Rhinoplasty

Benjamin Swartout and Dean M. Toriumi

Purpose of review

Successful rhinoplasty requires a detailed understanding of the nasal structure needed to produce a functional and aesthetically pleasing nose. Recent advances in surgical technique have focused on cartilage repositioning and reshaping, often with the use of cartilage grafting.

Recent findings

Newer techniques for strengthening the middle vault, stabilizing the base, and modifying the lateral crura are presented, as well as the M-arch model, a modification of the tripod concept.

Summary

Technical advances in rhinoplasty provide numerous options for reconstruction and reshaping of the nose.

Keywords

autologous graft, cephalically malpositioned lower lateral cartilage, composite reconstruction, lateral crural strut graft, M-arch, rhinoplasty

Curr Opin Otolaryngol Head Neck Surg 15:219–227. © 2007 Lippincott Williams & Wilkins.

Division of Facial Plastic and Reconstructive Surgery, Department of Otolaryngology – Head and Neck Surgery, University of Illinois at Chicago, Chicago, Illinois, USA

Correspondence to Dean M. Toriumi, MD, Division of Facial Plastic and Reconstructive Surgery, Department of Otolaryngology – Head and Neck Surgery, University of Illinois at Chicago, 60 East Delaware Place, Suite 1460, Chicago, IL 60611, USA
Tel: +1 312 255 8812; fax: +1 312 996 1282; e-mail: dtoriumi@uic.edu

Current Opinion in Otolaryngology & Head and Neck Surgery 2007, 15:219–227

1068-9508

Introduction

Rhinoplasty is the most challenging procedure in all of facial plastic surgery and it has undergone significant changes in the past 25 years. In the past, surgeons used reductive techniques to decrease the size and alter the shape of the underlying cartilage and bone. This frequently produced a smaller, more well defined nose in the immediate postoperative period, but the structure of the nose was weakened and was made more susceptible to collapse and deformity. Surgeons have recently focused more on repositioning and restructuring existing tissues, frequently with suture techniques and cartilage grafting.

The major steps of rhinoplasty will be discussed, including managing the middle vault, stabilizing the nasal base, controlling nasal tip contour, managing the nasal lobule, setting dorsal height, and performing the alar base reduction. Recent articles furthering the development of these rhinoplasty techniques will be discussed. In addition, pertinent anatomic variations will be included in each section, as well as techniques to correct these malformations.

Managing the middle vault

The middle nasal vault is composed of the upper lateral cartilages and the nasal septum. In patients with short nasal bones and long upper lateral cartilages, the middle vault is long and more prone to collapse after dorsal hump reduction. This is especially true in patients treated with reductive rhinoplasty techniques without adequate structural augmentation. The middle vault must therefore be made strong and sufficiently wide to prevent collapse. There are two general techniques that can be applied to the middle vault: the upper lateral cartilage can be left connected to the dorsal septum, or the upper lateral cartilage can be divided from the dorsal septum thereby opening the middle vault.

When the middle vault is generally midline, and minimal reduction of the cartilaginous dorsum is required, the upper lateral cartilage can be left connected to the dorsal septum. Submucosal spreader grafts are applied into tunnels dissected under the junction of the upper lateral cartilage and dorsal septum [1,2]. The position of the tunnel must be high enough and the grafts must be thick enough to adequately cantilever the upper lateral cartilage off the septum.

When the middle vault and dorsal septum are significantly off midline or asymmetric, the middle vault may

need to be opened to adequately expose the septum and straighten it. Additionally, with a high cartilaginous dorsum, the cartilaginous connection between the upper lateral cartilage and the dorsal septum must be resected to create appropriate dorsal contour, thereby opening the middle vault. Once the upper lateral cartilages are disconnected from the dorsal septum, a structural weakness is created. Correction requires spreader grafts that extend up to the nasal bones, with reconstitution of the connection between the upper lateral cartilage and the dorsal septum. An alternate method of middle vault reconstruction has been detailed by Gassner *et al.* [3•] and utilizes a horizontally oriented graft. In this technique, after the middle vault is opened, the mucosa is dissected off the nasal septum and undersurface of the upper lateral cartilages. Next, the dorsal septum is reduced to accommodate the graft and the upper lateral cartilages are sutured to the undersurface of this graft.

When the cephalic trim has been performed on the lower lateral cartilage, or the cartilage has been repositioned (discussed later), an additional area of middle vault is exposed and can be prone to collapse and pinching [4]. Spreader grafts alone are often not sufficient to correct the supra-alar pinching in this situation. In these cases, additional lateral wall grafts or alar batten grafts can be used [5]. These grafts are placed into precisely positioned pockets along the lateral wall of the nose.

Stabilization of the nasal base

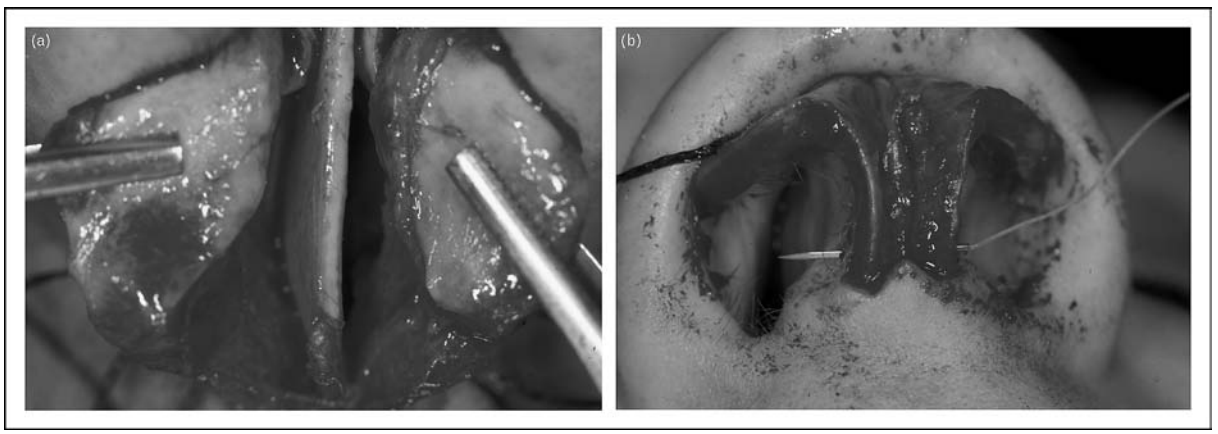
Prior to working on the contour of the nasal tip, the surgeon must stabilize the nasal base, or pedestal [6]. Patients with a poorly supported nasal base will heal unpredictably and may lose tip support during the postoperative period, becoming under-projected with a dependent nasal tip and an acute nasolabial angle. These noses will lose the tip/supratip relationship and can develop a polly beak deformity. Correctly stabilizing the nasal base will allow the surgeon to accurately and predictably set tip projection, nasal tip rotation, and nasolabial angle. There are several techniques from which to choose and the surgeon must choose a method based on the existing tip support, nasolabial angle, rotation, and the alar/columellar relationship.

Patients with long, strong medial crura and medial crural footplates that extend down to the nasal spine typically have excellent support and are less likely to lose projection postoperatively. If the projection, rotation, and nasolabial angle do not require modification or reinforcement, the base can be stabilized with a columellar strut. This strut is placed into a pocket between the medial crura and sutured in place. This graft will add support to the tip, but will not alter the tip position [7].

A patient with a hanging columella and a caudally elongated septum that would otherwise require trimming may be a candidate for a medial crural set-back, or tongue-in-groove technique [8]. In this maneuver, the final position of the medial crura will depend on the position of the caudal septum, and therefore the caudal septum must be midline. The medial crura are dissected apart and mucoperichondrial flaps are elevated on both sides of the nasal septum. The medial crura are then set back on the caudal septum and sutured in place (Fig. 1).

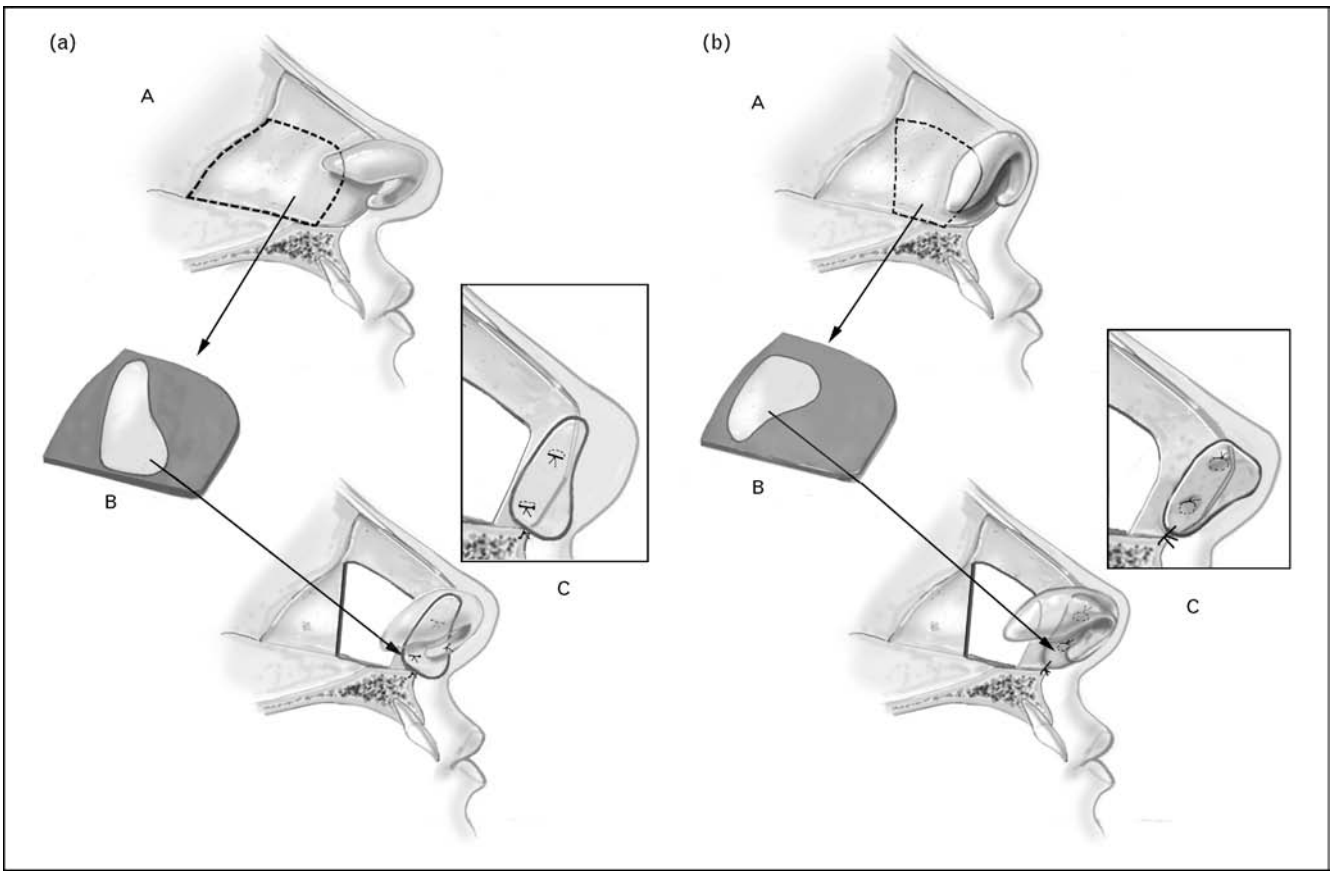
If the caudal septum is appropriate or short and where there is insufficient tip support, an acute nasolabial angle, poor tip position (under-rotated or over-rotated), or inappropriate alar/columellar relationship, and if there is no need for premaxillary augmentation, a caudal septal extension graft can be used [10,11]. This graft overlaps

Figure 1 In the presence of a hanging columella with a prominent caudal septum (a), the surgeon can set the medial crura back on the midline caudal septum (b)



Reproduced from [9••], Figure 14.

Figure 2 The caudal extension graft can be contoured to rotate or counter-rotate the nose



When rotation is required, the graft can be fashioned with a longer inferior margin (a). When counter-rotation is required, the graft should be longer on the superior margin (b). Reproduced from [9••], Figures 18 and 20.

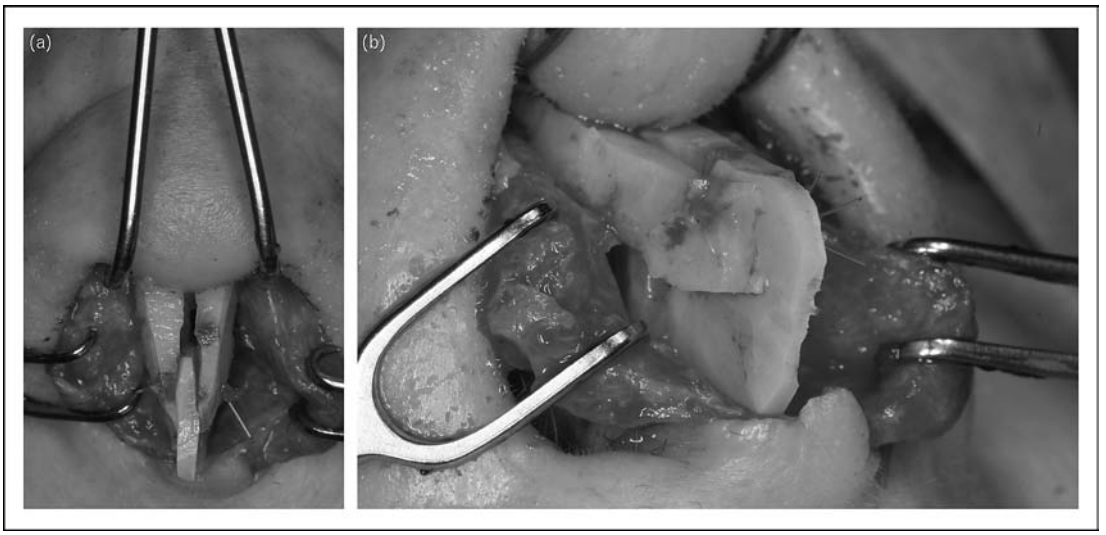
and is sutured to the caudal septum, and creates a stable fixation point for the medial crura. The shape and attitude of this graft, as well as the location of placement, will set the tip rotation, tip projection, and alar/columellar relationship [12]. The angle of the caudal edge of the graft can be tailored to create the desired tip rotation and nasolabial angle. Patients requiring counter-rotation will benefit from a graft that is longer on the superior margin, while patients requiring increased rotation will benefit from a graft that is longer on the inferior margin (Fig. 2). Major lengthening can be accomplished with this graft in combination with spreader grafts that extend beyond the caudal septum and are fixated to the caudal extension graft (Fig. 3). After suture fixation of the graft to the caudal septum, the medial crura are sutured to the graft (Fig. 4).

In cases of extreme loss of septal support, as with nasal septal saddle nose deformity, Daniel [13••] detailed a two-part reconstructive process, called a composite reconstruction, composed of a nonvisible structural component and a visible aesthetic component. In the first part, pistol spreader grafts and a septal strut are carved from costal cartilage. The pistol spreader grafts extend under the bony vault and are sutured to a strut fixated to the nasal spine to create a solid framework. Next, the visible aesthetic component is built, composed of a columellar strut graft and a dorsal graft. The dorsal graft is made from diced cartilage and injected through a syringe into a sleeve fashioned from deep temporal fascia. Some authors advocate wrapping the diced cartilage in Surgicel, but Brenner *et al.* [14•], in a recent animal study, demonstrated less of an inflammatory response, less resorption, and more predictable results with deep temporal fascia.

Controlling nasal tip contour

In their article entitled 'Applications of the M-arch model in nasal tip refinement', Adamson and Litner [15••] proposed the M-arch model as a mechanism of understanding the contributions of the cartilaginous nasal structure on tip parameters. This model is a modification of the tripod concept, first proposed by Jack R. Anderson in 1969 [16]. This new model takes into account the

Figure 3 Major lengthening can be accomplished using a caudal extension graft or extended columellar strut in combination with extended spreader grafts



The extended spreader grafts stabilize the nasal tip and push the nasal tip down to increase nasal length. (a) Base view. (b) Surgeon's view. Reproduced from 'Augmentation rhinoplasty with autologous cartilage grafting', in David Kim (editor) *Asian Face* (Amsterdam: Elsevier).

contribution of the intermediate crura and the anterior component of the lateral crura to the shape of the lobule, and allows for modification of the tip through vertical division at any point in the arch. This model helps guide surgical modifications, helping the surgeon understand the sum of all effects a maneuver may have on nasal tip parameters.

The size, shape, and position of the lower lateral cartilage are some of the main determinants of tip contour. Ideally, the long axis of the lower lateral cartilage should be pointing at the lateral canthus of the eye, creating an angle between 45 and 55° off midline. When this angle is more acute, the long axis of the lower lateral cartilage is pointing to the medial canthus and it is considered

Figure 4 After the caudal extension graft is overlapped onto the septum (a), the medial crura are suture fixated to the graft (b)

Note the midline tip structure. Reproduced from [9••], Figure 17.

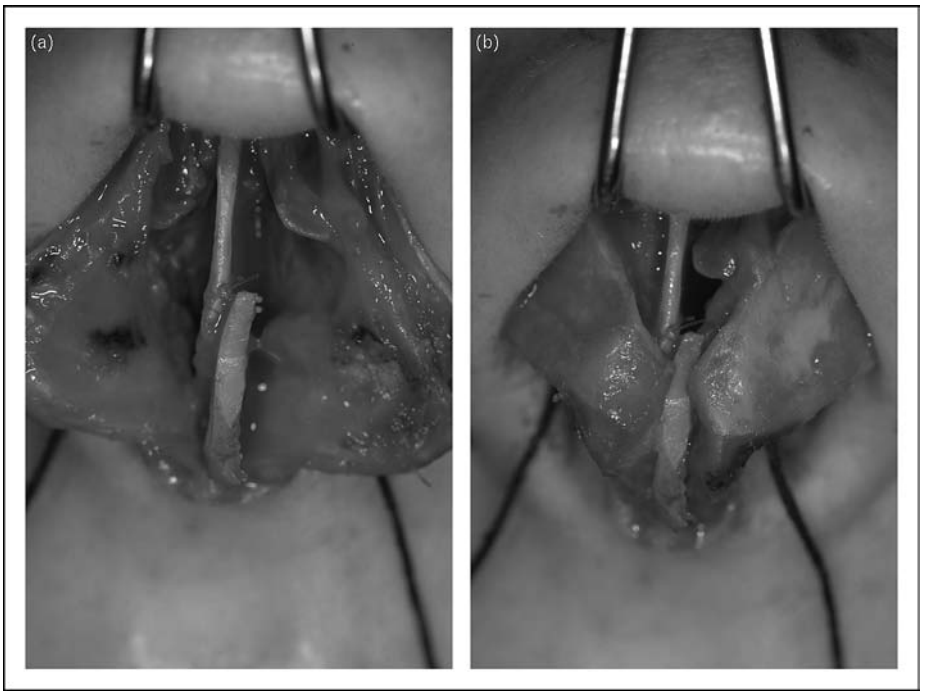
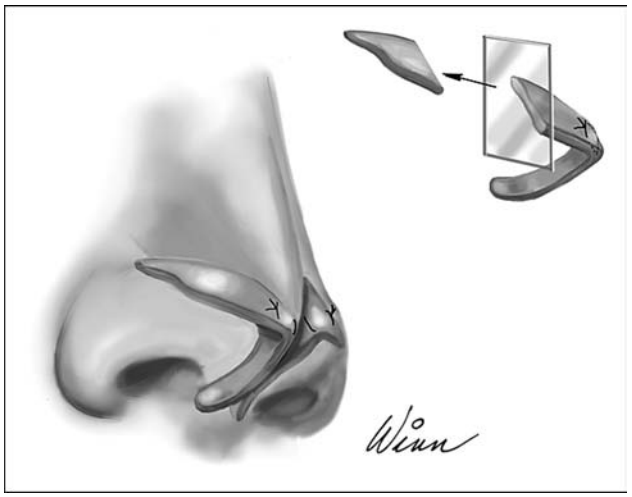


Figure 5 To help create an ideal nasal tip contour, the caudal margin of the lateral crura should lie close to the same level as the cephalic margin



Reproduced from [9••], Figure 10.

cephalically malpositioned. Constantian [17] described this phenomenon in 200 consecutive rhinoplasty patients, showing that these patients are prone to a 'boxy' or 'ball' nasal tip with a 'parentheses' deformity on frontal views. In addition, the lateral crura may be rotated along its long axis into an unfavorable position (Figs 5 and 6). The ideal position is with the caudal edge of the lateral crura at the same level as the cephalic edge [18].

One of the simplest methods of modification is cephalic trim and dome binding sutures [18]. This may be appropriate when the cartilages are not cephalically malpositioned and are not contributing to nasal tip bulbosity [19]. Frequently, however, this technique can create medialization of the lateral aspect of the lateral crura, leading to nasal obstruction. This is especially common in patients who present with internal recurvature of the lower lateral cartilage or in patients with weak lower lateral cartilages (Fig. 7). The dome binding sutures can, in some cases, create excessive pinching or buckling with an unnatural postoperative appearance (Fig. 8). In these situations, more aggressive reshaping and restructuring of the lateral crura is required using cartilage grafting.

When the lateral crura are in good position, but weak and either concave or convex, the lateral crural turnover graft technique can be used. This technique was described by McCollough and Fedok in 1993 [20] and reviewed in an excellent article by Gunter *et al.* [21••] entitled 'Frequently used grafts in rhinoplasty'. In this technique, the lateral crura are scored along the long axis and the cephalic half is folded over the caudal half. What was the cephalic margin is then sutured to the caudal margin.

Figure 6 When the caudal margin of the lateral crura lies below the cephalic margin (a and b), support of the nasal tip soft tissue envelope is decreased and pinching of the nasal tip can occur

This is frequently manifested as shadowing between the tip and alar lobule (c). Reproduced from [9••], Figure 11.

A completely different approach is required when the lateral crura are cephalically oriented [22]. Cephalically oriented lower lateral cartilages create a characteristic shadowing between the nasal tip and alae, thereby demarcating the tip from the alar lobule with a 'parentheses'

Figure 7 Internal recurvature of the lower lateral cartilage

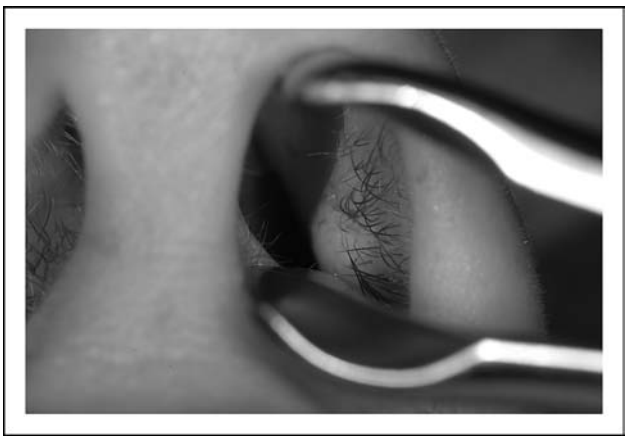
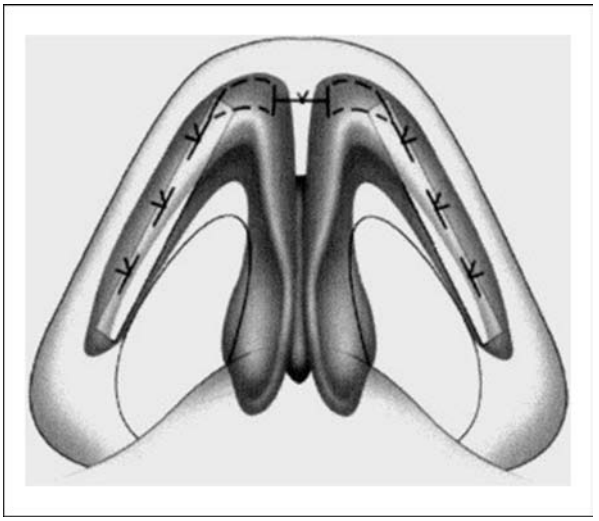


Figure 8 Excessive narrowing or pinching of the lobule can result in unsightly shadowing between the tip lobule and alar lobule

(a) Frontal view. (b) Base view. Reproduced from [9••], Figure 2.

appearance on frontal view. These cartilages should be treated with a conservative cephalic trim and then the lower lateral cartilage can be dissected from the vestibular skin. Next, lateral crural strut grafts are fashioned and can be sutured to the undersurface of the lateral crura (Fig. 9).

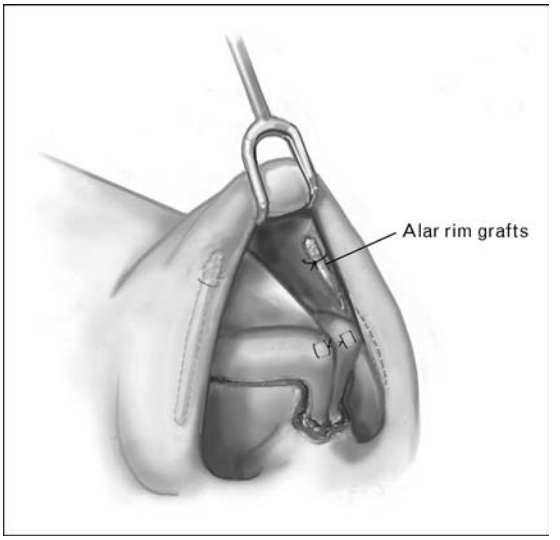
Figure 9 Lateral crural strut grafts are rectangular-shaped cartilage grafts affixed to the undersurface of the lateral crura



Reproduced from [23], Figure 15.

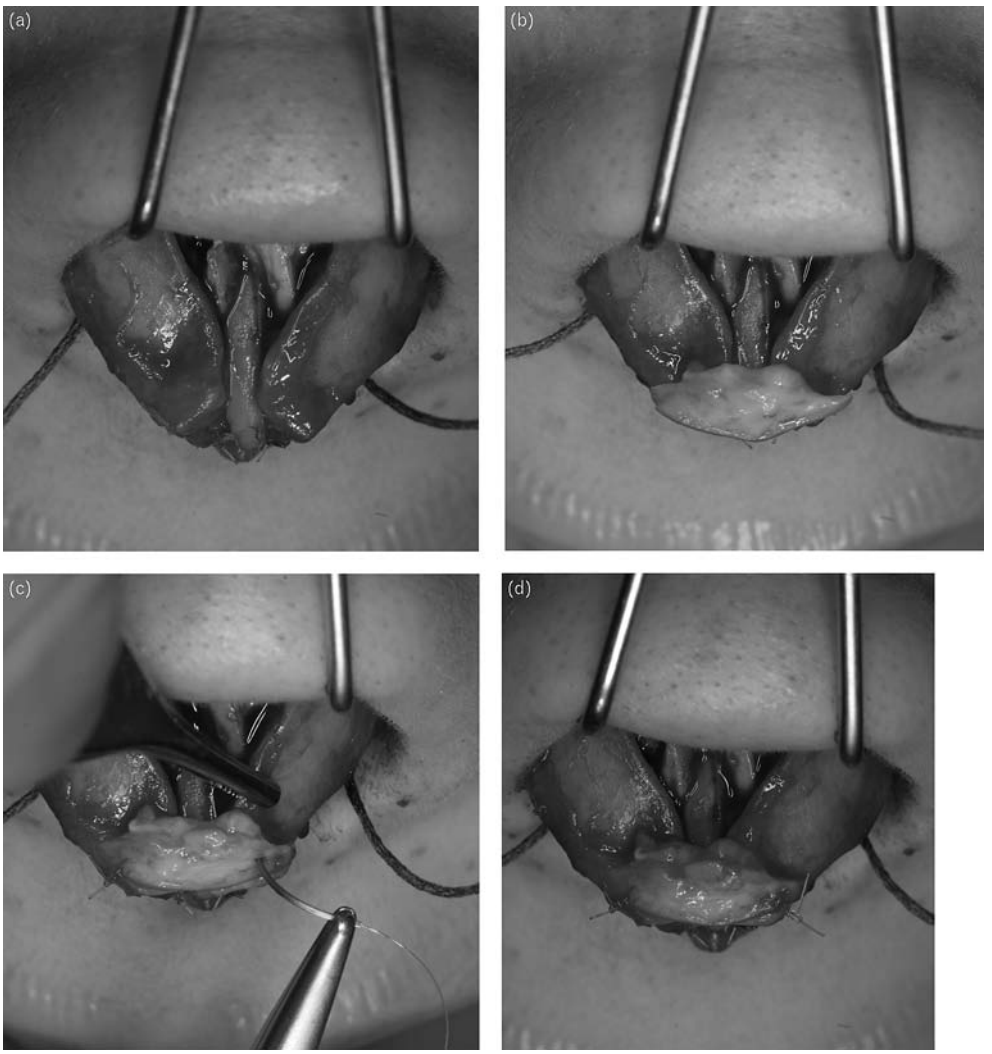
These grafts are designed to flatten and strengthen the lateral crura and bring the caudal edge of the lower lateral cartilage up to the same level as the cephalic edge. The lateral crura are then repositioned into new, caudally positioned pockets. By stiffening the lower lateral

Figure 10 Alar rim grafts are soft, thin grafts that are placed into precise pockets along the caudal margin of the marginal incision



Reproduced from [9••], Figure 25.

Figure 11 Soft cartilage can be sutured across the domes to provide additional projection and definition (a)–(d)



If needed, a second layer of soft tissue can be applied, and the entire tip can be covered with perichondrium. Reproduced from [9••], Figure 29.

cartilages, these grafts also prevent nasal sidewall collapse.

After appropriate treatment of the lower lateral cartilages, dome binding sutures are placed to reduce the horizontal dimension of a bulbous nasal tip and to flatten the lateral crura. The sutures are placed to create symmetry of the tip, and should be oriented to preserve the normal divergence of the intermediate crura [24]. This divergence creates an appropriate columellar/lobular angle [25].

In revision cases where the lower lateral cartilage is over-resected, the entire cartilaginous structure may need to be replaced. Pedroza *et al.* reviewed [26•] experience with the seagull wing graft, a technique where auricular cartilage is harvested and shaped to replace the lower lateral cartilage. This technique was evaluated by looking at the postoperative photographs and patient satisfaction questionnaires. Based on this retrospective analysis, the authors obtained excellent aesthetic and functional results.

After these techniques are used and the skin is re-draped, the caudal edge of the lower lateral cartilage should create an elevated ridge along the alar margin, which corresponds to a highlight when light is cast upon the nose [27]. If this elevation is insufficient, alar rim grafts can be applied [28] (Fig. 10). These are placed into pockets along the caudal margin of the marginal incision.

Management of the nasal tip lobule

Additional tip projection and definition can be created with a soft, gently crushed cartilage graft sutured in a

horizontal orientation over the domes. For additional projection in the tip, a second layer of crushed cartilage can be placed. If available, cartilage perichondrium can be used here to further camouflage this graft (Fig. 11).

Patients with thick skin and with weak lower lateral cartilage often require more tip projection than can be provided by the aforementioned graft alone. In these situations, a shield-type tip graft can project into the thick nasal tip skin, creating favorable nasal tip contour. These grafts have a high potential for becoming visible and appropriate camouflaging techniques must be utilized [29]. This graft is carved in a shield shape and should be slightly convex. The edges are beveled and the graft is sutured to the caudal margin of the medial crura. The top edge of the graft should then be camouflaged to prevent visibility in the future.

Setting dorsal height

The dorsal height is next set based on the tip projection. Many patients will require reduction of the dorsal height. In patients with thin skin, irregularities of the nasal dorsum are more likely to become a problem postoperatively when the edema resolves. In patients undergoing secondary rhinoplasty to correct dorsal irregularities under thin skin, a layer of costal cartilage perichondrium can be laid over the dorsum to help create a smooth dorsum. This material typically adds 1 mm to the dorsal height, and this should be accounted for when reducing the dorsum initially.

Thick-skinned patients can frequently benefit from a radix graft to elevate the nasal starting point and decrease the nasal width in the upper one-third of the nose [30]. A deep supratip break should be maintained in these patients to prevent the development of supratip fullness [31]. This distance can be precisely and reliably set only if the base of the nose is stabilized and the tip projection will not change appreciably during the postoperative healing period.

In some patients, a small amount of dorsal augmentation is needed to balance the tip projection and give a favorable width on frontal view. In this case, single layer or stacked septal cartilage can be used. These grafts are also frequently covered with perichondrium to ensure a seamless contour between the graft and nasal sidewall, without visible step-off at the graft's edge.

Alar base reduction

After placement of lateral crural strut grafts and alar rim grafts, the alae tend to flare, creating large, disproportionate nostrils. This can be corrected with alar base reductions. The most common type of reduction is internal, confined to the area between the nasal sill and the ala. These incisions should be beveled at 10–15° from perpendicular to evert the skin once it is closed (Fig. 12).

Figure 12 Alar base reduction is accomplished by resecting a segment of skin between the nostril and the nasal sill

A slight bevel ensures that the skin closes with some eversion. Reproduced from [9••], Figure 28.

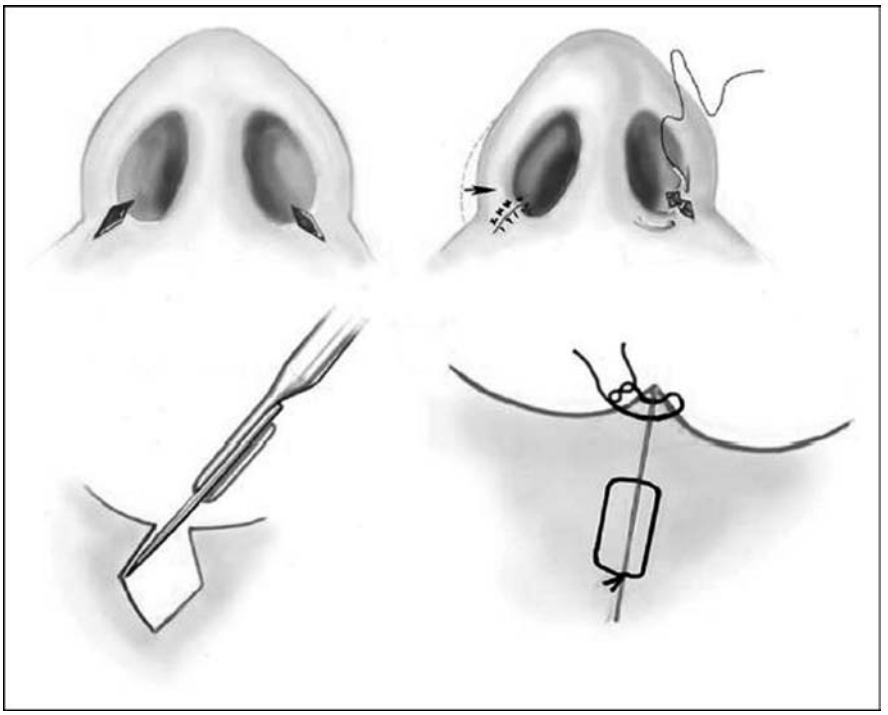
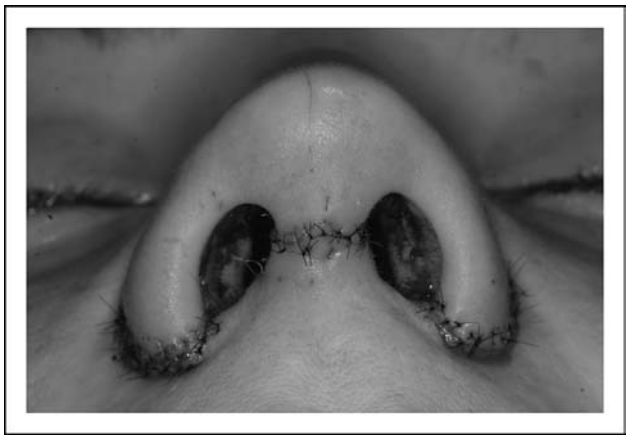


Figure 13 Multiple 7-0 nylon vertical mattress sutures are placed to create good approximation and eversion of the skin edge



Multiple 7-0 vertical mattress nylon sutures are used to close the skin (Fig. 13). Foda [32•] described a combined technique of alar base reduction where an internal nostril floor excision is performed and then closed. Next, the base is assessed and a second excision is done at the alar-facial groove. Separating these incisions allows the surgeon to evaluate the effect the first resection has on nostril shape and alar position before proceeding to the next step.

Conclusion

Structural approach to rhinoplasty with autologous cartilage grafting is a safe and effective way to create appropriate nasal contour and function. The techniques chosen should be tailored to the anatomic variables and deformities presented by the patient. When properly employed, these techniques can produce reliable results that are stable throughout the healing process.

References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

- • of special interest
- •• of outstanding interest

Additional references related to this topic can also be found in the Current World Literature section in this issue (p. 290).

1 Sheen JH. Spreader graft: a method of reconstructing the roof of the middle nasal vault following rhinoplasty. Plast Reconstr Surg 1984; 73:230–237.

2 Toriumi DM. Management of the middle nasal vault. Op Tech Plast Reconstr Surg 1995; 2:16–30.

3 • Gassner HG, Friedman O, Sherris DA, Kern EB. An alternative method of middle vault reconstruction. Arch Facial Plast Surg 2006; 8:432–435.
A good review of spreader graft techniques with the introduction of a modification of the dorsal onlay technique.

4 Tardy ME. Rhinoplasty: the art and science. Philadelphia, PA: WB Saunders; 1997.

5 Toriumi DM, Josen J, Weinberger M, Tardt ME Jr. Use of alar batten grafts for correction of nasal valve collapse. Arch Otolaryngol Head Neck Surg 1997; 123:802–808.

6 Johnson CMJ, Godin MS. The tension nose: open structure rhinoplasty approach. Plast Reconstr Surg 1995; 95:43–45.

7 Johnson CM, Toriumi DM. Open structure rhinoplasty. Philadelphia, PA: WB Saunders; 1989.

8 Kridel RWH, Scott BA, Foda HMT. The tongue-in-groove technique in septorrhinoplasty: a 10 year experience. Arch Facial Plast Surg 1999; 1:246–256.

9 •• Toriumi DM. New concepts in nasal tip contouring. Arch Facial Plast Surg 2006; 8:156–185.
Discussion of the philosophy and techniques involved in creating appropriate nasal tip contour.

10 Toriumi DM. Caudal septal extension graft for correction of the retracted columella. Op Tech Otolaryngol Head Neck Surg 1995; 6:311–318.

11 Ha RY, Byrd HS. Septal extension grafts revisited: 6-year experience in controlling nasal tip projection and shape. Plast Reconstr Surg 2003; 112:1929–1935.

12 Toriumi DM. Structure concept in nasal tip surgery. Op Tech Plast Reconstr Surg 2000; 7:175–186.

13 •• Daniel RK. Rhinoplasty: septal saddle nose deformity and composite reconstruction. Plast Reconstr Surg 2007; 119:1029–1043.
A classification scheme for saddle nose deformities is described. A novel mechanism for reconstruction is described that involves a deep structural component, and a separate aesthetic component.

14 • Brenner KA, McConnell MP, Evans GR, Calvert JW. Survival of diced cartilage grafts: an experimental study. Plast Reconstr Surg 2006; 117:105–115.
Diced human cartilage was implanted into nude mice and harvested 8 weeks later to examine the cartilage viability and architectural characteristics.

15 •• Adamson PA, Litner JA. Applications of the M-arch model in nasal tip refinement. Facial Plast Surg 2006; 22:42–48.
The M-arch model, a modification of the tripod concept, is presented.

16 Anderson JR. The dynamics of rhinoplasty. In: Bustament GA, editor. Proceedings of the Ninth International Congress of Otolaryngology, Mexico City; 10–14 August 1969. Amsterdam: Exerpta Medicina; 1970.

17 Constantian MB. The boxy nasal tip, the ball tip, and alar cartilage malposition: variations on a theme – a study in 200 consecutive primary and secondary rhinoplasty patients. Plast Reconstr Surg 2005; 116:268–281.

18 Tebbetts JB. Shaping and positioning the nasal tip without structural disruption. Plast Reconstr Surg 1994; 94:61–77.

19 Toriumi DM, Tardy ME. Cartilage suturing techniques for correction of nasal tip deformities. Op Tech Otolaryngol Head Neck Surg 1995; 6:265–273.

20 McCollough EG, Fedok FG. The lateral crural turnover graft: correction of the concave lateral crus. Laryngoscope 1993; 103 (4 Pt 1):463–469.

21 •• Gunter JP, Landecker A, Cochran CS. Frequently used grafts in rhinoplasty: nomenclature and analysis. Plast Reconstr Surg 2006; 118:14e–29e.
An excellent review of the most commonly used cartilage grafts in rhinoplasty.

22 Gunter JP, Friedman RM. Lateral crural strut graft: technique and clinical applications in rhinoplasty. Plast Reconstr Surg 1997; 99:943–955.

23 Toriumi DM. Structure approach in rhinoplasty. Facial Plast Surg Clin North Am 2005; 13:93–113.

24 Daniel RK. The nasal tip: anatomy and aesthetics. Plast Reconstr Surg 1992; 89:216–224.

25 Gunter JP, Rohrich RJ, Friedman RM. Classification and correction of alar-columellar discrepancies in rhinoplasty. Plast Reconstr Surg 1996; 97:643–648.

26 • Pedroza F, Anjos GC, Patrocinio LG, *et al.* Seagull wing graft: a technique for the replacement of lower lateral cartilages. Arch Facial Plast Surg 2006; 8:396–403.
A retrospective review of the aesthetic and functional outcomes of this seagull wing graft for reconstruction of the lower lateral cartilages.

27 Kim DW, Toriumi DM. Nasal analysis for secondary rhinoplasty. Facial Plast Surg Clin North Am 2003; 11:399–419.

28 Rohrich RJ, Raniere J Jr, Ha RY. The alar contour graft: correction and prevention of alar rim deformities in rhinoplasty. Plast Reconstr Surg 2002; 109:2495–2505.

29 Toriumi DM, Johnson CM. Open structure rhinoplasty: featured technical points and long-term follow-up. Facial Plast Surg Clin North Am 1993; 1:1–22.

30 Toriumi DM, Hecht DA. Skeletal modifications in rhinoplasty. Facial Plast Surg Clin North Am 2000; 8:413–431.

31 Guyuron B, DeLuca L, Lash R. Supratip deformity: a closer look. Plast Reconstr Surg 2000; 105:1140–1151.

32 • Foda HM. Nasal base narrowing: the combined alar base excision technique. Arch Facial Plast Surg 2007; 9:30–34.
Description of an alar base reduction technique composed of a separate internal and external resection.