ORIGINAL ARTICLE

Saddle nose: Autologous augmentation techniques and their relevant patient satisfaction

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Saddle nose; Rhinoplasty; Autologous cartilage; Grafts

Abstract Introduction: The analysis and treatment of saddle nose have always been a surgical challenge. The study describes the three-stage classification of this deformity as well as a treatment algorithm adapted to each case.

Materials and methods: A prospective study was carried out on 46 patients with saddle nose. The patients were divided into 3 groups according to the severity of saddling: minimal, moderate and major. The authors describe the treatment protocol adopted for each stage.

Results: This series comprised 16 cases of minimal saddle nose, 20 cases of moderate saddle nose and 10 cases of major saddle nose. Minimal saddle nose was treated by enforcing and reconstructive septoplasty and dorsal septal augmentation grafts, conchal grafts were used to treat moderate saddle nose, and costal cartilage was used to reconstruct major saddle nose. We have used the open rhinoplasty approach to correct saddle nose in all cases. Surgical revision was never required.

Conclusion: Saddle nose is a condition that is quite commonly faced by Otolaryngologists. The proposed treatment strategy is based on a meticulous analysis of the saddle nose, resulting in a graduated reconstruction adapted to each stage according to the severity of deformity.

Level of evidence: IV.

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1. Introduction

Throughout the history of existence of mankind nasal saddling has been a significant problem that was frequently addressed. Saddle nose was mentioned in the oldest medical document that is the Edwin Smith surgical papyrus from ancient Egypt. This deformity was also discussed by Ayur Veda of Sushruta of India in approximately 800 BC.1

The years passed by and an interesting reconstructive technique for the dorsal concavity was proposed by Dieffenbach in the year 1834. Dieffenbach buried a vertical frontal forehead flap for saddle nose correction. This was followed by John Roe in 1887 who named the problem the Bug-nose. The next surgical pioneer to address the saddle nose was Robert Weir who published his work in 1892.2,3

This saddle nose deformity is described as a loss of projection of the cartilaginous and/or bony structure of the nasal dorsum, this affects both the functional and esthetic prospective of the patient. The nasal saddling is usually due to
infection, nasal trauma, and iatrogenic causes as a result of primary or secondary reduction rhinoplasties. The iatrogenic causes are now the most common etiology of the deformity.4

Saddle nose deformity is most commonly classified into three stages according to the severity. The first stage corresponds to the minimal depression above the supratip of the nose and due to loss of septal support this might be associated with minimal columnar retraction affection of the nasal tip projection. The second stage has a moderate depression of the dorsum that does not exceed 5 mm. In this stage the loss of septal supports affects the normal anatomical relations of the nasal septum with the surrounding cartilaginous structure. The nasal tip might also lose projection and gain an upward rotation in the second stage.4,5

The third stage of saddle nose has a major lack of bony and cartilaginous support. The tip loses more projection and the nostrils change their orientation to become broad. The intranasal change is in the form of a major nasal mucosal retraction. These features when accompanied together results in the short-nose.4,5

The Saddle nose surgery is mainly based on the use of supporting grafts to obtain the desired esthetics and functional results. To achieve the desired results various materials have been employed for nasal contour restoration. The most commonly used grafts are autologous cartilages. Septal cartilage is ideal for reconstruction and often insufficient except in mild cases. The conchal and costal cartilage grafts are the most commonly used in moderate and severe nasal saddling. The purpose of this study was to report the surgical management and long-term esthetic results of patients undergoing rhinoplasty for saddle nose and their quality of life changes.6,7

2. Methods

2.1. Ethical considerations

The study protocol was presented to the human subjects committee of ethics and an approval was obtained prior to the start of the study. The enrollment period was May 2010 through January 2014. All patients enrolled gave their written informed consent.

2.2. Study design and patient selection

The study was conducted on 46 patients admitted for elective reconstruction of saddle nose deformity, with the approval of the human subjects committee. This is a prospective observational outcomes study of patients desiring correction of deformity that caused functional and/or esthetic problems.

Exclusion criteria were as follows: patients with autoimmune disease; Granulomatosis with polyangiitis (GPA), formerly known as Wegener granulomatosis, and relapsing polychondritis.

During the enrollment period, all of the patients in this study were examined. Patients completed a questionnaire, and data such as history of previous trauma or surgery and any similar family history. Patient demographic data were noted. Simple grading of the degree of saddling was obtained and recorded. The patients in this study were divided into 3 groups in order to define graft adaptation for each stage of deformity. All the patients were enrolled after a clinical examination and nasal endoscopy and all the patients were requested to complete a Visual Analogue Scale prior to surgery and 6 months after the reconstructive procedure.

During the 6 month follow-up period, patients were visited weekly for 2 weeks, biweekly for 2 months, and then monthly thereafter. During these visits the patients were examined and questionnaires were completed, patients were asked to grade the degree of improvement after the surgery.

Outcomes were measured preoperatively and postoperatively with the Visual Analogue Scale questionnaire for patient satisfaction after the esthetic procedure. We have considered an individual outcomes instrument that had been previously developed by Alsarraf (2000) to assess quality of life change in a quantitative manner. The questionnaire consisted of an instrument which is composed of 6 questions capturing 3 quality of life domains: physical, mental/emotional, and social. Inclusion of these 3 domains is the recommended methodology in the quality of life literature. Each question is scored on a scale from 0 to 4 and is converted to a total score of 0–100 by dividing by 24 and multiplying by 100. This was obtained preoperatively and after a period not less than 6 months after rhinoplasty and not more than 1 year. All patients in the second group undergoing both functional and esthetic rhinoplasty were requested to complete this questionnaire.6,9

Statistical analysis was then performed. A mixed model was statistically analyzed with the XLSTAT (Addinsoft, New York, USA) to analyze the obtained data and to assess improvement in esthetic results.

2.3. Esthetic assessment

All patients’ noses were inspected both externally and internally. External assessment was used to assess the nasal dorsum and tip support. The support was assessed by the septal support test adopted by Kim in 2004. Shortening of the nose and any change in tip rotation was noted. The bony pyramid was also assessed for deviations and depressions. Internal assessment with rigid endoscopes was performed to assess any septal deviation, or other causes of nasal obstruction.10,11

A thorough external examination of the nasal shape was performed with special emphasizes on; lateral and frontal nasal lengths (the distance from the nasion to the tip defining point, and from the nasion to the subnasale), nasal axis deviations, dorsal humps or pseudohumps, degree of dorsal depression, and degree of tip rotation and projection.

2.4. Management algorithm

For nasal dorsum augmentation we harvested cartilage from multiple origins and this was tailored for each stage of saddling. The cartilage was harvested from the septum, concha, and rib. In this study we have used the external rhinoplasty approach to reconstruct the nasal dorsum and to address other accompanying deformities.

2.4.1. Stage 1: Minimal saddle nose

The main feature of this stage is the presence of a mild depression in the middle third (supratip), with fairly good residual cartilaginous septal support dorsally and caudally, and in most cases a normal lower third and tip position.
Figure 1  Open approach saddle nose reconstruction of a female patient with stage I deformity showing an onlay augmentation of the nasal dorsum using septal cartilage.

Figure 2  (Below) Autologous conchal cartilage graft folded and sutured in a double layer fashion to gain a desired dorsal height. (Above) An additional inferior turbinate bone stripped of mucosa could be harvested in patient complaining of turbinate hypertrophy to gain an extra dorsal augmentation if needed.
This type of defect typically occurs after surgery or trauma. Through an open rhinoplasty approach the septum assessed to determine the possibility to harvest a segment to be used as a columellar strut. The graft is fashioned into a straight strut which is positioned between and sutured to the medial crura of the lower lateral cartilages such that the posterior border of the strut is anterosuperior to the anterior nasal spine. The strut will prevent tip retro-projection and may provide

Figure 3  Preoperative frontal and lateral views of a male patient with stage II saddle nose.

Figure 4  Intraoperative image of the same patient showing the lost caudal and inferior loss of the septal support due to a previous septoplasty.
improved projection. The dorsal defect is addressed by insertion of a single small piece of septal cartilage that is secured in place with Polydioxanone 5/0 sutures. In case of a very mild defect the use of diced or minimally crushed cartilage was inserted to enhance the supratip area (Fig. 1).

2.4.2. Stage 2: Moderate saddle nose
In this stage it is not uncommon that the saddling is a result of an excessive removal of the caudal septum with disarticulation or even excision of the remaining septal support. In these cases realignment of the septum is a must. This should be

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Figure 5  Batten graft septal support to enforce the septum and provide the needed septal support to gain an additional septal height. The graft is secured to the septal remains and the nasal spine.

Figure 6  Post operative frontal and lateral views of the same patient after conchal cartilage augmentation and septal enforcement.
accompanied by the insertion of an enforcing anterior inferior graft to account for the lost height.

In moderate saddle nose, a dorsal augmentation cannot be restored by the limited amount of septal cartilage present in the surgical field. Thus the use conchal cartilage is a must in these cases. To harvest the conchal cartilage an anterior or posterior approach could be used according to the surgeon preference. In this study we preferred the use of a posterior approach in all the patients (Fig. 2).

In this stage the cartilaginous vault is mostly intact and dorsal septal height is relatively present but the caudal septum is deficient and requires a fair amount of support. The

Figure 7 Preoperative frontal, lateral, and basal views of a female patient with stage III saddle nose.

Figure 8 (Left) Intraoperative image showing the harvested costal cartilage prior to insertion into the nasal dorsum to calculate the desired height. (Right) The graft is secured to the nasal dorsum with Polydioxanone sutures and the tip is augmented and esthetically refined.

Figure 9 Post operative frontal, lateral, and basal views of the same patient after costal cartilage augmentation and nasal tip enforcement.
harvested conchal cartilage was frequently folded to gain the desired thickness and height to account for the deficient area of the caudal septum. These grafts are inserted via an external approach and are sutured to avoid any displacement and secondary deformity. In few cases we have found that the tip projection was sufficient thus we did not slit the lower lateral cartilages to keep the membranous septum intact. Dorsal augmentation does not solely solve the problem as tip projection and rotation should be restored to normal by placing a columnellar strut and adjusting the degree of rotation (Figs. 3–6).

2.4.3. Stage 3: Major saddle nose

Major saddle nose is observed less frequently and corresponds to a marked lack of bony and cartilaginous support. This stage necessitates a major reconstructive procedure using a sufficient quantity of graft material. The costal cartilage is ideal in such cases. It is usually obtained from the 7th, 8th ribs according to the quantity needed. If the nasal tip is not markedly affected, the costal cartilage is used to augment the dorsum and the tip is augmented by a columnellar strut in a similar reconstructive maneuver done in the second stage nasal saddling (Figs. 7–9).

If the tip is significantly deformed the costal graft is modeled to the L-shaped frame of the dorsum. The prefabricated graft is generally inserted to augment the dorsum and the columnella. Functionally, this deformity alters both the internal and external nasal valves which are frequently repaired using nasal valve spreader grafts. The nostrils become flatter and wider and nasal base reduction and reshaping are mostly needed.

Figure 10  (Left) Female patient with stage I saddle nose. (Right) Post operative image of the same patient 3 months after the surgery with reconstruction of the supratip deficiency.

Figure 11  Preoperative frontal and lateral views of a male patient with stage II saddle nose.
The commonest problem that surgeons face upon the use of costal cartilage is the warping. We have found that most of the warping occurs within the first hour after the harvest. During the reconstruction we advise to harvest the cartilage then perform the approach thus upon the time of carving of the cartilage most of the warping would have been already occurred and we could compensate for it.

It is quite common for these patients to have a revision procedure to correct the position of a warped costal cartilage if not considered during the operation. In these cases correction of the cartilage position is done and that might include an additional enforcing layer of conchal cartilage and tip augmentation.

3. Results

The study period started January 2010 and ended in August 2014, a total of 46 patients (30 men 65.21% and 16 women 34.78%) underwent Batten graft septoplasty with or without esthetic rhinoplasty. The patients' ages ranged from 19 to 46 years with a mean of 27.76 years.

Group one included 16 (6 females and 10 males) patients complaining of stage I saddle nose; these patients underwent repair and augmentation of saddle nose through an external approach rhinoplasty. These patients had an augmentation with the readily available septal cartilage in the surgical field (Fig. 10).

Figure 12 Post operative frontal and lateral views of same patient with conchal cartilage augmentation and esthetic rhinoplasty.

Figure 13 Preoperative frontal and lateral views of a female patient with stage III saddle nose.
Group two included 20 (6 females and 14 males) patients who requested esthetic rhinoplasty for correction of stage II saddle nose and other nasal airway obstructive complaints. These patients had an augmentation with an autologous conchal cartilage. In few cases an additional septal cartilage was used if available and in two patients partial inferior turbinectomy was indicated and the underlying bone was used for augmentation (Figs. 11 and 12).

Group three included 10 (4 females and 6 males) patients with stage III nasal saddling. The follow-up period ranged from 6 to 12 months. The costal cartilage harvested from 7th rib was our graft of choice for dorsal and caudal augmentation. A substantial improvement in the shape and nasal patency was observed in all cases. Postoperative improvement of the nasal airway was documented with clinical examination (Figs. 13 and 14).

In all groups, a Visual Analogue Scale questionnaire was acquired to assess patient satisfaction with the shape of their noses before and after surgery. In stage I patients the preoperative VAS scores had a minimum of 16.1 and a maximum of 37.5 with a mean of 23.41. The same patients had post operative scores with a minimum of 66.6 and a maximum of 87.7 with a mean of 78.86. In stage II patients the preoperative VAS scores had a minimum of 16.1 and a maximum of 41.6 with a mean of 24.14. The same patients had post operative scores with a minimum of 75 and a maximum of 91.6 with a mean of 83.43. Stage III saddle nose patients had a preoperative VAS score minimum of 12.5 and a maximum of 29.9 with a mean of 20.48. In this group the post operative minimum VAS score was 78.5 and a maximum of 95.8 with a mean of 85.74. In all patients the mean preoperative VAS score for the degree of satisfaction of the shape of their noses was 23.09 and the mean of the postoperative satisfaction was 82.34.

4. Discussion

Nasal surgeries are always evolving and new techniques continue to emerge to enhance the results and decrease the complications. As far as septoplasties and nasal trauma are present nasal saddling will be an annoying complication that should be dealt with. Many surgeons find the correction to be difficult and unpredictable, however associating the reconstructive techniques to the patient post operative satisfaction is a helpful tool.

The most important step of repair is to analyze the degree of saddling as each stage encompasses its own repair maneuver. It is of great significance to determine the cause of saddling specially if an ongoing autoimmune disorder is present. Daniel in 2006 proposed a detailed scheme of classification. He classified saddle nose into 5 categories: (1) supratip depression and columellar retraction; (2) loss of tip projection and septal support; (3) total loss of cartilaginous vault integrity and flattening of the nasal lobule; (4) progression, with involvement of the bony vault; and (5) catastrophic deformity. The importance of his proposition is that many factors are incorporated. These factors are the external appearance of the nose, the degree of compromise of the septal support, and the selection of surgical treatment.

In this study we evaluated the surgical management outcomes of reconstruction of the saddle nose in 46 patients. We found that all of the patients showed a good esthetic improvement after the operation. None of the patients in this study needed a revision surgery for additional augmentation. The overall degree of satisfaction of the nasal shape improved from 23.09 to 82.34 after the surgery. In literature only few studies have reported surgical outcomes of saddle nose. In a review of 20 saddle nose cases, Mao et al reported that only 5% had unsuccessful surgical results. Various causes do exist and might lead to the unsatisfactory results. The incomplete analysis and classification has a major role of an unsatisfactory result. Saddle nose repair in an ongoing infection contributes in these results. Costal cartilage warping has a significant role in yielding poor results that is why we advise waiting for at least 30 min before insertion of the graft to carve against any possible warping. In severe cases with collapse, a gap is noted beneath the graft. In order to secure the graft in place and to avoid the floating appearance of the graft we advise the use of wafers of cartilage to be inserted beneath the graft until

![Figure 14](image-url) Post operative frontal and lateral views of same patient with costal cartilage augmentation and esthetic rhinoplasty.
the graft stops floating. These wafers of cartilage are inserted ideally between the septum and the onlay graft that is already inserted.\textsuperscript{12}

To the best of our knowledge, no study has reported the surgical outcomes of saddle nose as expressed by patients’ satisfaction in correlation to the degree of saddling. The degree of post operative satisfaction in all three saddle nose stages enrolled in our study is nearly close to each other with a slight increase of satisfaction as the stage of saddling increases. This could be explained by the degree of nasal shape improvement that is mostly noted in catastrophic noses.

\section*{5. Conclusion}

Saddle nose is a commonly faced classical otolaryngologic deformity yet it is a difficult complication to be reconstructed. It requires a meticulous analysis and examination prior to surgical planning. The management strategy should be tailored to the stage of deformity. It is highly advised to use autologous grafts to guard against complications that might arise from other grafts. The autologous cartilages constitute the best graft material for reconstruction. The results obtained support our belief that correction of saddle nose must be adapted to the severity of each case rather than using a single technique for all cases.

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III. Indication of no financial disclosures; all patients were performed in the university hospital as part of a routine management that all patients receive without the need of an extra material or financial support.

\section*{Conflict of interest}

None.

\section*{References}