

Outcome of In Situ Septoplasty and Extracorporeal Subtotal Septal Reconstruction in Crooked Noses: A Randomized Self-Controlled Study



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Abstract

Importance Severe dorsal deviations in crooked noses are treated by either in situ septoplasty with asymmetric spreader grafts (ISS) or extracorporeal subtotal septal reconstruction (ECS). To our knowledge, except one retrospective study, there is no other that compares the objective and subjective results of these two treatment modalities.

Objective The aim of this study was to compare the aesthetic and functional outcomes of ECS and ISS in crooked noses.

Design, Setting and Participants This study was carried out on 40 patients (ISS in 20 patients and ECS in 20 patients) who underwent external rhinoplasty surgery due to crooked noses between May 2014 and January 2016. While performing rhinoplasty on the patients, the decision of whether to use the ECS or ISS technique was randomized in a sequential fashion.

Main Outcomes and Measures Surgical outcomes were assessed and compared using the anthropometric measurement of photographs with Rhinobase software. Subjective assessments of nasal obstruction and aesthetic satisfaction were evaluated with a visual analog scale.

Results There was a significant difference between rhinion deviation angle, supratip deviation angle (SDA) and tip deviation angle pre- and postoperatively in the ECS group, whereas in the ISS group, except SDA, all other

postoperative angles were significantly improved from preoperative values ($p = 0.218$). The nasal tip projection in the ECS and ISS groups was 29.48, 31.5 preoperatively and 29.78, 31.26 postoperatively. The mean postoperative nasal tip projection value ($p > 0.005$) did not change significantly compared to the preoperative value in both groups. The mean postoperative value of nasolabial ($p = 0.226$) angle did not change significantly compared to the mean preoperative one in the ECS group. However, in the ISS group, the mean postoperative value of nasolabial ($p = 0.001$) angle significantly improved compared to the mean preoperative value. There was significant improvement in both groups, while improvements in both functional and aesthetic outcomes were much higher in the extracorporeal group. None of the patients had postoperative nasal obstruction that required revision surgery. One patient underwent revision rhinoplasty due to an irregularity on the nasal dorsum in the ECS group.

Conclusions and Relevance This is the first study that compares subjective and objective aesthetic and functional outcomes of crooked nose surgery according to two common septoplasty techniques in a randomized self-controlled fashion. This study was effective in both objectively and subjectively comparing the functional and aesthetic aspect of the patients submitted to two common different techniques of treatment of nasal deviations in crooked nose patients.

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Introduction

The crooked nose is one of the most common complaints among patients who seek medical attention for nasal obstruction or facial asymmetry. High expectations of these patients may become an issue for the surgeon because correction of the deviated or crooked nose is one of the most challenging deformities in rhinoplasty patients.

The aesthetic units that make up the nose, from the nasion to the nose tip, should be symmetrically positioned. The condition in which this symmetry is broken and tilted to one side is called a crooked nose, in other words a twisted nose. Crooked nose is a complex deformity in which multiple structures are involved such as bone, cartilage and skin. Successful reconstruction of a crooked nose can be related to the cartilaginous structure, especially the dorsal section of the nasal septum [1]. The nasal septum has an important role in the function and aesthetic shape of the nose. Thus, septal correction is essential for treatment success in patients with a deviated nose [2]. Severe dorsal deviations in crooked noses are treated by either in situ septoplasty with asymmetric spreader grafts (ISS) or extracorporeal subtotal septal reconstruction (ECS) [3–6].

Numerous studies have reported various outcomes in correction of the crooked nose. To our knowledge, except one retrospective study [7], there is no other that compares the objective and subjective results of these two treatment modalities. Furthermore, there is no randomized controlled trial regarding the outcome of both ISS and ECS in crooked noses. The aim of this study was to compare the aesthetic and functional outcomes of ECS and ISS in crooked noses. The secondary aim was to compare the objective photogrammetric facial analysis results with the subjective ones.

Materials and Methods

This study was carried out on 40 patients (in situ septoplasty in 20 patients and extracorporeal subtotal reconstruction in 20 patients) who underwent external rhinoplasty surgery due to crooked noses in a rhinology clinic of a tertiary medical centre between May 2014 and January 2016. All procedures that were performed in the study were in accordance with the ethical standards of the institutional and/or national research committee and the Declaration of Helsinki in 1964 and its subsequent amendments or comparable ethical standards. Informed consent was obtained from all of the participants in the study. This has been planned as a prospectively randomized self-controlled single-centre study.

Patient Selection

Forty patients with primary crooked noses were included in the study. They were randomized into two groups: ISS and ECS regarding the technique for correction of dorsal septal deviation. Randomization was sequential in a one-by-one manner. None of the randomized patients were excluded. Revision cases were excluded. Age, gender, comorbidities, trauma, previous functional complaints were neither inclusion nor exclusion criterion.

Surgical Techniques

All operations were performed by the same senior surgeon via an open approach. The minimum follow-up period was 1 year for each group. While performing rhinoplasty on the patients with deviated noses, the decision of whether to use the ECS or ISS technique was made in a randomized sequence fashion. All patients were primary cases. The patient's own septal cartilage was used as grafting material in all cases.

In the ECS technique, after the osseocartilaginous skeleton was exposed, the septal mucoperichondrial flaps were elevated. The deviated caudal septal cartilage was excised, but a few millimetres of the dorsal strip at the keystone area was preserved for the new L-strut septal cartilage suturing which was described previously by Most [8]. A new L-strut, which was straight and strong, was formed with the harvested cartilage extracorporeally. Then it was fixed with the preserved cartilage tail to the keystone with 4–0 polydioxanone (PDS) sutures. The stability of the caudal septum was accomplished by suturing the newly shaped septal cartilage to the soft tissue that was around the anterior nasal spine with 4–0 polydioxanone (PDS) sutures [9]. After stabilization of the new L-strut, the dorsal aspect of the septal cartilage was stitched to the upper lateral cartilages with 4–0 polydioxanone (PDS) sutures to provide additional stability. If the bony vault was crooked, unilateral intermediate osteotomy was performed to the longer side of the nasal bone additional to the lateral and middle ones. Figure 1 shows intraoperative photographs of a 23-year-old man with a crooked nose deformity who underwent ECS.

In the ISS technique, after the osseocartilaginous skeleton was exposed, the septal mucoperichondrial flaps were elevated. The deviated cartilage was excised leaving 1 cm dorsally and caudally from the L-strut of supporting septal cartilage via the classic submucous resection technique. Afterwards, the cartilages for unilateral or asymmetric spreader grafting were prepared. Following the scoring and cross-hatching of the deviated L-strut, the unilateral or asymmetric splinting spreader grafts were stitched to the concave side of dorsal deviation with 4–0

Fig. 1 Intraoperative photographs of a 23-year-old man with a crooked nose deformity who underwent ECS (extracorporeal subtotal septal reconstruction). Asterisk: preserved cartilage tail at the keystone area, arrow: newly shaped L-strut cartilage



polydioxanone (PDS) sutures to straighten the nasal dorsum as described previously by Menger [10]. A rectangular strip of cartilage was positioned on either side of the dorsal septum as it was described for the use of spreader grafts by Sheen [11]. If the bony vault was crooked, unilateral intermediate osteotomy was performed to the longer side of the nasal bone additional to the lateral and middle ones. Figure 2 shows intraoperative photographs of a 27-year-old man with a crooked nose deformity who underwent ISS.

Procedure

All of the patients underwent a detailed physical examination and standard preoperative and postoperative facial photography for rhinoplasty. An informed consent related to photography, including the permission for publication, was obtained from all patients and the control group who were included in the study. Measuring the important angles and lengths on a patient's picture is a labour-intensive task that requires the use of a ruler and a protractor in the

traditional way or computer software. Rhinobase is a free software that has an automated photographic analysis application which decreases the duration of entire facial analysis to a maximum of 10–15 min. The Rhinobase 1.1 program was designed in 2002 by Apaydin F and Akyildiz NS (Department of Ear Nose Throat, Faculty of Medicine, Ege University, Izmir) and Dr. David A. Hecht, Prof. Dr. Dean M. Toriumi (Department of Otolaryngology Head & Neck Surgery, University of Illinois at Chicago, IL, USA). Figure 3 shows a preoperative screenshot of the photogrammetric facial analysis with Rhinobase software. The photographic set-up was composed of a digital SLR camera (Nikon D700, Nikon, Japan), a tripod and a flash system (Multiblitz profilux 600, Multiblitz, Germany). Frontal, lateral, three-quarter, basal and sky views were taken by the same medical photographer. Each patient stood 2 m away from the camera, and the visual axis was parallel to the floor of the room for the frontal, three-quarter and lateral views. The camera height was adjusted according to the patient's height so that the patient's head was

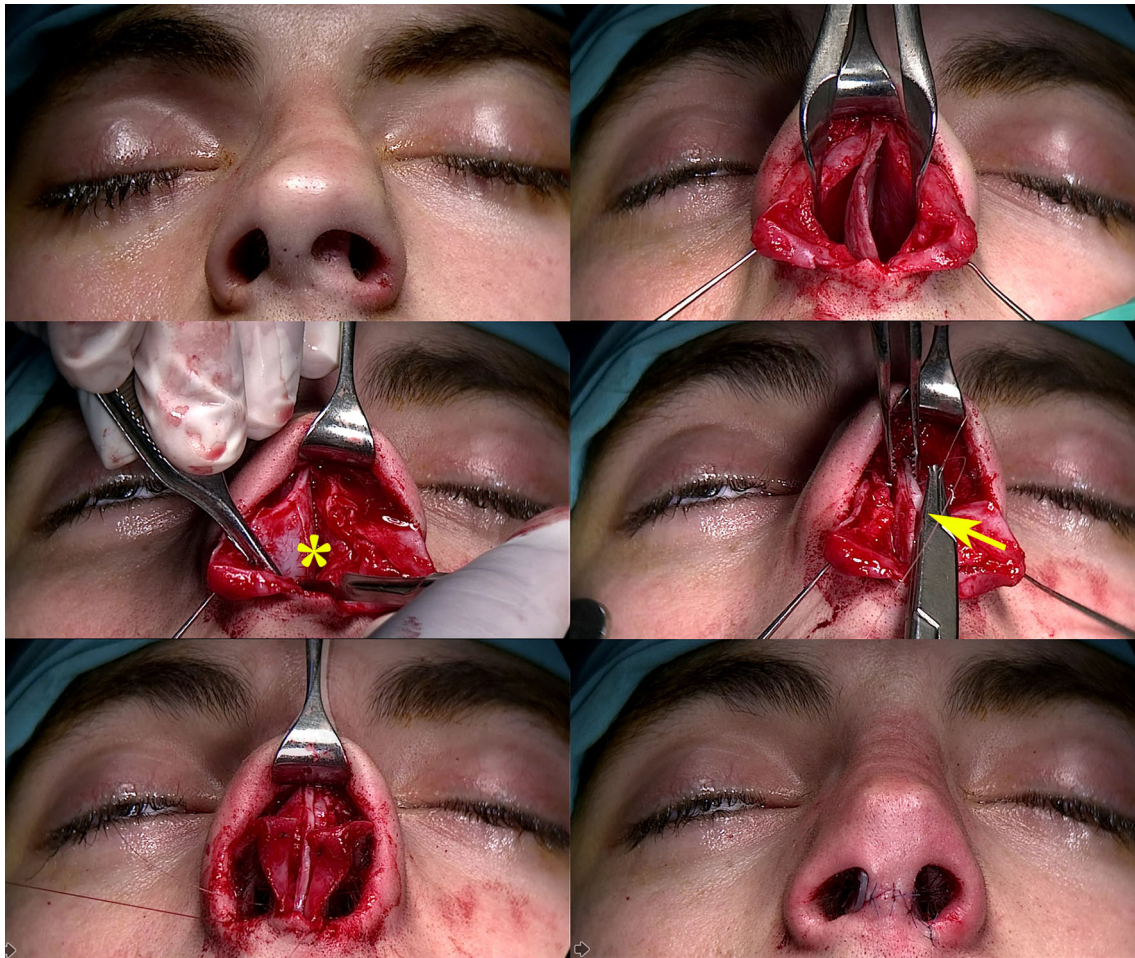
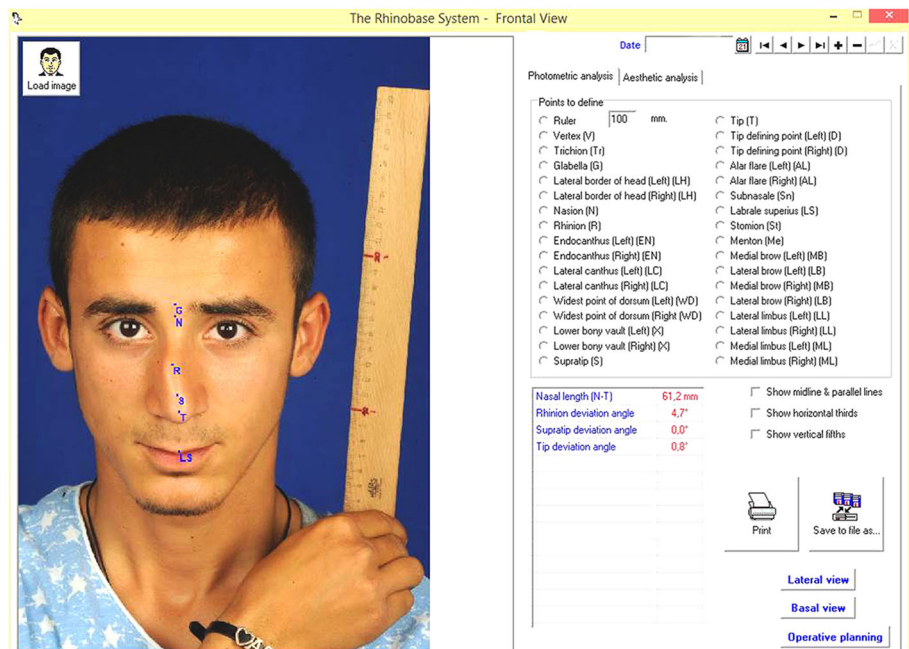


Fig. 2 Intraoperative photographs of a 27-year-old man with a crooked nose deformity who underwent ISS (in situ septoplasty with asymmetric spreader grafts). Asterisk: cross-hatching of the deviated cartilage, arrow: asymmetric splinting spreader grafts stitch to the dorsal deviation

Fig. 3 Preoperative screenshot of the photogrammetric facial analysis with Rhinobase software



horizontal to the lens of the camera (Nikkor f2.8 105-mm macrolens, Nikon, Japan). The patients were seated in a fixed position and asked to gaze directly at the fixed points for different views. Standard pictures were obtained as follows: the eyes were fully open with direct gaze and the lips were closed with no smile. Additional frontal, lateral and basal pictures were taken with a ruler on the one side of the head during photogrammetric analysis for calibration purposes. Photographic measurements were taken by one otolaryngologist who did not participate in the operations. In this study, the frontal and lateral views of these photographs were used. Frontal views were used to assess rhinion deviation angle (RDA), supratip deviation angle (SDA), tip deviation angle (TDA) and brow tip aesthetic line. The reference midline has been selected as nasion to labrale superior. The angles between this reference midline to nasion–tip, nasion–rhinion and nasion–supratip lines were calculated as TDA, RDA and SDA, respectively. Figure 4a, b, c shows rhinion, supratip and tip deviation angle, respectively, to determine the alignment of the nose. Lateral views were used to assess nasolabial angle (NLA), nasofrontal angle (NFA), nasal tip projection according to Goode [12] and to determine the dorsal nasal irregularities. Preoperative and at least 1-year postoperative photographs were used for comparisons.

Visual Analog Scale Assessment

The preoperative and postoperative 1-year subjective assessments of nasal obstruction were evaluated with a visual analog scale (VAS). The question of how well they could breathe through their nose in the preoperative and postoperative period was asked. Also, VAS was used for

the aesthetic analysis in the preoperative and postoperative period by asking the patients how much they liked the appearance of their nose.

Postoperative complications, including irregular contour of the dorsum, saddling, asymmetric nostrils, upper lip stiffness, infection, septal perforation, septal haematoma and persistent nasal obstruction, were evaluated in all patients.

Statistical Analysis

Statistical analysis was done using computer software (SPSS version 22.0, SPSS Inc. Chicago, IL, USA). We used t tests to compare the anthropometric measurements and VAS outcomes in the ECS and ISS groups. Data were expressed as “mean (standard deviation SD)”, per cent (%), minimum–maximum, odds ratio (OR); 95% confidence interval (CI) and “median (interquartile range IQR)” where appropriate. $p < 0.05$ was considered as statistically significant.

Results

The mean ages of the ECS and ISS groups were 22.5 years (range 18–39 years) and 27.5 years (range 18–37 years), respectively. There were sixteen males and four females in the ECS group. The ISS group included fourteen males and six females. Nasal trauma history was present in 13 patients (65%) in the ECS group and nine patients (45%) in the ISS group. The mean postoperative follow-up period was 20 months (range 12–32 months). The characteristics of the ECS and ISS groups are shown in Table 1.

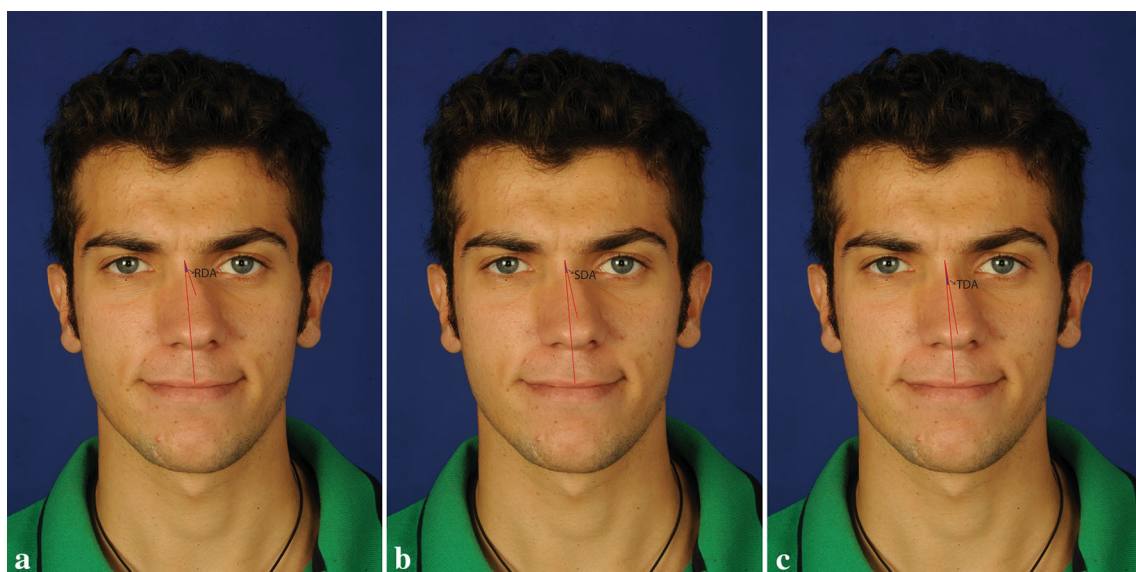


Fig. 4 a, b, c Rhinion, supratip and tip deviation angle, respectively

The mean preoperative rhinion, supratip and tip deviation angles were 9.09, 3.47 and 2.42 degrees in the extracorporeal group, whereas they were 6.23, 2.86 and 2.92 in the in situ septoplasty group, respectively. The mean angles of postoperative rhinion, supratip and tip deviation were 1.48, 1.28 and 1.01 in the extracorporeal group, whereas they were 2.13, 2.08 and 1.42 in the in situ group, respectively. (*p* values for preRDA-postRDA, preSDA-postSDA and preTDA-postTDA were 0.000, 0.001 and 0.002 in the ECS group, and they were determined to be 0.000, 0.218 and 0.001 in the in situ group, respectively.) There was a significant difference between RDA, SDA and TDA pre- and postoperatively in the ECS group, whereas in the ISS group, except SDA, all other postoperative angles were significantly different from preoperative values (*p* = 0.218). The nasal tip projection in the ECS and ISS groups was 29.48, 31.5 preoperatively and 29.78, 31.26 postoperatively. *p* values of the mean tip projection in the ECS and ISS groups were 0.470, 0.625, respectively. The mean postoperative nasal tip projection value (*p* > 0.005) did not change significantly compared to the preoperative value in both groups. Comparisons of the data obtained from the preoperative and postoperative measurements between the ECS and ISS groups are shown in Table 2.

The mean values of preoperative NLA and NFA were 101.44 and 146.7 in the extracorporeal group and they were 103.17 and 146.8 in the in situ septoplasty group, respectively. The mean values of postoperative NLA and NFA were 104.2 and 143.8 in the extracorporeal group and 111 and 146.3 in the in situ septoplasty group, respectively. The mean postoperative value of nasolabial (*p* = 0.226) angle did not change significantly compared to the mean preoperative one in the ECS group. However, in the ISS group, the mean postoperative value of nasolabial (*p* = 0.001) angle significantly improved compared to the mean preoperative value. The mean postoperative value of nasofrontal (*p* > 0.005) angle did not change significantly compared to the preoperative one in both groups. Comparisons of the data obtained from the preoperative and

postoperative measurements between the ECS and ISS groups are shown in Table 2.

Functional and aesthetic outcomes were assessed with VAS. There was significant improvement in both groups, whereas improvement in both functional and aesthetic outcomes was much higher in the extracorporeal group. The VAS values of functional and aesthetic outcomes in both groups changed significantly compared to the preoperative values of both groups (*p* < 0.005). Comparisons of the VAS data obtained from the preoperative and postoperative measurements between the ECS and ISS groups are shown in Table 3.

The rate of complications, such as irregular contour of the dorsum and postoperative infection, was not significantly different between the two treatment groups. There was one patient with irregular contours of the dorsum in the ECS group and one patient in the ISS group. No serious postoperative infection was detected in either group during the follow-up period. One patient in the ISS group had a preoperative septal perforation almost 1 cm above the anterior septal angle; it regressed approximately to 3–4 mm during the postoperative follow-up period. No saddling deformity occurred in our patients. No patients experienced haemorrhage or septal haematoma. Also, no patient had postoperative nasal obstruction that required revision surgery. One patient underwent revision rhinoplasty due to irregularity on nasal dorsum in ECS group.

Discussion

The nasal septum is one of the most important structures which are generally deviated in a crooked nose patient. Therefore, septoplasty is almost always performed in crooked nose rhinoplasty.

Killian mentioned the importance of sparing 1 cm dorsally and caudally from the “L”-strut of supporting septal cartilage while defining the submucous resection in 1905 [13]. Subsequently, numerous techniques have been

Table 1 Characteristics of the ECS and ISS groups

	Extracorporeal septoplasty (ECS) (<i>n</i> = 20)	In situ septoplasty (ISS) (<i>n</i> = 20)
Mean age (y)	22.5	27.5
Sex		
Male	16	14
Female	4	6
History of previous nasal trauma	13 (65%)	9 (45%)
Follow-up period mean (range) mo	22 (12–32)	18 (12–32)

y year, mo month

Table 2 Comparison of the values obtained from preoperative and postoperative measurements between the ECS and ISS groups

	Extracorporeal septoplasty (ECS) (<i>n</i> = 20)			In situ septoplasty (ISS) (<i>n</i> = 20)		
	Preoperative	Postoperative	<i>P</i> value	Preoperative	Postoperative	<i>P</i> value
Deviation angle						
RDA	9.09	1.48	0.000	6.23	2.13	0.000
SDA	3.47	1.28	0.001	2.86	2.08	0.218
TDA	2.42	1.01	0.002	2.92	1.42	0.001
Lateral view						
NLA	101.44	104.2	0.266	103.17	111	0.001
NFA	146.7	143.8	0.035	146.8	146.3	0.665
Tip projection						
Goode (mm)	29.48	29.78	0.470	31.5	31.26	0.625

RDA rhinion deviation angle, SDA supratip deviation angle, TDA tip deviation angle, NLA nasolabial angle, NFA nasofrontal angle, mm millimetre

Table 3 Comparison of the VAS values obtained from preoperative and postoperative measurements between the ECS and ISS groups

	Extracorporeal septoplasty (ECS) (<i>n</i> = 20)			In situ septoplasty (ISS) (<i>n</i> = 20)		
	Preoperative	Postoperative	<i>P</i> value	Preoperative	Postoperative	<i>P</i> value
Functional VAS (mean)	3.00	7.90	0.000	4.50	8.50	0.000
Aesthetic VAS (mean)	2.90	8.40	0.000	3.60	6.60	0.000

VAS visual analog scale

described, but this basis is still acceptable nowadays. Peer proposed removal of caudal septum and replacement with the straightened one in the midline [14]. ECS and ISS are the main techniques to correct the deviated septum in a crooked nose [7]. ECS was first described in 1952 by King and Ashley, who removed a severely deviated septum, straightened it and then replaced it [4]. Gubisch [15] reviewed the outcomes of 2119 patients who underwent extracorporeal septoplasty for markedly deviated septum. The whole septum is removed and reshaped in ECS, while the integrity of the structures is preserved in ISS. Therefore, serious technical differences exist between the two methods. It is those differences that directed the authors to which technique would provide better results, and thus, various studies have been performed accordingly.

Lee et al. [7] compared the two methods in their retrospective study and reported that ECS was better especially in terms of functional outcomes compared to ISS. In addition, acoustic rhinometry results were lower in the ECS group, and thus, the ECS group was reported to contain more serious deviations [7]. According to the results of our study, deviated septum in a crooked nose can be corrected effectively by either ECS or ISS. Figure 5 shows pre- and postoperative front, profile and head tilted back views, with

the quarter views of a crooked nose patient who underwent a nasal alignment surgery by ECS. ECS yielded better results than ISS in terms of functional and aesthetic outcomes. However, this difference did not reach a statistically significant level.

Nevertheless, based on these results, it can be suggested that preoperative deviation was more common in the ECS group in this present study. Although the difference between pre- and postoperative status was not significant, it was more in the ECS group. This is in concordance with the previous results; as stated in a study by Most [8], ECS can be used effectively in seriously deviated noses compared to ISS. The finding of significantly less improvement in the supratip region in the ISS group compared to ECS may be attributed to the memory of septal cartilage. In the ISS group, the cartilage was not actually straightened, only a spreader graft was placed along the curved cartilage; after a few months, it could have a tendency to return to its original position. Figure 6 shows pre- and postoperative front, profile and head tilted back views, with the quarter views of a crooked nose patient who underwent a nasal alignment surgery by ISS. In daily practice, excellent success may be obtained immediately after surgery. However, it may turn out to be a failure after a few months



Fig. 5 Preoperative (a, b, c, d and e) and postoperative (f, g, h, i and j) front, profile and head tilted back views, with the quarter views of a crooked nose patient who underwent a nasal alignment surgery by ECS (extracorporeal subtotal septal reconstruction)

due to the recurrence of deviation to some degree. It depends on the deviation memory of the cartilaginous structures; they tend to return to their original position because of their elasticity [4]. In this case, ECS seems to be more advantageous in prevention of occurrence of re-deviation compared to ISS, although the duration of follow-up is inadequate in this study to be able to make a conclusion.

We assessed the tip projection (Goode) with photogrammetric measurements preoperatively and postoperatively. Nasal tip projection did not change significantly compared to the preoperative period. Particularly, in the ECS group, no evidence was observed regarding the loss of tip projection. Considering NFA and NLA, Lee et al. reported that significant differences were found in both groups between preoperative and postoperative values. However, no significant differences were found in preoperative and postoperative NFA and NLA in the ECS group in this present study. NLA was significantly changed in the ISS group, whereas no such change was seen in NFA. This difference may be attributed to the limited number of patients. The undiminished NLA or tip projection may be accepted as a favourable finding for ECS because it has traditionally been related to saddle nose.

The present study compared the aesthetic and functional outcomes of ECS with those of ISS. A comparable degree of aesthetic improvement was determined in both groups. However, regarding the degree of aesthetic satisfaction, it was more pronounced in ECS compared to ISS. Likewise, both groups benefited in terms of functional satisfaction. Similarly, functional satisfaction was superior in ECS compared to ISS. This difference may be due to the well-known better outcome of ECS in severe septal deviations. Because this is a randomized controlled trial, some severe septal deviations were treated by ISS. None of the patients complained about a worse nasal obstruction after the surgery in either group.

There are many techniques for suturing of the neoseptum in its proper place in ECS. The surgeon may drill a hole to the nasal bone as it has been described previously [16] or leave a cartilage part on the keystone region as it has been published by another author [8]. Proper fixation of the posterior nasal angle to the soft tissue around the anterior nasal spine in the midline was chosen in this study rather than stitching it to the anterior nasal spine itself. Because crooked nose is a complex deformity, the anterior nasal spine could be severely deviated as the septum. This has been previously described by Guyuron [17].



Fig. 6 Preoperative (a, b, c, d and e) and postoperative (f, g, h, i and j) front, profile and head tilted back views, with the quarter views of a crooked nose patient who underwent a nasal alignment surgery by ISS (in situ septoplasty with asymmetric spreader grafts)

Bloom et al. [18] reviewed an article about the complications of septoplasty. The potential complications of a standard endonasal approach included haemorrhage or septal haematoma (6–14%), aesthetic deformities (4–8%), infection (0.048–2.5%), septal perforation (1–6.7%), adhesions or synechiae (7%), hyposmia (0.3%) and cerebrospinal fluid leak (rare). In our study, irregular contour of dorsum was observed in two patients (one patient was in the ECS (underwent a revision for aesthetic reason) and the other one was in the ISS group). Nasal obstruction did not deteriorate to an extent that revision septoplasty was required in either group.

In the current medical literature, there is no precise indication for ECS or ISS except some subjective considerations. The aim of designating indications for techniques based on objective findings is nearly impossible due to the complex nature of the disease “crooked nose”. Furthermore, it is not a subject of this study. Further randomized studies with different patient groups for each technique are warranted to elucidate the possible objective indications.

This is the first randomized controlled trial that compares extracorporeal and in situ septoplasty techniques in crooked nose patients. Extracorporeal septoplasty yielded slightly better objective and subjective aesthetic and functional outcomes compared to the in situ one. We may

conclude that extracorporeal septoplasty should be chosen over the in situ technique in crooked nose patients with the most severe deviations. Mild cases can also be treated safely and effectively. It is important to leave a small septal residual cartilage on the keystone region as described before [13]. There are a relatively small number of patients; however, saddle nose or tip ptosis has not been encountered in extracorporeal septoplasty patients.

Low patient numbers may be one of the shortcomings of this study. However, we attempted to overcome this limitation by relatively standardizing the surgical techniques that were used in the study. Regarding functional outcomes, lack of acoustic rhinometry or rhinomanometry may be another limitation of the study.

As a conclusion, this is the first study that compares subjective and objective aesthetic and functional outcomes of crooked nose surgery according to two common septoplasty techniques in a randomized self-controlled fashion. This study was effective in both objectively and subjectively comparing the functional and aesthetic aspects of the patients submitted to two common different techniques for treatment of nasal deviations in crooked nose patients.

Compliance with Ethical Standards

Conflict of interest There is no conflict of interest in this paper.

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