Aesth Plast Surg (2022) 46:818–829
https://doi.org/10.1007/s00266-021-02531-w

ORIGINAL ARTICLE RHINOPLASTY

A Comparative Study of Isolated Osteotomies Versus Osteotomies with Spreader Graft Placement to Correct Primary Deviated Nose

Sharad Hernot[1] · Arpit Agrawal[2] · Madhuri Kaintura[1] · Tripti Maithani[1] · Rishabh Dogra[1]

Received: 22 June 2021 / Accepted: 7 August 2021 / Published online: 19 August 2021

Abstract

Background It is a complete objective and subjective comparative study between two techniques of septorhinoplasty in patients undergoing primary rhinoplasty for crooked nose deformity.

Methods Forty patients having crooked nose deformity were randomly divided into 2 groups exhibiting two different techniques of correction. Patients were randomly divided into 2 group:

Group 1: 20 patients underwent correction of crooked nose by performing bilateral triple osteotomies + Septoplasty

Group 2: 20 patients underwent correction of crooked nose by performing bilateral triple osteotomies as well as placement of spreader grafts + Septoplasty

Objective and subjective assessment of patients in preoperative and postoperative period was done by various scales and scores.

Results Both the groups showed improvement in facial angles, ROE score, nasal airflow, and NOSE score. But, group 2 patients were more satisfied than group 1 patients in terms of both aesthetic appearance of nose and breathing function.

Conclusion It is very well known to the authors that aesthetic result of rhinoplasty is not just dependant on one technique. Keeping this in mind, we conclude that as group 2 patients were more satisfied with their overall results, the additional step of spreader graft placement helped these patients with the complaints associated with crooked nose deformity. However, we also emphasize that additional studies on larger numbers of patients should be performed to compare and know other intricacies of each technique that may play minor or major roles in deciding the success of each technique.

Level of Evidence III 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 Crooked nose · Septorhinoplasty · Spreader grafts · Osteotomies · Nasal deviation alignment angle (NDAA) · Rhinomanometry · ROE scale · NOSE score

✉ Madhuri Kaintura
doc.kaintura@gmail.com

Sharad Hernot
hernots@yahoo.com

Arpit Agrawal
sharadmotog5s@gmail.com

Rishabh Dogra
dr.rishabhdogra@gmail.com

[1] Department of ENT and Head and Neck Surgery, Shri Guru Ram Rai Institute of Medical and Health Sciences and Associated Shri Mahant Indiresh Hospital, Patel Nagar, Dehradun, Uttarakhand 248001, India

[2] Northwest ENT and Rhinoplasty center, Prashant Vihar, Sector 14, Rohini, New Delhi 110085, India

Introduction

Rhinoplasty [rhinos (nose) + plassein (to shape)] is a surgical procedure, which helps in not just improving the appearance of nose, but also improves the function of the nose, helping the patient look as well as breathe better. The term 'crooked nose' is being referred to as a twisted nose which represents complex deformity of anatomical components of nose, leading to cosmetic and functional disturbances. Rhinoplasty done for crooked nose deformity

correction comprises of mobilization and realignment of nasal tissues which can be unpredictable because of the destabilization nature of these surgical techniques and the wound healing processes [1].

Composite grafts, including skin/mucosa and cartilage, spreader grafts, and spreader flaps are different types of techniques used for managing the midvault [2]. Sheen, in 1984, was the first surgeon who used spreader grafts to prevent the functional collapse of the nasal internal valve following reduction rhinoplasty [3]. Osteotomies were first implemented to narrow the open roof that followed a major hump reduction and initially consisted of a lateral osteotomy placed in the nasofacial groove. Subsequently, a medial osteotomy that paralleled the septum was added to ensure total mobilization of the lateral wall, and correct the convexity of the crooked nose [4].

There is a paucity of data on comparison of two techniques of primary rhinoplasty. Hence, we aim to study and compare the preoperative and postoperative objective as well as subjective findings of both the functional and aesthetic component of nose in patients undergoing septorhinoplasty for the crooked nose deformity.

Material and Methods

We did a prospective study to analyse 40 patients of either sex with crooked nose deformity who had undergone primary rhinoplasty from 2014 to 2017 after obtaining ethical clearance from the institute.

Study subjects were randomly allocated into two groups of 20 patients each:

Group 1: 20 patients underwent correction of crooked nose by performing bilateral triple osteotomies + Septoplasty

Group 2: 20 patients underwent correction of crooked nose by performing bilateral triple osteotomies as well as placement of spreader grafts + Septoplasty

Inclusion Criteria

Patients having contour deformities-lateral depression, dorsal deformities and/or deviated nose with or without deviated nasal septum, dorsal hump, or tip deformity were included in the study.

Exclusion Criteria

The following patients were excluded from the study: -

1) Patients with external nasal deformity associated with cleft lip and palate,
2) Isolated dorsal hump,
3) Isolated saddle nose deformity,
4) Patients having unstable mental status,
5) Patients having unrealistic expectations,
6) Previous history of rhinoplasty,
7) Autoimmune or connective tissue diseases (if family history or other history suggestive),
8) Neoplastic or polypoidal coexisting disease,
9) Poor perioperative risk profile,
10) Major cardiovascular and respiratory disease, and
11) Skin disease over dorsum of nose.

Patients were fully explained about the deformity, surgical procedure, risks, benefits and outcome. A complete informed consent about the procedure of rhinoplasty was taken.

Evaluation of the Patient

A detailed history was recorded and physical examination was performed in all the patients at the time of initial presentation, including anterior and posterior rhinoscopy. Routine investigations were sent. Tools used to evaluate the patient in the preoperative period and postoperative period to record and compare were—

- Measurement of various angles like nasofacial, nasolabial, nasal deviation alignment angle (NDAA), etc., for objective evaluation of aesthetic appearance of nose.
- ROE (Rhinoplasty Outcome evaluation) score for the subjective evaluation of aesthetic appearance of nose.
- Rhinomanometry for the objective evaluation of nasal obstruction.
- NOSE (Nasal Obstruction Symptom Evaluation) questionnaire for subjective evaluation of nasal obstruction.

Objective Evaluation of Aesthetic Appearance of Nose Using Facial Angles/Dimensions

The nasofrontal angle (NFR), between the frontal bone and the nasion, is formed by the intersection of the tangent to the glabella and the nasal dorsal line, transecting any intervening hump. The nasofacial angle (NFA) is created by the intersection of the nasal dorsal line with a vertical facial plane at the nasion. The nasolabial (columellar-labial) angle (CLA), the slope between the columella and philtrum is created by the intersection of lines tangent to the columella segment and upper lip segment. The tip angle, the slope of the tip of the nose relative to plane of the face is approximately produced by a line from tip (T) to Vertical Facial Plane (Fig. 1a) [5].

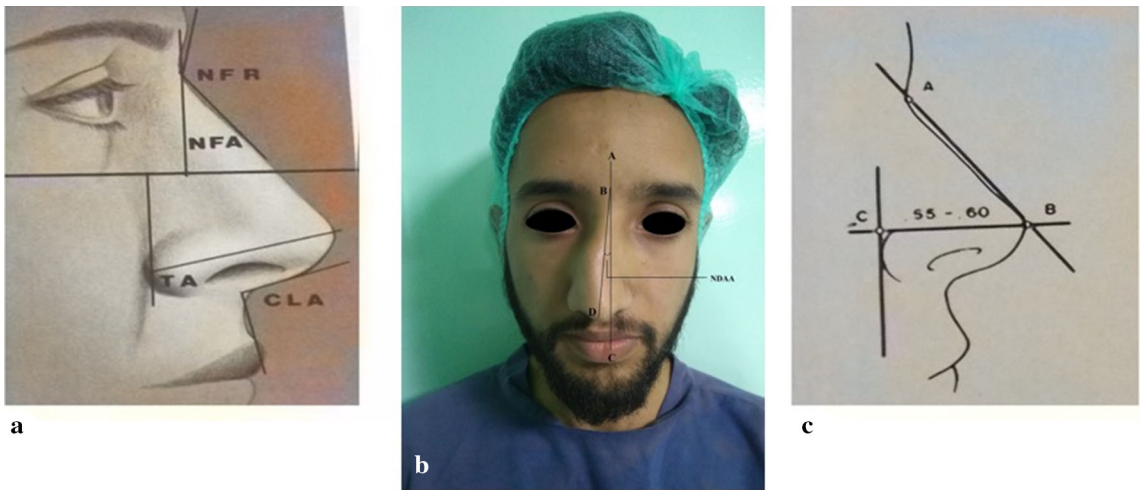

Fig. 1 **a** Four critical angles of nose: nasofrontal angle (NFR); nasofacial angle (NFA); tip angle (TA); columellar labial angle (CLA); vertical facial plane (VFP). **b** Nasal deviation alignment angle (NDAA). **c** Nasal tip projection by Goode method. If BC is greater than 0.55–0.60 of AB, the nasal tip appears disproportionately over projected

Nasal deviation alignment angle (NDAA) is defined as the deviation of the nose from the longitudinal midline. This is a vertical line drawn from the nasion. In a true 'straight' nose, this line will align with the nasal tip (Fig. 1b). In our study, the 'normal' value for NDAA was set at 0° [6].

The Goode method determines the facially proportionate projection of the nasal tip (the distance of the nose's tip from the face), when the projection of the nasal tip should be 55–60% of the distance between the nasion (nasofrontal junction) and the tip defining point (Fig. 1c) [7].

Subjective Evaluation of Aesthetic Appearance of Nose Using ROE (Rhinoplasty Outcome Evaluation) Score

The ROE score provides an assessment of patient's satisfaction before and after septorhinoplasty. The ROE questionnaire used is composed of six questions (5 about nose shape and 1 about nasal breathing). Each question is scored by the patient on a scale from 0 to 4, where 0 is the most negative answer and 4 the most positive one (Fig. 2a). The ROE scale is scored from 1 to 24 points. A score of ≥ 12 out of 24 is considered 'normal' and a score of < 12 reflects patient's dissatisfaction regarding the aesthetics of his/her nose. Patients were judged to be satisfied after surgery if the ROE score was above 12 or if their score did not decrease after surgery [8]. The ROE questionnaire was completed by the patient a day before surgery and then at 6 months after surgery.

Objective Evaluation of Nasal Obstruction by Rhinomanometry

Rhinomanometry was performed before surgery and at 6 months after surgery. The same rhinomanometer was used for all patients (ATMOS® Rhino 31 Rhinomanometer). Anterior rhinomanometry during spontaneous breathing was performed. In order to limit the influence of the nasal cycle on rhinomanometry data, the nasal resistance and nasal airflow values used were recorded for left nasal cavity, right nasal cavity and also combined resistance of both nasal cavities as a mean of the readings at pressure of 75, 150 and 300 Pascals (Pa). Nasal resistance was reported in $Pa/cm^3/sec$ and flow in cm^3/sec. Resistance between 0.30 and 0.49 $Pa/cm^3/sec$ was designated as mild obstruction, resistance between 0.50 and 0.80 as moderate obstruction, and resistance > 0.80 $Pa/cm^3/sec$ indicated severe obstruction [8, 9].

Subjective Evaluation of Nasal Obstruction by NOSE Scale (Nasal Obstruction Symptom Evaluation Scale)

The NOSE scale is a graduated 20-point scale; the result is multiplied by 5 to give a final total out of 100 [10]. A score of 100 indicates complete nasal obstruction. A NOSE score under 25 is considered normal, between 25 and 50 denotes mild to moderate nasal obstruction, and above 50 denotes severe nasal obstruction (Fig. 2b) [11]. The NOSE questionnaire was completed by the patient a day before surgery and again at 6 months after surgery.

a ROE (Rhinoplasty Outcome Evaluation) Score

Please circle the most correct response					
Do you like how your nose looks?	Absolutely no (0)	A little (1)	Moderately (2)	Very much (3)	Absolutely yes (4)
Do you breathe well through your nose?	Absolutely no (0)	A little (1)	Moderately (2)	Very much (3)	Absolutely yes (4)
Do you believe your friends and the people who are dear to you like your nose?	Absolutely no (0)	A little (1)	Moderately (2)	Very much (3)	Absolutely yes (4)
Do you think the current appearance of your nose hampers your social or professional activities?	Always (0)	Frequently (1)	Sometimes (2)	Rarely (3)	Never (4)
Do you think your nasal appearance is as good as it could be?	Absolutely no (0)	A little (1)	Moderately (2)	Very much (3)	Absolutely yes (4)
Would you undergo surgery to change the appearance of your nose or to improve your breathing?	Definitely (0)	Very likely (1)	Possibly (2)	Probably not (3)	No (4)

b NOSE (Nasal Obstruction Symptom Evaluation) Scale

Over the past one month, how much of a problem were the following conditions for you? Please circle the most correct response					
	Not a problem	Very mild problem	Moderate problem	Fairly bad problem	Severe problem
Nasal congestion or stuffiness	0	1	2	3	4
Nasal blockage or obstruction	0	1	2	3	4
Trouble breathing through my nose	0	1	2	3	4
Trouble sleeping	0	1	2	3	4
Unable to get enough air through my nose during exercise or exertion	0	1	2	3	4

Fig. 2 **a** ROE (rhinoplasty outcome evaluation) score. **b** NOSE (nasal obstruction symptom evaluation) scale

Photographs

The standard facial photographs were taken, for the documentation of the accurate extent of nasal deformity and basic framework of the bony and cartilaginous vault of the nose, which included Frontal view; Right and Left lateral views; Right and Left oblique views; Basal view (worm's eye view).

Surgical Procedure

Patients were admitted a day before the surgery. All the patients were taken up under general anaesthesia. Patient was laid in supine position with head end elevated to about 20 degree and the local site was prepared with povidone iodine solution. Neuro-patties soaked in vasoconstrictive agent were placed inside the nasal cavities and were removed after 15 minutes.

Surgical Approach

Nasal dorsum, lateral nasal walls, nasofacial grooves, septum was infiltrated with a mixture of 2% lidocaine and 1:200000 epinephrine. The surgical procedure was done through an open (external) approach.

The general sequence followed was:

1. Inverted V incision over the mid columella (Midcolumellar incision)
2. Bilateral infracartilaginous (marginal) incisions connected with a columellar incision, followed by the dissection.
3. Raise a columellar flap
4. Midline dorsal surface dissection
5. Exposing anterior septal angle.
6. Management of septal deformity
7. Septoplasty
8. Caudal septal repositioning
9. Correction of septal L-strut
10. Hump Reduction (if hump present)
11. Detachment of the upper lateral cartilages from the septum
12. Management of deformed nasal bones

Group 1: Patients underwent septoplasty along with medial, transverse, and lateral osteotomies.

Group 2: Patients underwent septoplasty, medial, transverse, and lateral osteotomies, along with placement of spreader grafts on both sides of septum in all the patients. Thickness of spreader grafts was sometimes unequal to achieve good dorsal lines.

Technique of Performing Triple Osteotomies

For Lateral Osteotomy

A stab incision was given at the midpoint between vestibule and medial canthus. The tip of 2 mm osteotome was firmly pressed against the bone. Periosteum was not elevated for any possibility of disrupting the lacrimal sac or damage to the medial canthus ligament. It was incised cleanly with tip of osteotome by moving the osteotome up and down at the proposed line of osteotomy and perforation of bone was done with 2 mm sharp osteotome. From a single skin stab incision, bone was perforated at 2 mm distance with tap-tap stroke of the mallet taking care not to damage the underlying mucosa of the bone. The change of sound of the tapping of osteotome signals that internal cortical bone has been broken. There is also a give way feeling which warns the surgeon against the undue perforation of nasal mucosa. The multiple site bone perforation was done by moving the osteotome from caudal to cephalic direction to give a low-to-low lateral osteotomy.

For Transverse Osteotomy

A midpoint was selected between medial canthus and nasion and a stab incision was given. Periosteum was incised with the tip of osteotome and perforating osteotomy was done as described earlier to meet the upper end of lateral osteotomy laterally, and the cephalic end of medial osteotomy medially.

For Medial Osteotomy

In all the cases, straight 4 mm sharp osteotome was engaged para-median to mid-line in order to safeguard the keystone area to avoid loss of septal support and was directed to meet the medial end of horizontal perforating transverse osteotomy.

The similar procedure was done on the opposite side. Firm pressure was applied with fingers for straightening of nasal vault. The skin stab incision was not sutured any time.

Technique for Placing and Securing Spreader Grafts

Spreader grafts were harvested from autologous septal cartilage and were approximately 1.5–2.5 cm in length, 2–3 mm in width and 1.5–2.5 mm thick. If hump is present, it is excised. Division of upper lateral cartilages from their attachment to the dorsal septum is then undertaken in the sub-mucoperichondrial plane. Placement of spreader grafts is undertaken once hump reduction and osteotomies have been performed. Spreader grafts are then placed in the pockets between upper lateral cartilages and septum (Fig. 3). A typical graft in our case extended from the osseocartilaginous junction to the anterior septal angle. The spreader grafts were secured with 5,0 PDS (polydioxanone) or Monocryl suture. Two horizontal mattress sutures were put to engage all the structures from upper lateral cartilage-to-spreader graft-to-septum-to-spreader graft-to-upper lateral cartilage in position.

10. Tip plasty (if required)
11. Suturing of incisions.
12. Packing, taping and splinting.

After the surgery, patients were shifted to ward. Nasal pack removal was done after 48 hours. Patients were mostly discharged between 3rd and 5th postoperative day on oral antibiotics, anti-inflammatory, normal saline and liquid paraffin nasal drops. Sutures were removed on the 7th postoperative day. Tape and POP (Plaster of Paris) cast was removed between 10th and 14th postoperative day.

Follow-up Care

Patients underwent regular follow-up for 1st, 2nd, 3rd, and then at 6th month postoperatively. Final assessment of preoperative and postoperative result of Group 1 and Group 2 patients was made at the end of 6th month (Fig. 4 and 5).

Statistical Analysis

Difference in preoperative and postoperative data was observed using Student's paired t test, and the difference was considered statistically significant if p value < 0.05. Data were shown as mean $\pm$ SD.

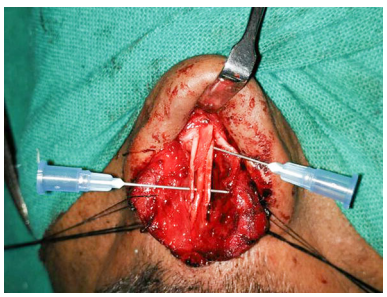

Fig. 3 Figure showing placement of spreader grafts parallel to septum

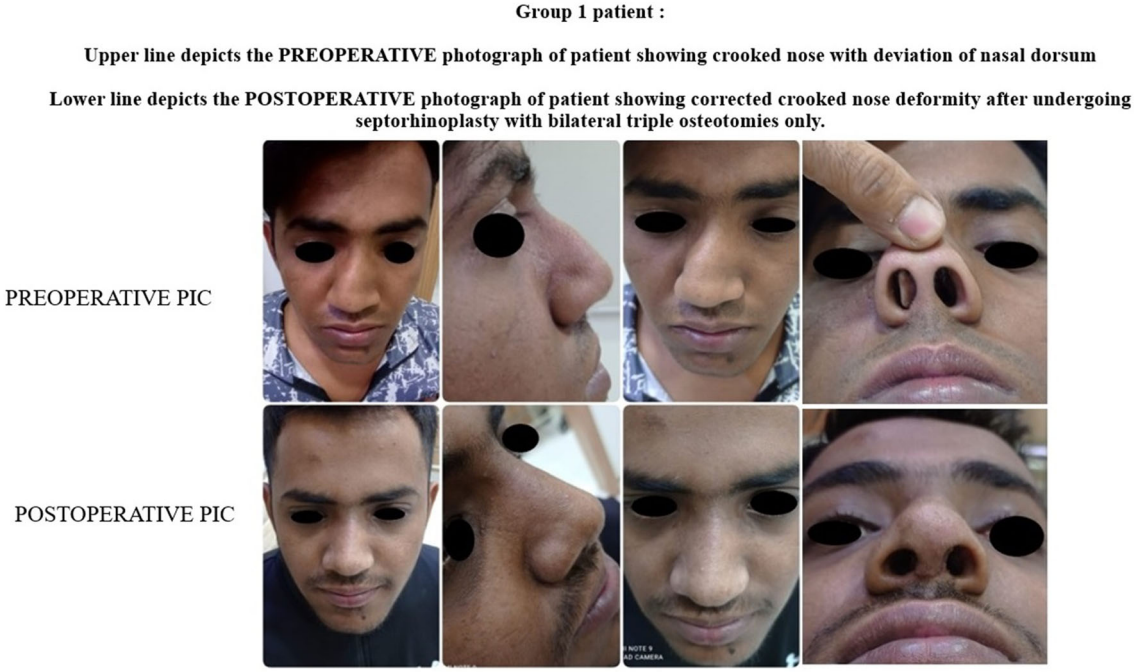

Fig. 4 Showing preoperative and 6 months postoperative photograph of group 1 patients

Fig. 5 Showing preoperative and 6 months postoperative photograph of group 2 patients

Results

Forty patients with crooked nose deformity admitted for surgical correction were evaluated. Twenty-nine out of 40 patients (72.5%) were in the 18–29 years of age group, indicating it is seen more commonly in young adults (Table 1A). Crooked nose was seen more in males than females (Table 1B). History of trauma was present in 32 out of 40 patients (80%), which was the most important aetiology of crooked nose deformity. Second most common aetiology was developmental in 8 out of 40 patients (20%) (Table 1C).

Table 1 Age group, gender distribution, & aetiology of patients with crooked nose

Age (in years)	No. of patients
(A) Age group of patients with crooked nose	
18–23	17 (42.5%)
24–29	12 (30%)
30–35	10 (25%)
36–40	1 (2.5%)
(B) Gender distribution of patients with crooked nose	
Male	28 (70%)
Female	12 (30%)
Total patients	40
(C) Aetiology of crooked nose	
Etiology	No. of patients
Developmental	8 (20%)
Trauma	32 (80%)
Fist injury	5 (12.5%)
Fall on face	5 (12.5%)
Sports injury	10 (25%)
Road traffic accident	12 (30%)

Associated dorsal hump alone was present in 10 out of 40 patients (25%). Associated tip deformity alone was present in 3 out of 40 patients (7.5%). Associated dorsal hump as well as tip deformity was present in 2 out of 40 patients (5%). Isolated crooked nose deformity without any dorsal hump or tip deformity was present in 25 out of 40 patients (62.5%). Deviated nasal septum and symptom of nasal obstruction (unilateral or bilateral) was present in all patients (100%). Septoplasty and bilateral triple osteotomies were done in all 40 patients (Table 2).

Objective Aesthetic Evaluation

Nasal Deviation Alignment Angle (NDAA)

Pre- and postoperative NDAA of all the patients were measured. Before surgery the range of NDAA in group 1 patients was from 2.8 to 24.6°, while after surgery the range of NDAA was from 0.2 to 7.1°. Similarly, before surgery the range of NDAA in group 2 patients was from 8.8 to 23.6°, while after surgery the range of NDAA was from 0.5 to 5.3°. Mean correction achieved in NDAA of group 1 patients was 10.22 ± 4.6°, while mean correction achieved in NDAA of group 2 patients was 11.7±3.7° (Table 3A), which is greater than group 1 patients.

Maximum patients in both groups achieved a degree correction between 5 and < 15°. Degree of correction range we achieved in group 1 patients varied from 2.4 to 18.9°. Fifteen out of 20 patients (40%) in group 1 achieved the correction range of 5–< 15°. Degree of correction range we achieved in group 2 patients varied from 6.0 to 21.3°. Seventeen out of 20 patients (40%) in group 2 achieved the correction range of 5–<15° (Table 3B).

Preoperative & postoperative digital photographs were assessed with help of Adobe photoshop version CS2 software. Preoperative and postoperative angles were documented & compared.

Nasofrontal Angle Its normal range is 120–130°. In present study, the mean preoperative and postoperative angles were in normal range. After surgery, there was slight increase in nasofrontal angle in both groups (Table 4A).

Nasolabial Angle (NLA) Its normal range is 90–105°. In present study, the mean preoperative and postoperative angles were in normal range. After surgery, there was

Table 2 Associated deformities and surgical procedure performed in crooked nose patients

Associated deformity	Chief complaint	Surgery performed	No. of patients
Crooked nose with dorsal hump only	External nasal deformity with nasal obstruction	Septoplasty with hump resection with bilateral osteotomies with spreader graft	10 (25%)
Crooked nose with tip deformity only	External nasal deformity with nasal obstruction	Septoplasty with bilateral triple osteotomies with tip plasty	3 (7.5%)
Crooked nose with both dorsal hump and tip deformity	External nasal deformity with nasal obstruction	Septoplasty with hump resection with bilateral osteotomies with spreader graft with tip plasty	2 (5%)
Isolated crooked nose	External nasal deformity with nasal obstruction	Septoplasty including bilateral triple osteotomies	17 (42.5%)
		Septoplasty with bilateral osteotomies with spreader graft	8 (20%)
Crooked nose with deviated nasal septum	External nasal deformity with nasal obstruction	Septoplasty	40 (100%)

Table 3 Degree of correction of NDAA (nasal deviation alignment angle) of patients of both groups

	Group 1 (Isolated triple osteotomies) [No. of patients] $n = 20$ Mean ± SD	Group 2 (Triple osteotomies plus spreader graft) [No. of patients] $n = 20$ Mean ± SD
(A) Comparison of preoperative and postoperative nasal deviation angle on both groups		
Preoperative nasal deviation angle (in degrees)	13.76 ± 5.08	14.79 ± 3.92
Postoperative nasal deviation angle (in degrees)	3.5 ± 1.7	3.06 ± 0.83
Correction of nasal deviation angle (in degrees)	10.22 ± 4.6	11.7 ± 3.7
Degree of correction of NDAA (Nasal deviation alignment angle) (0°)	Group 1 (Isolated triple osteotomies) $n = 20$	Group 2 (Triple osteotomies plus spreader graft) $n = 20$
(B) Degree of correction of NDAA of patients of both groups		
0 to <5°	2	0
5 to < 10°	8	6
10 to < 15°	7	11
15 to < 20°	3	2
20° or more	0	1
Total patients	20	20

slight increase in nasolabial angle in both groups (Table 4B).

Tip Projection Ratio Its normal range is 0.55–0.60. In present study, the mean preoperative and postoperative ratios were in normal range. After surgery, there was slight increase in ratio in both groups (Table 4C)

Nasal Deviation Alignment Angle (NDAA)

In Group 1 and 2 patients, the preoperative NDAA was 13.76° and 14.79°, which was corrected after surgery up to 3.5° and 3.06°, respectively. Both values were significant with p value < 0.0001 (Table 4D).

Subjective Aesthetic Evaluation

ROE (Rhinoplasty Outcome Evaluation)

The average ROE score in group 1 patients before surgery was 6 ± 1.02/24. After surgery, it was 15 ± 2.44/24. The difference was statistically significant ($p < 0.0001$), whereas the average ROE in group 2 patients was also 6 ± 1.2/24 before surgery. After surgery, the average ROE of group 2 patients was better than group 1 patients, and was 18.35 ± 3.02/24, with $p < 0.0001$ (Table 4E).

Overall, the ROE score improved in all patients. However, there were 3 patients in group 1, and 1 patient in group 2 who had a score of < 12.

Subjective Functional Evaluation by NOSE Score

The average NOSE (Nasal Obstruction Symptom evaluation) score before surgery of Group 1 patients was 62.75/100 [range 40–80, standard deviation (SD) 12.2]. After surgery, it was 21/100 (range 10–35, SD 7.1). There was a statistically significant difference between the preoperative and postoperative values ($p < 0.0001$). Similarly, the average NOSE score before surgery of Group 2 patients was 69.5/100 (range 40–100, SD 15.4). After surgery, it was 9.75/100 (range 0–20, SD 6.2) ($p < 0.0001$) (Table 4F).

The spreader graft placement along with septoplasty done in group 2 patients according to us resulted in better functional results of nose, as straightening of nasal septum by septoplasty removes nasal obstruction caused by mechanical obstruction to airway, and placing spreader grafts widens the internal nasal valve area, and prevents its collapse by supporting the valve area relieving the complaints of nasal obstruction caused by narrow internal nasal valve.

Table 4 Objective evaluation of nasal aesthetics using angles & subjective evaluation of function of nose using ROE and NOSE scores

	Mean ± SD	*P* value	Aesthetic ideal
(A) Nasofrontal angle			
Before surgery	123.92 ± 4.110	0.095	120–130°
After surgery	125.30 ± 9.250		
(B) Nasolabial angle			
Before surgery	92.38 ± 3.02°	0.172	90–105°
After Surgery	93.67 ± 3.67°		
(C) TIP projection ratio			
Before surgery	0.55 ± 0.05	0.469	0.55–0.60
After surgery	0.56 ± 0.02		
(D) Nasal deviation alignment angle (0°)			
Group 1 patients NDAA			
Before surgery	13.76 ± 5.08	< 0.0001	0°
After surgery	3.5 ± 1.7		
Group 2 patients NDAA			
Before surgery	14.79 ± 3.92	< 0.0001	0°
After surgery	3.06 ± 0.83		
(E) Rhinoplasty outcome evaluation			
Group 1 patients			
Before surgery	6.05 ± 1.02	< 0.0001	Score ≥ 12
After surgery	15 ± 2.44		
Group 2 patients			
Before surgery	6 ± 1.2	< 0.0001	Score ≥ 12
After surgery	18.35 ± 3.02		
(F) NOSE score			
Group 1 patients			
Before surgery	62.75 ± 12.2	< 0.0001	Score < 25
After surgery	21 ± 7.1		
Group 2 patients			
Before surgery	69.5 ± 15.4	< 0.0001	Score < 25
After surgery	9.75 ± 6.2		

Objective Functional Evaluation

Rhinomanometry

Nasal resistance and nasal airflow were recorded of group 1 and group 2 patients by Rhinomanometry test before surgery, and the readings were compared with the readings of the postoperative period. The nasal resistance as well as nasal airflow of each nasal cavity, also the total value of both nasal resistance and airflow was noted. In group 1 patients, the mean resistance of left and right nasal cavity was 3.2 ± 2.2, and 4.2 ± 2.3, which decreased after surgery to 2.3 ± 1.2, and 2.6 ± 1.2, respectively, with p value < 0.001. The total resistance of Group 1 patient was 1.6 ± 0.6, which also decreased to 1.2 ± 0.6 ($p < 0.001$) (Table 5A).

Similarly, the findings of Group 2 patients were assessed and were observed that the nasal resistance of left and right nasal cavity before surgery was 4.72 ± 7.89 and 1.67 ± 1.89, which decreased after surgery to 1.8 ± 1.19 and 0.58 ± 0.45, respectively. The total resistance also decreased from 0.65 ± 0.45 before surgery to 0.30 ± 0.15 post-surgery (Table 5B).

The nasal airflow of group 1 patients before surgery of left and right nasal cavity was 196.4 ± 139.4 and 292.2 ± 214.9, which increased to 329.2 ± 167.9 and 382.2 ± 202, respectively. The total nasal airflow also improved from 385.9 ± 193.4 before surgery to 426.6 ± 204.9 after surgery (Table 5C).

Similarly, the nasal airflow of group 2 patients before surgery of left and right nasal cavity was 216.9 ± 154.2 and 258.4 ± 176.9, which increased to 250.6 ± 130.8 and 388.1 ± 208.3, respectively ($p < 0.001$). The total nasal airflow also improved from 356.1 ± 234.4 before surgery to 456.1 ± 219.3 after surgery (Table 5D).

It was observed that irrespective of the group, nasal resistance decreased in all cases, and nasal airflow improved in all the cases after surgery.

Discussion

In the past 20 years, the emphasis on aesthetic outcome has moved into the forefront, not just in plastic surgery but also in the field of facial plastic surgery (as a subspecialty of otorhinolaryngology).

The present study was based on the surgical outcome of 40 patients with crooked deformity of nose. Khullar and Nagar (2006) reported that maximum numbers of patients who had maxillofacial trauma were found in the age group of 20–30 years. In our study, 29 of the 40 patients were in the age group of 18–29 years. The highest incidence in this age group is due to the fact that this age group shows maximum activity in the sports, brawls, and high-speed transportation, and they also are more self-conscious, because of marriageable age [12]. Our observations are comparable with the mentioned study.

Erdam and Ozutran have mentioned that crooked nose is almost always associated with septal deviation [13]. In our study, we also found all 40 patients (100%) had deviated nasal septum.

As per Leong et al. (2008), the mean preoperative nasal deviation angle (NDAA) of the cohort was 35.28°. This angle was reduced to 9.98° ($p = 0.001$) following surgery, giving a 72 per cent reduction in the mean alignment deformity [6]. In our study, the mean NDAA in preoperative period in group 1 patients was 13.76 ± 5.08° and

Table 5 Preoperative and postoperative comparison of rhinomanometry findings in group 1 and group 2 patients

	Pre-op resistance ($pa/cm^3/sec$)		Post-op resistance ($pa/cm^3/sec$)		*p* value
	Range	Mean ± SD	Range	Mean ± SD	
(A) [Nasal resistance]					
Group 1 patients					
Left nasal cavity	0.75–7.8	3.2 ± 2.2	0.55–5.5	2.3 ± 1.2	< 0.001
Right nasal cavity	0.55–8.5	4.2 ± 2.3	0.25–4.5	2.6 ± 1.2	< 0.001
Total	0.4–2.5	1.6 ± 0.6	0.20–1.75	1.2 ± 0.6	< 0.001
(B) [Nasal resistance]					
Group 2 patients					
Left nasal cavity	0.59–39.5	4.72 ± 7.89	0.34–6.21	1.8 ± 1.19	< 0.001
Right nasal cavity	0.34–9.35	1.67 ± 1.89	0.22–2.06	0.58 ± 0.45	< 0.001
Total	0.20–1.75	0.65 ± 0.45	0.17–0.96	0.30 ± 0.15	< 0.001
	Pre-op nasal airflow (cm^3/sec)		Post-op nasal airflow (cm^3/sec)		*p* value
	Range	Mean ± SD	Range	Mean ± SD	
(C)[Nasal airflow]					
Group 1 patients					
Left nasal cavity	10–450	196.4 ± 139.4	25–575	329.2 ± 167.9	< 0.001
Right nasal cavity	20–645	292.2 ± 214.9	75–690	382.2 ± 202	< 0.001
Total	99–780	385.9 ± 193.4	150–796	426.6 ± 204.9	< 0.001
(D)[Nasal airflow]					
Group 2 patients					
Left nasal cavity	15–485	216.9 ± 154.2	35–550	250.6 ± 130.8	< 0.001
Right nasal cavity	25–650	258.4 ± 176.9	75–710	388.1 ± 208.3	< 0.001
Total	95–780	356.1 ± 234.4	150–800	456.1 ± 219.3	< 0.001

mean NDAA in postoperative period was 3.5 ± 1.7°. We achieved 74.5% reduction in deformity after surgery in group 1 patients ($p < 0.001$), whereas in group 2, the mean NDAA in preoperative period was 14.79 ± 3.92° and mean NDAA in postoperative period was 3.06 ± 0.83°, achieving 79.3% reduction in deformity.

Radulesco et al. [8] in 2017 mentioned that all patients in their study experienced improvement in ROE score from an average of 7.5/24 to 18/24. Esteves et al in a separate study on 110 patients also noted that 100% of patients had a higher ROE score after surgery, showing that all patients were more satisfied after the rhinoplasty [14]. Our findings were somewhat consistent with this study and we also found that ROE score improved in all of the patients irrespective of the group. However, there were 3 patients in group 1, and 1 patient in group 2 who had an improvement in ROE score but the score remained below 12 reflecting patients' some dissatisfaction regarding the aesthetics of their noses. In our study, we have observed an important point that there is difference in surgeon and patient's satisfaction in terms of aesthetic outcome. This is due to the stubborn concealed human desire of patient wherein the patient not just wants an improved nose but also a perfect nose. We have observed that irrespective of how more or less a patient's preoperative nose is crooked in shape, they believe that every small or big fault in their noses will be corrected by surgery and they will have an absolutely new flawless nose. This hidden desire of attaining a perfect celebrity type nose leads to development of a hindrance to retrieve a proper unbiased response from the patient. And despite regular patient counselling throughout the treatment, we still speculate that this variable is very difficult to control or abolish, and might alter an unbiased response from the patient. But still, the ROE scale enables an accurate subjective analysis of cosmetic results and quality of life, and has been used and validated in the literature.

Our observations are comparable with the study conducted by Radulesco et al that NOSE score in their study showed statistically significant difference between the preoperative and postoperative values. The average NOSE score noted by them before surgery was 72.5/100. After surgery, it was 22/100 [8]. In our study also, both the

groups of patients showed statistically significant difference between the preoperative and postoperative values of NOSE score with significant reduction in score in both groups.

Zahedi et al. [15] in their study mentioned that there were improvements in the nasal resistance during inspiration and expiration in both nasal cavities. Improvement in values of nasal airflow and decrease in the nasal resistance postoperatively can be explained by the correction of septal deformity. Straightening of septum leads to removal of the mechanical blockage, whereas spreader graft helps in patients with concomitant problem of nasal valve collapse.

Jessen and colleagues evaluated the effect of rhinomanometry on 92 patients undergoing rhinoplasty. Rhinomanometry findings revealed an improvement among 56 patients with midline deviation and in 36 patients without any septal deviation [16]. In the study conducted by Broms, Johnson and Malm, comparison of preoperative and postoperative nasal airway resistance showed that there was a significant decrease in total nasal airway resistance ($p < 0.01$) after functional septoplasty [17]. This is in concordance with our study as we also found that there was reduction in nasal resistance and improvement in nasal airflow in both groups.

Gurlek et al. [18] believed that nasal spreader grafts were not only useful in improving internal nasal valve but they also help in creating pleasant dorsal-nasal lines. While most patients of both groups experienced good results after surgery, we observed that patients in group 2 were more satisfied than group 1 with their aesthetic as well as functional outcome. This is because of the fact that septorhinoplasty in their group comprised of septoplasty that corrected the deviated septum, triple osteotomies that took care of the crooked nasal shape, and spreader graft placement that not just took care of the nasal valve insufficiency but also helped in achieving pleasant nasal dorsal lines which looked aesthetically way more superior.

To our knowledge, we found that there is no data available, and ours is the only study concerning a thorough evaluation of septorhinoplasty where a complete subjective and objective evaluation of functional and aesthetic results of two mentioned techniques is illustrated.

Conclusion

It is very well known to the authors that both osteotomies as well as spreader grafts carry an individual important role in correcting the external nasal deformity. In the hands of experienced rhinoplasty surgeons, isolated osteotomies or combining osteotomies with spreader grafts can give equally good result, and also that many experienced rhinoplasty surgeons can debate in favour or against of this topic. Keeping this is mind, our study concludes that while both techniques improved function as well as cosmetic appearance of nose in both groups, the patients of group 2 who had undergone septoplasty with bilateral triple osteotomies and spreader graft placement were more satisfied in terms of not just the aesthetic appearance of nose but also the breathing function. We suggest that these superior results in group 2 patients were because of the additional step of placement of spreader grafts which not just helped in widening the internal nasal valve area resulting in better breathing, but they also helped in giving a strong support to the nasal dorsum and also aesthetically superior looking nasal dorsum lines which enhances the beauty of the nose and the face.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Approval Ethical clearance from the institute was taken vide no. IEC/91/14. 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.

Consent to Participate Informed, written, and signed consent was taken from all patients included in the study.

Consent for Publication Informed, written, and signed consent was taken from all patients included in the study regarding using their photographs and data for publication.

References

1. Rohrich RJ, Gunter JP, Deuber MA, Adams WP Jr (2002) The deviated nose: optimizing results using a simplified classification and algorithmic approach. Plast Reconstr Surg 110:1509–1523
2. Gentile P, Bottini DJ, Cervelli V (2008) Rhinoplasty procedures: state of art in plastic surgery. J Craniofac Surg 19:1491–1496
3. Sheen JH (1984) Spreader graft: a method of reconstructing the roof of the middle nasal vault following rhinoplasty. Plast Reconstr Surg 73:230–239
4. Ghanaatpisheh M, Sajjadian A, Daniel RK (2015) Superior rhinoplasty outcomes with precise nasal osteotomy: an individualized approach for maintaining function and achieving aesthetic goals. Aesthet Surg J 35:28–39
5. Daniel RK (1993) Rhinoplasty Planning. In: Daniel RK, Regnault P (eds) Aesthetic plastic surgery rhinoplasty, lst. Little Brown and Company, Boston, pp 90–93
6. Leong SC, Abdelkader M, White PS (2008) Changes in nasal aesthetics following nasal bone manipulations. J Laryngol Otol 122:38–41
7. Calhoun KH, Stambaugh KI (2006) Facial analysis and pre-operative evaluation. In: Bailey BJ, Johnson JT, Newlands SD (eds) Head and neck surgery—otolaryngology, 4th edn. Lippincott Williams & Wilkins, Philadelphia, p 2490
8. Radulesco T, Penicaud M, Santini L, Thomassin JM, Dessi P, Michel J (2018) Outcomes of septorhinoplasty: a new approach

comparing functional and aesthetic results. Int J Oral Maxillofac Surg 47:175–179
9. Gulati SP, Sachdeva OP, Wadhera R, Sodhi N, Garg A (2008) Role of rhinomanometry to assess nasal airflow and resistance in patients undergoing septoplasty. Indian J Otolaryngol Head Neck Surg. 60:133–136
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 130:157–163
11. Menegat F, Monnazzi MS, Silva BN, de Moraes M, Gabrielli MA, Pereira-Filho VA (2015) Assessment of nasal obstruction symp-toms using the NOSE scale after surgically assisted rapid maxillary expansion. Int J Oral Maxillofac Surg 44:1346–1350
12. Khullar NK, Nagar RK (2006) Maxillofacial trauma study. Asian J Ear Nose Throat 4:27–29
13. Erdam T, Ozturan O (2008) Objective measurement of the deviated nose and a review of surgical techniques for correction. Rhinology 46:56–61
14. Esteves SS, Ferreira MG, Almeida JC, Abrunhosa J, Sousa CAE (2017) Evaluation of aesthetic and functional outcomes in rhinoplasty surgery: a prospective study. Braz J Otorhinolaryngol 83:552–557
15. Zahedi DF, Husain S, Gendeh BS (2016) Functional outcome evaluation of septorhinoplasty for nasal obstruction. Indian J Otolaryngol Head Neck Surg 68:218–223
16. Jessen M, Jacobsson S, Malm L (1988) On rhinometry in rhinoplasty. Plast Reconstr Surg 81:506–511
17. Broms P, Jonson B, Malm L (1982) Rhinomanometry IV. A pre and postoperative evaluation in functional septoplasty. Acta Otolaryngol 94:523–9
18. Gurlek A, Celik M, Fariz A, Ersoz-Ozturk A, Eren AT, Tenekeci G et al (2006) The use of high-density porous polyethylene as a custom-made nasal spreader graft. Aesthetic Plast Surg 30:34–41