Abstract

Introduction

Septoplasty is a commonly performed procedure that provides an effective treatment of nasal septum deformities. It has become an essential issue in nasal surgery for both functional and aesthetic reasons. The traditional septoplasty approach is often unsuitable for severe septal deviations. In such cases, extracorporeal septoplasty has been credited to obtain more reliable outcomes. However, this technique has received some criticisms because of the destabilization of the keystone area. Due to the increasing number of techniques available, an overview of the cosmetic and functional results of such methods is reasonable. In addition, a comparison of the outcomes of the different techniques may shed further light on which is the best method to correct severe septal deviations. This critical review discusses the correction of nasal septal deviations in rhinoplasty. A review of the literature on the evaluation of the main septoplasty techniques has been conducted. The procedures were evaluated and compared for indications, contraindications, advantages and disadvantages.

Conclusion

The classic septoplasty approach often appears inadequate in cases of marked septal deformations due to the increased risk of recurrence. From the critical review, the extracorporeal septoplasty technique seems more reliable in such cases. In particular, the modified conservative approach has demonstrated to achieve an adequate septum remodelling with cartilage spare and to avoid post-operative dorsum irregularities compared with the more traditional techniques.

Introduction

Nasal septum deviation is a common cause of respiratory obstruction, and is due to three main aetiologies: congenital, traumatic and iatrogenic. Septoplasty is currently considered among the most challenging procedures for the plastic surgeon. In a high percentage of rhinological patients, septal deviations represent a major cause of functional and aesthetic disorders. Furthermore, many authors emphasize the importance of the nasal septum in creating a harmonious relationship between the components of the nasal archway and ensuring the proper function of respiratory mechanics. Consequently, the correction of septal deviations plays a crucial role in rhinoplasty. Patient's history and expectations, correct pre-operative analysis and surgeon's experience determine the surgical approach.

Septal surgery has been greatly improved from the improvements in the available surgical techniques that have allowed to achieve better aesthetic and functional outcomes while minimizing the complication rates. A critical review of the main existing techniques involved in the correction of nasal septal deviations has been conducted to evaluate the best surgical treatment.

Historical background

The historical evolution of septoplasty dates back to early last century. The standard approach to correct cartilaginous septal deviations was firstly popularized by Killian and Freer. It involved a submucous dissection of the quadrangular cartilage and the removal of the deviation with the preservation of mucoperichondrial flaps. Subsequently, a variety of techniques were introduced to straighten the nasal septum after its exposure. Using a more conservative approach, the deviated cartilage may be weakened on its concave side by cross-hatching with partial thickness incisions to relieve intra-cartilaginous tension. Alternatively, the deviation may be submucosally resected leaving a caudal–dorsal ‘L-strut’ for support. Even if the described surgical approach has been the gold standard for the treatment of obstructive septal deformities, it has suffered from serious deficiencies in many common clinical situations. As a consequence, the traditional septoplasty approach was gradually modified during the last century to overcome its major drawbacks.

Intracorporeal septoplasty

The standard septoplasty procedure involves six steps: approach, mobilization, resection, repositioning, reconstruction and stabilization. Usually, the operation starts with a right caudal incision that assures the access to the anterior nasal spine, maxillary crest, nasal floor, nasal dorsum and tip (Figure 1, left). A submucoperichondrial dissection is performed starting on the concave side of the septum followed by a subperiosteal dissection of the nasal dorsum to provide exposure of...
the bony and cartilaginous septum (Figure 1, right). The tunnel combination performed to access the medial nasal structures varies from case to case depending upon the observed deformities and the surgical goals (Figure 2). The caudal septum represents a crucial structure in the nasal anatomy and, when an appropriate caudal strut of almost 2 cm in length is not preserved, significant deformities such as saddle nose and tip ptosis may occur.

Following the experiences of Kilian and Freer, Metzenbaum introduced a modified technique. The procedure entails a transfixed incision to raise bilateral mucoperichondrial flaps and expose the caudal septum from the anterior septal angle to the anterior nasal spine (Figure 3)\(^\text{13}\). A sharp incision may be necessary to maintain a continuous flap through the decussating fibers. A resection of the redundant cartilage is commonly performed, leaving a superior attachment for caudal septum. The freed inferior caudal septum is then anchored to the anterior nasal spine with sutures.

An alternative maneuver to treat caudal septal deviations, named the ‘swinging door’ technique, has been described by Wright\(^\text{14}\). It consists of a wedge resection of the vertical cartilage excess along the maxillary crest with the release of the caudal septal attachments to swing the septum to the midline. The midline position may be secured with an absorbable suture attached to the periosteum adjacent to the opposite side of the nasal spine (Figure 4). This approach has been modified by Pastorek, who introduced the ‘doorstop’ technique\(^\text{15}\). It involves the transposition of the deviated caudal septum over the anterior nasal spine to the opposite nasal cavity without further cartilage resection (Figure 5).

Some vertical wedge resections may be performed with the care to preserve more of the vertical height than would typically be saved in the swinging door maneuver. The deviated portion may be also scored on the concave side to weaken the cartilage. Alternatively, batten grafts applied to the weakened caudal septum may be effective in straightening moderate to severe septal cartilage deformities that are otherwise not correctable via conventional septoplasty techniques\(^\text{16}\). These grafts are typically taken from the posterior area of the quadrangular cartilage or from the perpendicular plate of the ethmoid bone. The batten grafts are then tied along the weakened cartilage to stabilize it in the corrected position. The placement of spreader grafts between the upper lateral cartilage and the caudal septum may also effectively stabilize the cartilage (Figures 6 and 7, right)\(^\text{17}\).

The approach introduced by Kridel (Figure 8) for the management of caudal septal deviation involves the cephaloposterior advancement of the medial crura of the lower lateral cartilages onto the caudal septum\(^\text{18}\). The medial crura are then fixed to the caudal septum ensuring stability and correction of the deviation.

**Extracorporeal septoplasty**

The extracorporeal septoplasty was first proposed by King and Ashley in the 1950s to cure more severe deviations or restore the loss of septal portions\(^\text{19}\). It consists of the total removal of the quadrangular cartilage...
followed by the extracorporeal reconstruction of a new septal plate that is subsequently re-implanted between the two mucoperichondrial flaps.

Vilar-Sancho has used an L-shaped cartilage graft to support both the back and tip of the nose, while Rees used to relocate the entire quadrangular cartilage\textsuperscript{20,21}. Gubisch described a surgical approach usually carried out in combination with a closed rhinoplasty\textsuperscript{22}. This technique consists of the excision of the entire quadrangular cartilage and, subsequently, pieces of the septal bone. The septal plate is straightened through the division of the septum into small, straight cartilage pieces connected by single sutures or by tension-reducing incisions. The new septum is then re-implanted and the cartilaginous dorsum and the nasal tip reconstructed. Anyway, this procedure may produce complications, among which the most important is the tendency to develop dorsum notching or saddling. Specifically, dorsum irregularity was described to be the most common post-operative complication with an 8% recurrence rate\textsuperscript{23}.

Senyuva described the extracorporeal septoplasty performed through an open approach that was considered more reliable because of the easier visualization for dissection and re-implantation\textsuperscript{24}. Subperi-chondrial dissection is performed, as described by Jost, to expose septal cartilage and bone\textsuperscript{25}. An extramucous incision is then performed from the dorsal septum junction to allow an accurate lateral dissection of the upper lateral cartilage. The dorsal septum is freed from the ‘keystone’ area, where the dorsal septal cartilage connects to the nasal bones and to the perpendicular plate of the ethmoid. An inferiorly based osteotomy may be necessary to separate the caudal septum from the anterior nasal spine and maxillary crest. Once the septum has been freed from its bony attachments, it is removed and its structure examined. The reconstructed septum must contain straight sections caudally and through the dorsum in order to recreate the L-strut. Recently, Most has described a modification.
Critical review

Figure 4: Swinging door manoeuvre: left, the caudal septum excess is removed allowing the septum to swing to the midline; right, the position may be secured with an absorbable suture anchoring the caudal septum to the periosteum on the opposite side.

Figure 5: Modified swinging door technique: left, the caudal septum is detached from the maxillary crest and nasal spine but is not excised; right, rather, the septum is flipped over the nasal spine, which acts as a doorstop and secures the caudal septum in a straighter position.

Figure 6: Internal nasal valve narrowing and collapse: this may be prevented by positioning a spreader graft.

Figure 7: Left: the typical orientation of the narrow stripes that will be excised and used as spreader grafts is shown; Right: spreader grafts in place.
of this technique that preserves the dorsal septum at the keystone area, minimizing the nose destabilization and dorsal irregularities. This technique, known as anterior septal reconstruction, is achieved via open rhinoplasty and mainly addresses anterior septal deviations.26

In an effort to further reduce destabilization risk and to preserve the nasal dorsum contour, Persichetti et al. have modified the classic technique with a more conservative approach that spares the dorsal cartilage and a portion of the caudal septum, thus maintaining a support for the nasal archway.27 This approach, that can be combined with an open or closed rhinoplasty, has already demonstrated to be effective from a functional point of view through a prospective observational study. An intercartilaginous incision is performed in the vestibule skin between the caudal border of the upper lateral cartilages and the cranial border of the lower lateral cartilages. Subsequently, further transfixion incision is performed 2 mm above the inferior border of the caudal septum to expose the nasal dorsum (Figure 9). Starting on the concave side of the nasal septum, submucoperichondrial and subperiosteal dissections of the nasal dorsum are performed. The cartilaginous septum is resected partially, thus preserving an ‘L’ strut, measuring at least 0.5 cm in height (Figure 10). The resected septal cartilage is then rectified on the surgical workbench by means of partial thickness tension-reducing incisions (as described by Cottle), cartilage crushing (Figure 11) or other means. Redundant or dislocated osteocartilagenous spur may be easily carried out during this procedure. The straightened and/or reconstruct-ed cartilage is then re-implanted between the two submucoperichondrial flaps (Figure 12). The securing of the re-implanted septum is obtained through mucoperichondrial transfixed 4-0 absorbable sutures.

The ‘L’ strut is also rectified if necessary. The correction technique depends on the degree of the deviation. Partial thickness tension-reducing incisions (as described by Cottle) are performed in cases of mild deviations (Figure 11). Cartilage crushing and mattress sutures are performed for moderate deviations.28

Discussion

The authors have referenced some of their own studies in this review. These referenced studies have been conducted in accordance with the Declaration of Helsinki (1964) and the protocols of these studies have been approved by the relevant ethics committees related to the institution in which they were performed. All human subjects, in these referenced studies, gave informed consent to participate in these studies. The importance of septoplasty was, when Killian and Freer laid the basis for the intracorporeal...
Several modifications have innovated their approach during the following decades. The surgical technique described by Pastorek has been demonstrated to be effective in reducing nasal obstructive symptoms and in treating mild to moderate deviations\textsuperscript{15}. However, it is criticized for the recurrence of subsequent deviations. Functional improvements have been achieved with the cephaloposterior advancement of the medial crura of the lower lateral cartilages onto the caudal septum, as described by Kridel\textsuperscript{18}. However, this technique is also associated with a widening of the columella. Generally, intracorporeal septoplasty is often inadequate to address severe septal deformities; in these cases cartilage grafts\textsuperscript{16,17} may be effective in straightening the septum. The main point of criticism of the grafting techniques is the tendency for the overlapping grafts to widen the caudal septum and narrow the internal and the external nasal valve. Thus, these grafts must be adequately thinned before fixation to the septum.

Extracorporeal septoplasty was first proposed by King and Ashley to adequately resect the anterior tip of the septal cartilage and to calibrate the resection of the dorsum. Initial experiences showed a residual dorsum irregularity as the most common postoperative complication (8\% of cases)\textsuperscript{19}. This was mainly due to the lack of stability of the reconstructed cartilaginous framework. Since then, plastic surgeons’ efforts have shifted towards a more conservative approach. The technique described by Most preserves the dorsal septum at the keystone area, thus minimizing nose destabilization and dorsum irregularities\textsuperscript{26}. However, it requires an open rhinoplasty and mainly addresses anterior septal deviations. The ideal approach for extracorporeal septoplasty should be adequate to address the entire and severely deformed septal cartilaginous plate and to build a solid framework. The technique for extracorporeal septoplasty described by Persichetti et al. shows different advantages compared with other approaches (Table 1). Foremost, it is versatile, allowing the correction of mild to most severe septal deformities, cartilage spurs and fractures. It is conservative, because only the central and dorsal portions of the septum are excised: as a consequence, complications such as nasal dorsum irregularity and saddle nose are avoided. Moreover, compared with the classical surgical technique, it spares as much quadrangular cartilage as possible, thus not hampering the use of septal cartilage graft for an eventual secondary rhinoplasty. In addition, the re-implantation of septal cartilage reduces the incidence of septum perforation, that is possible when the remaining tissue consists only of the mucoperichondrium.

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Figure 12: The straightened new septum is then replanted in between the two submucoperichondrial flaps.

Conclusion
The intracorporeal septoplasty approach may be inadequate in cases of marked septal deformations. In these cases, extracorporeal septoplasty is more reliable. However, its main limitation is the risk of destabilizing the cartilaginous septum and its junctions, thus resulting in post-operative dorsal irregularities. Recent more conservative extracorporeal septoplasties may allow the correction of severe septal deformities with a very low risk for post-operative dorsal irregularities, as well as the achievement of adequate functional and aesthetic results with minimum morbidity.

References
Table 1  Comparison among the techniques (NA = not available).

<table>
<thead>
<tr>
<th>Technique</th>
<th>Indications</th>
<th>Disadvantages</th>
<th>Complications reported</th>
<th>Number of patients</th>
<th>Outcome assessment</th>
<th>Mean follow-up time</th>
</tr>
</thead>
</table>
| Swinging door (Wright)\(^{14}\)                                           | - Caudal septum deviation  
- Caudal septum excess                                                        | - Not advisable if there is a weakened septum                                | NA                     | NA                | NA                | NA                  |
| Doorstop (Pastorek)\(^{15}\)                                            | - Caudal septum deviation                                                    | - Not advisable if there is a long caudal septum                              | NA                     | NA                | NA                | NA                  |
| Tongue in groove (Kridel)\(^{16}\)                                      | - Overly long midline caudal septum  
- Poor tip support  
- Nasal tip rotation and projection defects  
- Columellar show  
- Caudal septum deviation                                                  | - Widening of the columella                                                   | Nine (3%) cases required revision (8 required revision to further correct columellar show or to increase tip rotation or projection; 1 required revision for overprojection) | 287               | Clinical inspection | NA                  |
| Extramucosal excision of the osseocartilaginous septum and replacement as a free graft (Rees)\(^{21}\) | - Severe obstruction  
- Severely deviated external nose  
- Inadequate dorsal support  
- Dorsum irregularities  
- Alar cartilage deformities  
- Persistent obstructive symptoms                                             | - Two dorsum irregularities (8%)  
- One alar cartilage deformity (4%)  
- Five persistent obstructive symptoms (20%)                                   | 25                     | Clinical inspection | 36 mo              |
| Anterior septal reconstruction (Most)\(^{16}\)                           | - Severe septum deviation  
- Dorsal strut of septal cartilage preservation  
- Keystone area attachment preservation                                       | - Inadequate tip support                                                      | No complications reported | 12                | Clinical inspection | Subjective questionnaire (NOSE) |
| Standard extracorporeal septoplasty (Gubisch)\(^{22}\)                   | - Severe septum deviation  
- Need to achieve an effective median fixation                                 | - Dorsum irregularities  
- Recurrent deviation  
- Recurrent obstructive symptoms                                               | One epistaxis (1%)  
Twelve dorsum irregularities (12%)  
Three recurrent deviations (3%)  
Two persistent obstructive symptoms (2%)                                     | 98                | Clinical inspection | 8.75 mo             |
Table 1 (continued)

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Symptoms</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modified extracorporeal septoplasty (Vilar Sancho)</td>
<td>Severe septum deviation, Severeley deviated external nose, Severe obstruction</td>
<td>Not enough dorsal support and cartilage release, NA, NA, NA, NA</td>
</tr>
<tr>
<td>Modified extracorporeal septoplasty (Senyuva)</td>
<td>Severe septum deviation, Severeley deviated external nose, Severe obstruction</td>
<td>External scar, One persistence of the septal deviation (3%), One tip dropping (3%)</td>
</tr>
<tr>
<td>Modified extracorporeal septoplasty (Persichetti)</td>
<td>Severe septum deviation, Severeley deviated external nose, Severe obstruction</td>
<td>One epistaxis (0.6%), NA</td>
</tr>
</tbody>
</table>

