July 2017 have been reviewed. Functional results have been evaluated using the Nasal Obstruction Symptom Evaluation (NOSE) scores and the esthetical results through Rhinoplasty Outcome Evaluation (ROE) scores. The observation times have been arranged preoperatively as 6 months–1 year (group 1) and 1–2 years (group 2). Septorhinoplasty procedure has been performed on 158 patients with crooked noses. Out of this number, 104 of the patients (65.8%) were women and 54 were men (34.2%). The average age of the patients was 31.59 (9.3%), all of who have undergone this procedure. There was a significant improvement ($P < 0.001$) in the NOSE and the ROE scores of group 1 and group 2, which was statistically significant. There was no difference between group 1 and group 2. In crooked nose treatment, correction of the deviated bone pyramid using internal microperforating osteotomy and correction of the severely deviated septum using subtotal septal reconstruction yield improved functional and esthetic results.

Level of Evidence: Level V, therapeutic study.

Keywords Crooked nose · Internal microperforating osteotomy · Subtotal septal reconstruction · Rhinoplasty

Introduction

Achieving pleasing results in crooked nose surgery is difficult. In the crooked noses, there are deviations mostly both in the bone and in the cartilaginous parts of the nose that should be corrected separately. Not enough bone and cartilage exposition and mobilization procedures have been performed for fear of de-stabilization and the possibility of occurrence of complications. In correction of the bone, it is necessary to perform various osteotomies instead of employing only medial and lateral osteotomies. Power instruments such as piezo and burr are used to remove the humps and the protrusions and to perform multiple osteotomies [1]. Extended periosteal elevation contributes a lot to use of power instruments easily. Extended elevation is also an advantage in protection of surface structures and re-draping. In the event that septal cartilage cannot be corrected using partial resection and scoring, it is necessary to mobilize the cartilaginous structures and perform reconstruction procedure. Extracorporeal septoplasty [2, 3] and subtotal septal reconstruction [4, 5] techniques have been used for years in severe deviated septum and dorsum incidents. Following removal and correction of septum, the L-strut must be rebuilt. Fixation of the bone pyramid of the L-strut and anterior nasal spine (ANS) is significant for stabilization [2]. Maintenance of bone and cartilage skeleton relationship at point K (keystone) offers significant advantages for fixation [3]. Following formation of bone and cartilage, rotation and elevation of the tip of the nose are significant for getting

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functional and esthetic results. The Tongue in Groove [6] Method is one of the techniques that provide medial crura stabilization and rotation. In crooked nose, there are often asymmetric lateral cruses that have to be mobilized for correction. In the event that they cannot be corrected by partial resection and suturing, both strengthening and much better symmetric angling of lateral cruses can possible be performed through lateral crural strut technique.

In this study, we have evaluated the functional and esthetical improvement of crooked nose of those patients with bone and cartilage pyramid deviations that cannot be corrected only by using conservative techniques.

Materials and methods

Operations have been performed by a single surgeon (HN), using an external septorhinoplasty approach, between 21 June 2016 and 31 July 2017. A total number of 158 patients have had operation. We excluded those patients who have previously undergone rhinoplasty. The bone and cartilaginous structures of all the patients have been corrected. Bone hump removal and osteotomies have been performed by using burr and osteotome. Septum has been corrected using subtotal septal reconstruction procedure. The patients who could be treated without the need for subtotal septal reconstruction have not been included in this study. All the patients have been evaluated pre- and postoperatively in accordance with the Rhinoplasty Outcome Evaluation (ROE) and Nasal Obstruction Symptom Evaluation (NOSE) [7, 8] score results. The results have been evaluated in regard to preoperative scores as 6 months–1 year (group 1) and 1–2 years (group 2).

The evaluation of the ROE questionnaire outcomes in regard to rhinoplasty are provided in Table 1. Alsarraf [9] has developed the questionnaire on three key points, which are based on patient satisfaction and quality of life, including physical, emotional, and social factors. The ROE is an easy and comprehensive questionnaire to complete and is used for functional and esthetical assessments. There are a total of six questions that can be scored using numbers between 0 and 4, "0" being the most negative answer and "4" the most positive answer. High points indicate that the outcome of the operation is excellent.

Nasal Obstruction Symptom Evaluation (NOSE) is provided in Table 2 [10, 11] and is used for nasal breathing outcomes. Decreased scores indicate improved functional results. The NOSE classification system will help to understand the severity of symptoms and potential treatment effects. The scale has been designed to use in measuring nasal obstruction and thus provides an ideal instrument for use in functional rhinoplasty techniques.

Surgical technique

The preoperative and postoperative Photoshop photographs of the patients have been compared, and the possible amount of resection to be performed has been established. Open technique has been used in all the patients. Transcolumellar inverted-V incision has been employed. The upper lateral cartilages and the top part of the lower lateral cartilages have been elevated. The bone has been elevated in an extended subperiosteal way. The dorsal hump has been removed using 4- and 5-mm burr. The estimated cartilaginous hump has been removed. The medial and the lateral osteotomy sites have been established, and the sites of the osteotomy line were thinned using 2-mm burr. Very often asymmetric medial osteotomy and intermedial osteotomy have been performed due to deviation of the bone pyramid. Using a 1-mm burr, perforations have been made in the osteotomy line at every 1-mm intervals, and these perforations have been joined using 2-mm osteotome. In this way, the osteotomy procedure has been completed. In endoscopic examinations of the nasal mucosa, no mucosa damage has been observed.

Following removal of the cartilage hump, the deviated cartilage has been completely removed leaving a cartilage at 1–1.5 cm in height and 1–1.5 cm in length at the point K. In order not to break off the septum and nasal bone relationship, we performed medial osteotomy on the deviated part, from the upper part of the intersection of septal bone and nasal bone. The asymmetric medial osteotomy has been designed to protect interrelationship (Fig. 1). By correcting the piece of bone, the K point has been brought to midline. In the cases when it becomes necessary to mobilize the cartilage at point K completely, a hole is made on the dorsal bone and suturing has been performed. A groove has been prepared by using 2–3-mm burr, where the cartilage septum would be placed at ANS in the front. A hole has been perforated on the front part of the ANS using 1-mm burr. Using PDS-4/0 sutures, the distal septal cartilage graft has been sutured twice in the shape of O in the hole that was opened previously.

The caudal and the proximal septal cartilages have been united using two spreader grafts. The spreader grafts have been sutured by checking the cartilage rotation. The angle of rotation has been arranged with length of the gap between proximal and distal parts of septal cartilage. In this way, there was no need to add cartilage to perform septal extension graft. Spreader grafts have been sutured using PDS 5/0 suture. First, the gap between proximal and distal septal cartilage has been filled with pieces of cartilage by suturing (Figs. 2 and 3). The back parts of medial cruses of alar cartilages have been sutured to septal cartilage. Medial domal and interdomal figure 8 sutures have been sutured with PDS 5/0. By placing the interdomal suture on the septum, the weight is loaded on ANS. The columellar strut,

Table 1 Outcomes of rhinoplasty evaluation (ROE)

	0	1	2	3	4
1. How well do you like the appearance of your nose?	Absolutely not	A little	More or less	Very much	Absolutely yes
2. How well are you able to breathe through your nose?	Absolutely not	A little	More or less	Very much	Absolutely yes
3. How much do you feel your friends and lovers like your nose?	Absolutely not	A little	More or less	Very much	Absolutely yes
4. Do you think your current nasal appearance limits your social and professional activities?	Always	Frequently	Sometimes	Rarely	Never
5. How confident are you that your nasal appearance is the best that it can be?	Absolutely not	A little	More or less	Very much	Absolutely yes
6. Do you like the appearance or function of your nose after operation?	Certainly yes	Very likely yes	Possibly yes	Possibly not	Certainly

Table 2 Nasal Obstruction Symptom Evaluation (NOSE)

	Not a problem	Very mild problem	Moderate problem	Fairly bad	Severe problem
1. Nasal congestion or stuffiness	0	1	2	3	4
2. Nasal blockage or obstruction	0	1	2	3	4
3. Trouble breathing through my nose	0	1	2	3	4
4. Trouble sleeping	0	1	2	3	4
5. Unable to get enough air through my nose during exercise or exertion	0	1	2	3	4

which is in the shape of triangular prism and which was taken from the dorsum and has been sutured between the medial cruses. Since the positions of the lateral cruses are asymmetric in deviated noses, the lateral crural strut technique has often been used. The lateral cruses have been completely mobilized from vestibular skin. The space between the dome and bone pyramid has been measured. The length of lateral cruse has been arranged in accordance with this measure. The lateral cruses have been placed to their new place under the lateral piece by adding 1–2-cm cartilage. The lateral cruses in good position have been

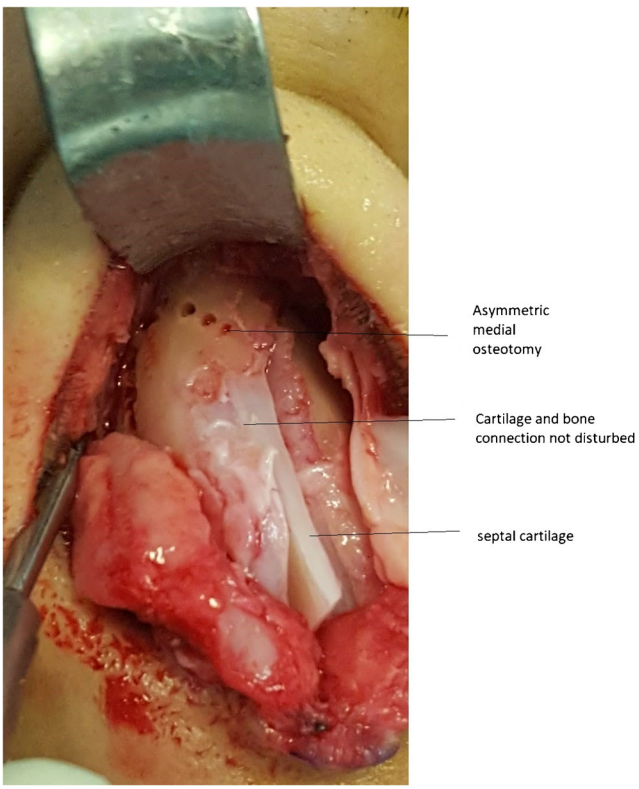

Fig. 1 Asymmetric medial osteotomy

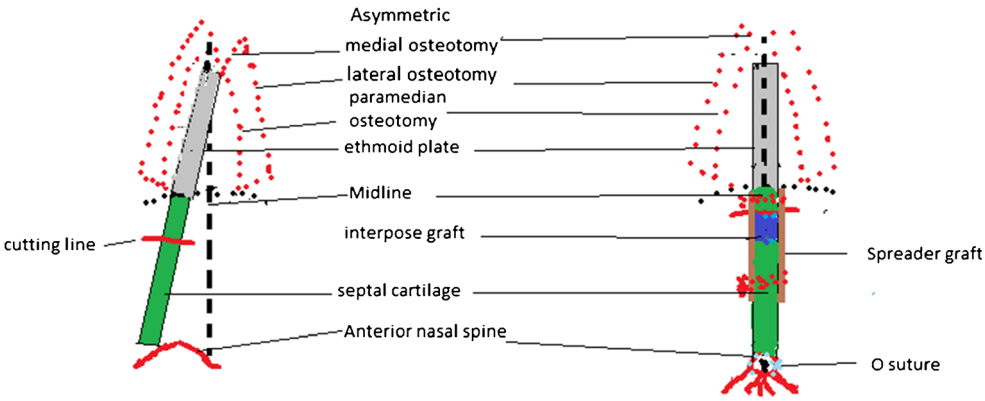

Fig. 2 Schematic illustration of front view

strengthened by putting batten graft, and thus, their collapse has been prevented. Depending on the conditions, cap and shield grafts have been used. The depression in the bone structure has been filled with the bone dusts obtained during the burr procedure. The depression in the cartilaginous structure has been filled using cartilage and soft tissues and covered with fibrin gel. Septum has been sutured using 5/0 Vicryl Rapide. No packing has been placed. The skin cuts have been sutured using 7/0 Prolene, and the operation has been ended (video in the electronic supplementary material).

Statistical analysis

Data analysis has been performed between 01 March 2018 and 15 March 2018. Statistical analysis was carried out using IBM-SPSS version 20.0 for Mac OS (IBM Corp. Released 2011). A P value < 0.05 was used to assess the significance of all the statistical analyses. In order to define the sample, variables were expressed as mean ± standard deviation, median, and categorical variables in numbers and percentages. The difference between the two dependent groups was compared with the Wilcoxon signed-rank test (Table 3).

Results

A total number of the patients who have undergone operation were 158, 54 (34.2%) males and 104 (65.8%) females, and the mean age (SD) was 31.58 (17–66). All of the patients had already undergone primary rhinoplasty. All the patients were asked, preoperatively, NOSE and ROE questions preoperatively, for a period of 6 months–1 year (group 1) and 12 months–2 years (group 2). There were 63 people in group 1 with an average age of 29.5 and 95 people in group 2 with an average age of 32.9 (Table 3).

NOSE analysis

Preoperative mean (SD) Nasal Obstruction Symptom Evaluation (NOSE) score in all the patients was 13.96 (± 6.8), and postoperative mean NOSE score was 2.05 (±4.1). The mean decrease in NOSE scores in all the patients was 11.91 and was statistically significant (P < 0.001). In group 1, the preoperative mean NOSE score was 13.41 (± 7.2) and postoperative mean NOSE score was 2.11(± 4.2). The mean decrease in group 1 was 11.3 and is statistically significant (P < 0.001). In group 2, preoperative NOSE score was 14.33(± 6.6) and postoperative NOSE score was 2.01 (± 4.15). The mean decrease in group 2 was 12.32 and was

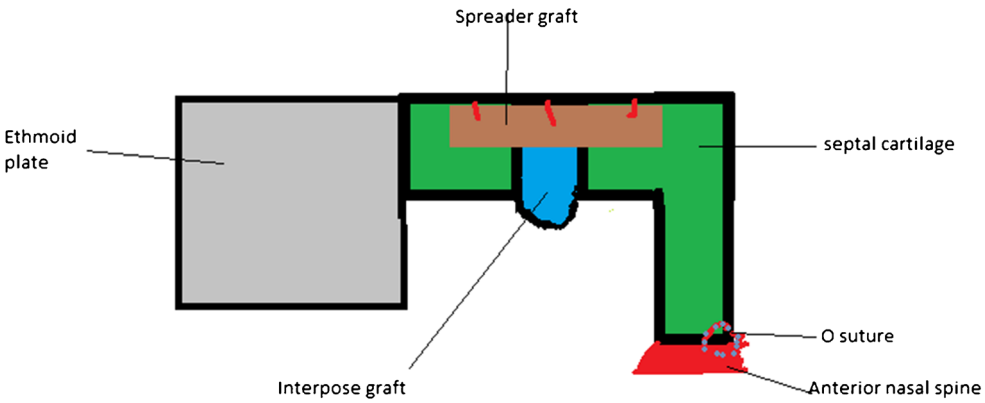

Fig. 3 Schematic illustration of lateral view

Table 3 Demographic characteristics and evaluation of NOSE and ROE scores by duration of follow-up

Demographic characteristics by duration of follow-up						
	All the patients		Group 1	Group 2		
Age (mean ± SD)	31.59 ± 9.333		29.51 ± 8.613	32.97 ± 9.577		
Female (%)	65.8 (104)		65.1 (41)	66.3 (63)		
Male (%)	34.2 (54)		34.9 (22)	33.7 (32)		
Evaluation of NOSE scores by duration of follow-up						
	All the patients		Group 1	Group2		
	Mean ± SD	Median (min–max)	Mean ± SD	Median (min–max)	Mean ± SD	Median (min–max)
NOSE scores preop	13.96 ± 6.884	15 (0–20)	13.41 ± 7.248	15 (0–20)	14.33 ± 6.645	15 (0–20)
NOSE scores postop	2.05 ± 4.192	0 (0–20)	2.11 ± 4.288	0 (0–20)	2.01 ± 4.15	0 (0–20)
P value[a]	< 0.001		< 0.001		< 0.001	
Evaluation of ROE score by duration of follow-up						
	All the patients		Group 1		Group2	
	Mean ± SD	Median (min–max)	Mean ± SD	Median (min–max)	Mean ± SD	Median (min–max)
ROE scores preop	4.15 ± 3.347	3 (0–14)	3.78 ± 3.17	3 (0–14)	4.4 ± 3.453	4 (0–14)
ROE scores postop	20.56 ± 3.967	21 (8–24)	21.06 ± 3.496	22 (13–24)	20.23 ± 4.236	21 (8–24)
P value[a]	< 0.001		< 0.001		< 0.001	

Group 1: 6–12-month follow-up patients; group 2: 12–24-month follow-up patients

[a] Wilcoxon signed-rank test

statistically significant ($P < 0.001$). There was no difference between group 1 and group 2 (Table 3).

ROE analysis

Preoperative mean (SD) Rhinoplasty Outcome Evaluation (ROE) score in all the patients was 4.15 (± 3.3), and postoperative ROE score was 20.56 (± 3.9). The mean increase in ROE scores in all the patients was 16.1, which was statistically significant ($P < 0.001$).

In group 1, preoperative mean ROE score was 3.78 (± 3.17) and postoperative mean ROE score was 21.06 (± 3.4). The mean increase in group 1 was 17.8 and was statistically significant ($P < 0.001$). In group 2, preoperative ROE score was 4.4 (±3.4) and postoperative ROE score was 20.23 (± 4.2). The mean increase in group 2 was 15.73 and was statistically significant ($P < 0.001$). There was no difference between group 1 and group 2 (Table 3).

Discussion

Crooked nose treatment is one of the most challenging operations. Very often, there are problems in the bone pyramid and the cartilage. It is necessary to mobilize the bones and the cartilage completely and perform reconstruction. During the reconstruction, the extent of deviation cannot be evaluated sufficiently [2]. King and Ashley [12] first defined extracorporeal septoplasty in 1952, and Gubisch [13] has popularized it. Subtotal septal reconstruction was defined by Toriumi [4]. Following these techniques, a notable improvement has been observed both in esthetic and functional results. In addition to severe cartilage deformations, we have also examined correcting bone pyramid disorders. We have performed open technical septorhinoplasty to entire patients. Over the cartilage and bone, dissections have been performed subperichondrial [14] and extended subperiosteal ways. With extended subperiosteal [1] and subperichondrial elevation, we aimed to protect the soft tissues. To perform

Fig. 4 Preoperative and 1-year postoperative look of a 30-year-old patient

Fig. 5 Preoperative and 1-year postoperative look of a 26-year-old patient

manipulations easily, more flexible alar and upper lateral cartilage have been obtained through subperichondrial elevation. To correct severe bone pyramid deviations, asymmetric and intermedial osteomies have often been necessary. In designing osteotomies, observing whole of the bone pyramid is of a great advantage. Extended elevation provides ease in using the burr and the fixation of sutures. One of the conditions that prevent desired osteotomy line is unclear sight of osteotomy lines [1]. It is rather important that the osteotomy line be performed from the desired line and without applying too much pressure. Undesired esthetic results may occur due to digital pressure, insufficient mobilization, and uncontrolled osteotomy line. The osteotomies that are not performed properly are the cause of significant revision rhinoplasty [15]. Thinning of the osteotomy sites using burr and microperforating osteotomies of 1 mm with 1-mm intervals provide us the opportunity, like piezo [1], to perform osteotomy at any line, in any numbers.

In order to correct the cartilaginous part, the subtotal septal reconstruction technique [4] has been used. Leaving enough amount of strong cartilage on the keystone area that will enable suturing. Leaving strong cartilage at the keystone is an advantage for stabilization [3]. In order not to break off the septum and nasal bone relation, we performed medial osteotomy on the deviated part, from the upper of the intersection of septal bone and nasal bone. If cartilage is taken out and corrected, its fixation to dorsal septum upper lateral cartilages is important [2] because it provides us the opportunity of suturing directly. In cases when we have made the dorsal septum completely mobile, we drilled a hole in the nasal bones with burr and sutured it to the nasal bone as well as to the upper lateral cartilage. Leaving of L-strut at a height of 1.5 cm is suggested as a dogma [7].

Thickness of the L-strut contributes more to septal strength than does the L-strut width [16, 17]. When the dorsum is thick and strong enough and point K is weak, this may cause breaking of it [8]. Direct cartilage and bone suture fixation at K point is very important. Distal septal cartilage and the proximal septal cartilage are joined using spreader graft, forming L-strut, which were sutured to ANS. By drilling a hole in the front part of the ANS using a 1-mm burr, the cartilage was sutured twice using 4/0 PDS like figure O. Since the distal septal cartilage carries the weight of the tip, a smooth and secure fixation was performed into the groove that was formed in ANS. Through direct fixation, the rate of slippage has been decreased [13]. Some other different techniques have been described through which direct fixations are not performed [5, 18]. The proximal and distal cartilage pieces have been joined using spreader graft. By adjusting the length of the gap between proximal and distal septal cartilages, the distal septal cartilage rotation angle was so arranged that there was no need to add any cartilage in the anterior part. By adjusting the distal cartilage rotation angle, there was no need to use septal extension graft and extended spreader graft; consequently, more economical cartilage was used. This technique can be used for elongation of septum in the short nose. To perform extended spreader and septal extension grafts, long spreader grafts are needed. When it comes to crooked nose, it is difficult to find this and is very often rib cartilage is necessary [19, 20].

Fig. 6 Preoperative and 4-month postoperative look of a 30-year-old patient

Fig. 7 Preoperative and 1-year postoperative look of a 31-year-old patient

The pre-formed gap between the dorsum proximal and distal cartilage was filled with the remaining short pieces of cartilage and sutured. In this way, the short cartilage pieces have been used. It is very important that dorsum be intact and smooth. Gubisch [2] argues that 10–15% of the complications are very often due to dorsal irregularities. We use bone dust and fibrin gel to prevent dorsal irregularity. The overall revision rate in a large cohort of 175,842 patients undergoing septorhinoplasty with a minimal 3-year follow-up period was 3.3%. The rate of revision surgery among primary cases was 3.1%, and that among secondary cases was 11.0%. Similarly, patients who have had a rib graft (also indicating greater procedural complexity) displayed the highest revision rate of 21.5% compared with that of those patients who have required only a septal graft or conchal graft (6.3% and 11.4%, respectively) [20]. Toriumi [19] gives the revision rate as 9.75%. In prevention of any complications, thickness and width of dorsum are very important.

Suturing of the medial parts of the medial cruses of the lower lateral cartilages to septum was performed through tongue in groove technique [6], which is important to prevent tip ptosis. We fixed the medial cruse to the back of septum and we sutured columellar graft in the gap at the anterior part. Columellar grafts are not in the position to stand the weight of the tip; it was used to provide divergence and strength to domal and the medial cruses. In this way, the load of the tip was transferred to ANS from distal septal piece.

Asymmetries and malpositions are often met in lateral cruses [21]. In crooked nose, their percentage is rather high. As in our approach concerning bone and cartilage, in the event that the symmetry could not be obtained through suturing and using batten graft, we employed lateral crural strut (LCSG) and repositioning technique [22]. Lateral crural repositioning with LCSG corrects tip asymmetry and malposition, especially in cases that cannot be repaired with traditional tip-plasty suturing, such as very thin, malpositioned, concave, or asymmetric tip cartilages [23, 24]. Through lateral crural repositioning, much better symmetry and functional and attractive position can be achieved. By repositioning the lateral crura to the ideal symmetric position, alar rim support can be achieved, thereby optimizing the appearance of the nostril shape and the tip and positively influencing the ROE scores during postoperative follow-up [25].

By separating lateral cruses and vestibules from skin and by adding 1–1.5-mm cartilage as underlay according to dome-bone pyramid distances, they are both strengthened and made it possible to place it at right angle. In this way, the tip becomes more symmetric and functional (Figs. 4, 5, 6, 7, 8, 9, 10, and 11).

While objective outcomes are important, facial appearance is subjective, and asking patients what they think about the appearance of their nose is of paramount importance. As such, a validated quality of life (QOL) instrument that comprehensively evaluates patient satisfaction with both nasal function and esthetics is paramount to an adequate assessment of outcomes after rhinoplasty. The patient perspective can be measured using patient-reported outcome instruments [26]. Multiple PROMs have been developed for use in facial plastic surgery [10, 11, 27], and the Nasal Obstruction Symptom Evaluation (NOSE) questionnaire is the most widely used

Fig. 8 Preoperative and 6-month postoperative look of a 20-year-old patient

Fig. 9 Preoperative and 4-month postoperative look of a 24-year-old patient

one [10, 11]. Currently, the gold standard QOL instrument for nasal surgery is the NOSE scale, as first described by Stewart et al. [10, 11]. Notably, this instrument focuses on the assessment of nasal obstructive symptoms alone, and such its application is relatively limited with regard to surgery performed for primarily esthetic or combined functional/esthetic indications.

The FACE-Q scales measure outcomes that matter to patients, including facial appearance, quality of life, and adverse effects. İn addition, the FACE-Q includes scales that measure the patient experience of care (e.g., satisfaction with provided information). The FACE-Q was developed for use with surgical and nonsurgical facial esthetic patients. The objective of the FACE-Q scales crafted specifically for measuring the appearance of the nose and adverse effects after rhinoplasty [26]. The FACE-Q can only be used to evaluate cosmetic or psychosocial aspects and is not helpful in pre- and postoperative functional evaluations [28]. RHİNO scale was developed as a comprehensive quality of life instrument to assess patient satisfaction with both functional and esthetic outcomes after rhinoplasty. The versatility of the RHİNO scale becomes apparent when assessing patients in whom satisfaction with functional or esthetic outcomes may be divergent from the overall satisfaction reported after surgery. In these patients, evaluating outcomes using a unidimensional QOL instrument would not have revealed a comprehensive or accurate assessment regarding the patient's overall self-reported outcome and satisfaction [27]. The ROE scale is a complementary QOL instrument initially developed and validated by Alsarraf et al. [18], with a focus on esthetic and functional outcomes after nasal surgery. Alsarraf has developed the questionnaire on three key points, which are based on patient satisfaction and quality of life, including physical, emotional, and social factors. ROE is increasingly as evidenced in several recent outcome studies [25, 29]. ROE is an easy and comprehensive questionnaire to complete and is used for functional and esthetic assessments. We used well-known NOSE and ROE scale. We found statistically significant improvement preoperative and postoperative result. We found no difference between 6-month and 1-year results.

The objective of this study is to evaluate the esthetical and the functional results of rhinoplasty. Decades of experience with rhinoplasty have demonstrated that the function and esthetics of the nose are inseparably related. Esthetic complaints, such as collapse or narrowing of the middle vault after a reductive rhinoplasty, will often present concurrently with functional nasal obstructive complaints. Similarly, functional correction of nasal valve compromise while simultaneously creating an esthetically unacceptable appearance will almost universally result in poor patient satisfaction and by extension a poor outcome [27]. We agree with Dr. Toriumi that often surgeons may be hesitant to alter cartilage in this portion of the septum for fear of destabilizing the support structures of the nose and creating deformity, such as a saddle, pollybeak, dorsal deviation, short nose, or retracted columella [19]. Failure to adequately address deviations in this portion of the septum, however, can result in continued nasal obstruction with or without esthetic deformity [19]. Not enough bone and cartilage exposition and mobilization procedures have been performed for fear of de-stabilization and the possibility of

Fig. 10 Preoperative and 1-year postoperative look of a 32-year-old patient

Fig. 11 Preoperative and 1 year postoperative look of a 17-year-old patient

occurrence of complications. Success depends on mobilization and reconstruction of all deviated part of the nose. We addressed all deviated part of the nose to get a successful result.

Conclusion

In crooked nose treatment, full mobilization and reconstruction of the bone pyramid, septum, and alar cartilage are necessary, which increase the opportunity for getting pleasing esthetic and functional results.

Compliance with ethical standards

Funding The authors received no funding for this study.

Conflict of interest Hadi Nural declares that he has no conflict of interest.

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. For this type of study, formal consent is not required.

Informed consent All patient cases were performed only after obtaining informed consent for the surgical procedure.

Patient consent Patients provided written consent for the use of their images.

References

1. Gerbault O, Daniel RK, Kosins AM (2016) The role of piezoelectric instrumentation in rhinoplasty surgery. Aesthet Surg J 361:21–34 Google ScholarCrossRefPubMed
2. Gubisch W (2005) Extracorporeal septoplasty for the markedly deviated septum. Arch Facial Plast Surg 7(4):218–226
3. Most SP (2006) Anterior septal reconstruction: outcomes after a modified extracorporeal septoplasty technique. Arch Facial Plast Surg 8(3):202–207
4. Toriumi DM (1994) Subtotal reconstruction of the nasal septum: a preliminary report. Laryngoscope 104(7):906–913
5. Ross Mobley S, Long J (2016) Extracorporeal septoplasty: assessing functional outcomes using the validated Nasal Obstruction Symptom Evaluation score over a 3-year period. Plast Reconstr Surg 137(1):151e–163e
6. Russell WH, Kridel MD, Bruce A, Scott MD, Hossam MT, Foda MD (1999) The Tongue-in-Groove Technique in septorhinoplasty: a 10-year experience. Arch Facial Plast Surg 1(4):246–256
7. Mau T, Mau ST, Kim DW (2007) Cadaveric and engineering analysis of the septal L-strut. Laryngoscope 117(11):1902–1906
8. Lee SJ, Liong K, Lee HP (2010) Deformation of nasal septum during nasal trauma. Laryngoscope 120(10):1931–1939
9. Alsarraf R (2000) Outcomes research in facial plastic surgery: a review and new directions. Aesthet Plast Surg 24(3):192–197
10. Stewart MG, Witsell DL, Smith TL, Weaver EM, Yueh B, Hannley MT (2004) Development and validation of the Nasal Obstruction Symptom Evaluation (NOSE) scale. Otolaryngol Head Neck Surg. 130(2):157–163
11. Stewart MG, Smith TL, Weaver EM et al (2004) Outcomes after nasal septoplasty: results from the Nasal Obstruction Septoplasty Effectiveness (NOSE) study. Otolaryngol Head Neck Surg 130(3): 283–290
12. King ED, Ashley FL (1952) The correction of the internally and externally deviated nose. Plast Reconstr Surg (1946) 10(2):116–120
13. Gubisch W (1995) The extracorporeal septum plasty: a technique to correct difficult nasal deformities. Plast Reconstr Surg 95:672–682
14. Çakır B, Öreroğlu AR, Doğan T, Akan M (2012) A complete subperichondrial dissection technique for rhinoplasty with management of the nasal ligaments. Aesthet Surg J 32(5):564–574
15. Gabra N, Rahal A, Ahmarani C (2014) Nasal osteotomies: a cadaveric study of fracture lines. JAMA Facial Plast Surg 16(4):268–271
16. Paul N, Messinger K, Liu YF, Kwon DI, Kim CH, Inman JC (2016) A model to estimate L-strut strength with an emphasis on thickness. JAMA Facial Plast Surg 18(4):269–276
17. Yuan F, Liu MD, Kelton Messinger BS, Jared C, Inman MD (2017) Yield strength testing in human cadaver nasal septal cartilage and L-strut constructs. JAMA Facial Plast Surg 19(1):40–45
18. Surowitz J, Lee MK, Most SP (2015) Anterior septal reconstruction for treatment of severe caudal septal deviation: clinical severity and outcomes. Otolaryngol Head Neck Surg 153(1):27–33
19. Asher SA, Kakodkar AS, Toriumi DM (2018) Long-term outcomes of subtotal septal reconstruction in rhinoplasty. JAMA Facial Plast Surg 20(1):50–56
20. Spataro E, Piccirillo JF, Kallogjeri D et al (2016) Revision rates and risk factors of 175 842 patients undergoing septorhinoplasty. JAMA Facial Plast Surg 18(3):212–219
21. Constantian MB (2005) The boxy nasal tip, the ball tip, and alar cartilage malposition: variations on a theme: a study in 200 consecutive primary and secondary rhinoplasty patients. Plast Reconstr Surg 116(1):268–281
22. Gunter JP, Friedman RM (1997) Lateral crural strut graft: technique and clinical applications in rhinoplasty. Plast Reconstr Surg 99(4): 943–952

23. Toriumi DM, Asher SA (2015) Lateral crural repositioning for treatment of cephalic malposition. Facial Plast Surg Clin North Am 23(1):55–71
24. Sheen JH (1978) Aesthetic rhinoplasty. Mosby–Year Book Inc, St Louis
25. Ilhan AE, Saribas B, Caypinar B (2015) Aesthetic and functional results of lateral crural repositioning. JAMA Facial Plast Surg 17(4):286–292
26. AF K, Cano SJ, East CA et al (2016) Development and psychometric evaluation of the FACE-Q scales for patients undergoing rhinoplasty. JAMA Facial Plast Surg. 18(1):27–35
27. Lee MK, Most SP (2016) A comprehensive quality-of-life instrument for aesthetic and functional rhinoplasty: the RHINO scale. Plast Reconstr Surg Glob Open 4(2):e611
28. Barone M, Cogliandro A, Di Stefano N, Tambone V, Persichetti P (2017) A systematic review of patient-reported outcome measures after rhinoplasty. Eur Arch Otorhinolaryngol 274(4):1807–1811
29. Byrne M, Chan JC, O'Broin E (2014) Perceptions and satisfaction of aesthetic outcome following secondary cleft rhinoplasty: evaluation by patients versus health professionals. J Craniomaxillofac Surg 42:1062–1070