The judicious use of grafts in endonasal septorhinoplasty

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Abstract. The use of grafts in rhinoplasty has increased exponentially over the past three decades, specially after the advent of the external approach to the nasal dorsum. The same results can be achieved with the endonasal approach, with judicious use of a small number of grafts, and still maintain the structural integrity of the nose.

Introduction

Although the first recorded example of grafting for rhinoplasty can be traced to around 600 BC by an Indian surgeon called Susruta, contemporary grafting techniques in Western medicine in rhinoplasty did not take hold until the pioneering work of Jacques Joseph in the early part of the 20th Century. He successfully used cartilage to augment the nose and thereby avoided the problems of alloplastic materials that had been tried in the 19th Century. As the anatomical knowledge of the nose evolved in the 20th Century, facial plastic surgeons attempted to restructure and rebuild more complex cases of nasal deformity mostly through the endonasal approach until the 1970s when the external approach became increasingly popular. Since then, the use of grafts has accompanied the meteoric rise of the external approach to such a degree that in many centres, rhinoplasty is almost inevitably accompanied by grafting.

This Chapter will review the various types of grafting materials and techniques currently in use; and describe the disadvantages and alternatives to this particular approach to septorhinoplasty.

Types of graft material

In order to simplify the large number of graft materials available for nasal surgery, it is instructive to consider whether they are of non-biological or biological origin, and to sub classify the biological grafts into two further groups.

a) Alloplastic materials are of non-biological origin and may include materials such as various plastics, ceramics and metals. Recently, more sophisticated materials such as poly-dioxanone and Gortex have added a new dimension to the use of alloplastic materials.1,2

b) Allograft materials originate within members of the same species but are transferred usually from a cadaveric specimen to the patient. Examples of this type of grafting include irradiated rib, and various modified skin preparations such as Alloderm.

c) Autograft materials originate from the patient and used within the same individual. At present, they provide the mainstay of graft material for many surgeons

Desirable characteristics of graft materials include:

- The graft material should not incite an immune response
- The donor site should not suffer more than a minimal morbidity
- Harvesting from the donor site should not interfere with the smooth running of the operation.
- The graft material should be relatively easy to mould into shape and not lead to a cosmetic deformity

Grafts in augmentation septorhinoplasty

The aim of using grafts initially consisted of augmenting the defects of a nose. Some of these defects were congenital, secondary to trauma, or due to destructive diseases such as Wegner’s grani-
lomatosis. However, as earlier septorhinoplasty surgeons often resected large amounts of septal cartilage, the defects were quite commonly iatrogenic in nature and resulted in major saddle deformities of the nose. This necessitated the use of grafting materials often from the pinna or rib as septal cartilage itself had been depleted by the primary operation. As the central importance of septal cartilage preservation became more widespread, the septum itself became the source for grafting the nose. This practice gained further popularity with the ascent of the external approach in the 1970s. Within a decade, the use of grafts in septorhinoplasty reached widespread proportions.\(^3\) Grafts were no longer simply used for augmentation of the dorsum and tip, they were also utilized for their potential effects on the nasal valve.\(^4\)\(^5\)

**Graft analysis by subtype**

1 **Alloplastic materials**

The gradual decline in the popularity of alloplastic materials has mirrored the rise in the complications associated with them. Short-term complications such as displacement and infection are more commonly seen with alloplastic materials such as silicone; and long-term complications include the formation of a fibrous capsule around the graft, dystrophic calcification, and extrusion. These changes may be due to the persistent effect of micro-trauma as the graft edges constantly irritated the tissues around them. Although popular in some parts of South East Asia for augmentation of the nasal dorsum, the use of silicone has faced a gradual decline in view of these problems. Similar problems have been noted with the use of Polytetrafluoroethylene (Gore-tex\(^8\)). Although this material does allow the host’s tissue to grow into the graft material, over time, the surrounding tissues suffer from inflammation, calcification, giant-cell granulomas, and the graft material itself loses its strength and volume. When compared to the criteria for an ideal graft material, alloplastic materials such as Silicone and Gore-tex\(^8\) compare quite poorly with other biological materials.\(^6\)\(^-\)\(^10\)

More recent advances in synthetic materials for septal reconstruction include the use of absorbable polydioxanone with either fragmented septal or auricular cartilage. No major complications have been reported with this material that seems to support the healing process until the new septum has reconstituted.

Tutoplast\(^8\) consists of processed, donated human collagen that provides a framework for the inflammatory process in the recipient’s tissues. Denuded of cells, bacteria, and viruses, this implant can be stored at room temperature and has found with many reconstructive rhinoplasty surgeons.

During the past few years, the concept of medical rhinoplasty has started to take hold in many centres. The use of reversible neuromodulators such as Botulinum toxin, and fillers give the patient and the surgeon to make reversible changes to the nose which by their very nature are non-permanent. This may be seen as an advantage in that a poor or undesirable result will not last forever. Furthermore, the application of these substances does not require general anesthesia or in-patient care. In some centres, non-surgical staff has been trained in the art of injecting the correct amount in to the right site. For those patients who do not want to go through the considerably involved operation of rhinoplasty, medical intervention seems like an attractive venture. This may help to explain their increasing popularity.

2 **Allografts**

These grafts originate from other patients and are usually cadaveric in nature. The application of irradiated cadaveric rib grafts has found great support with some rhinoplasty surgeons who use this material for major augmentation and reconstruction of the nose that has suffered major loss of its support structures, such as a major saddle deformity. In such cases, the patient has often had multiple previous attempts at reconstruction, with consequent lack of adequate septal cartilage. The use of a cadaveric donated rib graft reduces the potential for morbidities such as pain, scar, infection, and pneumothorax. Proponents of irradiated rib graft often use this technique through an external approach, and report very low rates of complications comparable to autogenous materials. Nevertheless, irradiated rib needs to pass several hurdles before being available for surgery; these include donation, tests for infection, and cost. Although available in many European countries and the USA, the use of irradiated rib is currently not widespread.\(^11\)\(^-\)\(^13\)

3 **Autografts**

Initial attempts at rhinoplasty in the 20\(^{th}\) Century concentrated on reduction rhinoplasty, whereby large amounts of septum and sur-
rounding cartilages were removed with little or no attempt at their replacement. This resulted in major long-term problems for the patient including septal perforations, saddle nose, and significant functional and cosmetic deformities. The major change in practice from reduction to augmentation and restoration created a major paradigm shift in the practice of rhinoplasty. Along with the increasing popularity of the external approach, the addition of cartilage and other tissues to the nose has resulted in a plethora of grafting techniques. The novice rhinoplasty surgeon is often confronted with a bewildering array of possible grafts and tends to replicate the local practice and teaching.

The use of grafts for the purposes of structural rhinoplasty and augmentation rather than reduction, has greatly changed the practice and outcomes of septrhinoplasty in the past 30 years. Currently, using the endonasal approach, emphasis is placed on the judicious use of grafts for structural, functional, and cosmetic aims; rather than the use of grafts for the sake of grafting. Whenever possible, local materials such as nasal septum and auricular cartilage are preferred to alloplastic or allograft materials.

i Septal cartilage

This material is often the most useful cartilage available for grafting as it can be remodeled and shaped as required, has a certain degree of resilience, and tends to maintain its volume with time. However, in many cases of revision rhinoplasty, there is a distinct lack of septal cartilage that deprives the surgeon from one of the most important reconstructive tools. Septal cartilage may be used for structural reconstruction of the septum itself, as an onlay graft for dorsal defects, columellar struts, or batten grafts; alternatively, it may also be utilized for contouring surfaces. In general, the judicious rhinoplasty surgeon will preserve as much of the septum, and replace cartilage that has been removed during surgery in order to prevent the dreaded complication of septal perforation. Nevertheless, it can be possible to harvest septal cartilage for revision cases if only a limited amount of cartilage is removed with utmost care.

Septal cartilage has also been extensively used for the restoration of a damaged internal nasal valve. Damage to this valve has been a known complication of septrhinoplasty for many decades and may result from resection of the upper lateral cartilage or trauma to its attachment to the septum. Ideally, the angle between the upper lateral and the septum should be at least 15 degrees. When this angle becomes more acute, the resistance to airflow increases, and normal laminar airflow becomes turbulent, resulting in a sensation of blocked airflow. In an attempt to increase this angle, the rhinoplasty surgeon may choose the external approach and place a sliver of septal cartilage between the septum and the upper lateral cartilage in order to increase the angle between them. The new cartilage graft is then kept immobile by non-absorbable sutures that span 3 components: the upper lateral cartilage, the graft in the middle, and the septum in the midline. Although the positioning of a cartilage graft in such a position should theoretically increase the angle, and lead to improved airflow, the results are far from predictable with any degree of certainty. Furthermore, the addition of cartilage to this critical site results in a broader, bulkier dorsum, which many patients do not desire. In more recent years, attempts have been made to find more objective outcome measures of nasal surgery such as the Nasal Obstruction Septoplasty Effectiveness (NOSE) score and the Rhinoplasty Outcome Evaluation score. So far, the studies have been on limited numbers of patients and do not show a conclusive benefit in increasing nasal airflow based on spreader grafts alone.

In addition to providing cartilage for spreader grafts, the septum can also be utilised as a donor for nasal tip surgery. Initially described by Sheen as grafts for the dome, shield grafts have enjoyed a massive popularity over the past 20 years that seems to be dwindling. Commonly used as an adjunct to a columellar strut, shield grafts pose several problems that may explain their fall in popularity. In patients with thin skin, shield grafts can become visible leading to an undesirable cosmetic result. In a retrospective 10-year study, 80% of malpositioned tip grafts were found to be due to shield grafts. In addition, the augmentation of the tip with cartilage could alter the sensation and flexibility of this area. Attempts have been made to disguise this particular graft with AlloDerm, temporalis fascia, or even autogenous fat.

ii Autologous rib graft

Proponents of rib graft point to the durability of the rib cartilage and...
patient satisfaction as it main advantage for dorsal nasal augmentation.22 This technique involves the harvesting the 7th costal cartilage at the same sitting as the reconstructive septrhinoplasty. Potential problems with this method include the addition to operating time, a submammary scar in females, a more readily visible scar in males, and pneumothorax that is a rare complication. Furthermore, beyond the age of 45, the costal cartilage may be ossified and not suitable for grafting.

iii Columellar strut graft

The aim of placing a rectangular-shaped piece of cartilage between the medial crura may consist of increasing nasal projection or vestibular show, and supporting distorted medial crura. Sources for columellar struts include the nasal septum, if available, auricular cartilage, and less commonly rib cartilage. The approach to the medial crura should ideally be through an endonasal incision as this avoids the possibility of an external scar and the potential for destabilisation of the tip. Through the endonasal approach a small columellar pocket is created, and then the strut is sutured in-situ with absorbable material. The strut needs to sit above the nasal spine without touching it, and the suturing of the cartilage must be done in a symmetrical way in order to avoid an asymmetric result. Further difficulties with columellar strut grafts include little or no increased tip projection and rotation, visibility of the graft in thin-skinned patients, displacement and extrusion of the graft with time, and tip hypoesthesia and stiffness.23,24 These complications have led to a revision rate of between 4-10%. Furthermore, there is an inherent discrepancy between the straight shape of a columellar strut, and the complex contour of the caudal septum and its relationship to the columella. Far from being straight, the caudal septum consists of an anterior, intermediate, and posterior angle. The nasal tip also has a supra and an infra-tip break point that need to be mimicked by reconstruction in order to achieve an acceptable cosmetic outcome. This may be accomplished by using two endonasal grafts: the first and larger of the two, spans the distance from the infra-tip break point to the pronasale, and the second, smaller graft fills the gap between the columella and the subnasale.

In order to avoid having to use a columellar strut, the endonasal surgeon may wish to consider alternative techniques for increasing projection and refinement of the nasal tip. While avoiding the external approach, it is possible to gain some cephalic rotation and refinement by using a modified tongue-in-groove technique. The basic principle consists of moving the caudal septum into a groove between the newly medial crura of the lower lateral cartilages. Vestibular skin is trimmed according to the caudal septal angles. More skin is removed compared to cartilage. Then, a pocket is made between the medial crura, the septum is moved into its new position between the crura, and sutured in-situ.

There are several other techniques that when used singly or in combination, can be regarded as an alternative to a columellar strut. Useful suturing techniques for this purpose include the sub-domal and wonder-bra sutures. The subdomal suture reinforces the infratip area by supporting the tissues immediately inferior to the dome. The wonder-bra suture—named after the ability of a Canadian bra created in the 1930s to “lift and separate”—consists of a suture that is passed superiorly, then inferiorly just posterior to the columella. This suture can then help to lift the tip in imitation of its namesake. Further refinement of the tip may be gained through intra and interdomal sutures. Trimming of the cephalic portion of the lower lateral cartilage while leaving a 5-7 mm strip behind is an effective means of gaining further refinement in the tip without compromising structural integrity. A lateral crural steal can be used to “borrow” cartilage from the lateral crus of the lower lateral cartilage and reinforce the medial crus through suturing.

iv Lateral crural graft

Many of the undesirable features and functions of the septrhinoplasty patient can be clearly attributed to over-zealous primary resection of vital structures. Excessive reduction of the lateral crus can lead to damage to the external valve and a cosmetic deformity. In order to correct this deformity, cartilage can be harvested from the septum, or the pinna. The latter option is preferred by some surgeons as its contour is more similar to that of the crura itself when compared to a septal graft. The lateral crural graft simply replaces the lost cartilage in an anatomical fashion. Although these grafts are sutured to the remaining intermediate or medial crura, and to the vestibular skin, their size and symmetry calls
for exacting surgery as small variations between the two sides lead to clearly visible cosmetic deformities and an asymmetric outcome.

\textit{v Alar batten graft}

These grafts are often used to correct a damaged external nasal valve that consists of the alar margin laterally and the caudal septum and columella medially. This valve is bound superiorly by caudal margin of the internal valve. As the relatively flexible mucosa of the nose is attached to a rigid bony framework, an increase in the airflow velocity, for example, during a rapid sniffing in of air, leads to an increase in the transmural pressure, and consequently, a reduction in airflow. According to the Bernoulli principle, the velocity of airflow in the nose will be greater at points where the pressure is least, i.e., the internal and external valve areas. Therefore, at these points there will be the greatest potential difference between the internal air pressure and the atmospheric pressure on the outside of the nose; hence the 2 valves are points at which the potential for collapse is greatest. Weakness in the framework of these valves can be secondary to previous septorhinoplasty, trauma, congenital overprojection, facial nerve palsy, or even ageing-related stiffness of the nose. This problem is mostly iatrogenic and results from the aggressive resection of lower lateral cartilages. Sources for batten grafts include septal cartilage or the pinna whose natural curvature may mimic that of the original cartilage. The graft can be placed through an endonasal technique, by creating a precise pocket in the subcutaneous plane that is tight enough to prevent unnecessary movement of the graft. This is then fixed in-situ with a trans-cutaneous suture. Alar batten grafts are typically placed caudal to the lateral crus, at the point of maximal inspiratory collapse. The complications rates for this graft are very small indeed, and include problems such as unsatisfactory increase in airflow, or extrusion.

\textit{vi Contour grafts}

In order to achieve a pleasing and harmonious nose, it may become necessary to use contour grafts. Ideally harvested from the soft tissues of the nose itself, such as mature scar tissue or excised cartilage. These grafts are used to create a smooth appearance to curved surfaces and achieve a natural look and feel to the final outcome. (Figures 1-4).

Following rhinoplasty with excessive or inaccurate cartilage resection, the caudal border of the lower lateral cartilage can retract giving rise to weakness of the external valve and a gnarled, unpleasant cosmetic effect. Less frequently, the defect may be due to congenital hypoplasia or an excessive cephalic position of the lower lateral cartilage. This problem can be addressed endonasally by the placement of a cartilage graft from the septum, or pinna, in an area deficient in cartilage. The incision is placed immediately posterior to the alar rim. The alar-vestibular pocket created to receive the graft should be slightly bigger than the graft such that the result of a slight excursion of the graft on the shape of the rim can be checked before it is fixed in place. Further refinement techniques may involved the use of temporalis fascia harvested through an incision within the hairline to prevent a visible donor site scar, and the use of allogr"en. However, both of these grafts may undergo a certain amount of resorption.

\textit{vii Inverted lateral crural graft}

A less common problem of the lower lateral cartilage involves its apparent inverted appearance that can lead to external valve mal-function. These deformities are more likely to be congenital, than iatrogenic. Their correction through an endonasal approach involves separation of the lower lateral cartilage from the vestibular surface and overlying skin, detachment from the intermediate crus, and inversion into the correct anatomical position. The 2 ends of the lower lateral are then sutured together.

\textbf{Technical challenges}

Since the advent of external approach septorhinoplasty and its ever-increasing popularity, the use of grafting for structural, functional, and cosmetic purposes has been steadily growing. In North America, where most cases are tackled through an external approach, the techniques of endonasal surgery seem to have been nearly abandoned by many surgeons. As most junior surgeons learn their trade from their teachers and seldom move away from their experiences, the dominance of the external approach has now carried forward into the new generation of surgeons.

The reason for grafting through an external approach has been the surgeon’s perception of seemingly
Figure 1
Pre-operative views of markedly deviated nose in a young female adult. [1a: frontal, 1b: frontal dynamic, 1c: basal, 1d: right lateral, 1e: lateral dynamic, 1f: left lateral, 1g and 1h: right and left ¾ views]
Figure 2
Post-operative views of patient in Figure 1. Summary of procedure: endonasal approach, tip delivery and tip sutures. Asymmetric reduction of cephalic margin of lower lateral cartilages more on the left side. Left cartilaginous dorsum was shaved to achieve a more aesthetic brow-dome-line (BDL). Right side: an onlay graft was used to fill the concavity so to re-create a more symmetric BDL. [2a: frontal, 2b: frontal dynamic, 2c: basal, 2d: right lateral, 2e: lateral dynamic, 2f: left lateral, 2g and 2h: right and left ¾ views]
Figure 3
Pre-operative views of a young, adult female patient with a iatrogenic open roof deformity, polly tip, upper dorsum depression and deviated, bifid tip. [3a: frontal, 3b: right lateral, 3c: left lateral, 3d: basal, 3e and 3f: two right-sided ¾ views, 3g and 3h: two left-sided ¾ views]
Figure 4
Post-operative views in Figure 3. Summary of procedure: septal realignment, double osteotomies both sides, tongue-in-groove suture, lowering of cartilaginous dorsum, onlay tip and dorsal grafts.
easier exposure of distorted anatomy and its correction through various suturing or augmentation techniques. However, the external approach in itself can lead to loss of tip support structures which in turn lead to more grafting. In contrast to this approach, the endonasal surgeon leaves the integrity of the support structures intact and can incorporate many of the grafting techniques that have been developed for external septrhinoplasty. The endonasal approach requires a highly detailed pre-operative planning process and an in-depth knowledge of the patient’s wishes. Most patients do not want major changes to their nose. With greater experience many endonasal surgeons who formerly practiced the external approach with a multitude of grafts, operate almost totally without the need for complete exposure of the nasal dorsum. Through careful and meticulous surgery, the results obtained through the external approach with its many grafts can be gained endonasally with a more judicious use of grafts. Technically, this is more demanding task, that may require years of experience to fulfill, but one with which the surgeon is able to offer the patient a less swollen and more stable nose without the need for a large number of grafts. Ultimately, the rhinoplasty surgeon may improve his skills to such a level that the division of rhinoplasty into external and internal seems superficial. Then, the surgeon can evolve his or her own hybrid rhinoplasty techniques.

References


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