Chapter 49: Reconstructive Rhinoplasty

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Nasal reconstruction differs significantly from cosmetic rhinoplasty. A cosmetic rhinoplasty attempts to create fairly subtle changes in nasal features to provide a more "proportioned" or "refined" look, whereas the purpose of a reconstructive rhinoplasty is to replace tissues that have been lost by trauma or disease. The content of this chapter is twofold. First, this chapter expands and updates several previously described techniques. Specifically, these include conchal cartilage grafting for nasal valve or other cartilage collapse, the perichondrial cutaneous graft for repair of partial tip defects, and the variations on local nasal and nasolabial flaps for upper and lower nasal defects. Second, we include a new technique of full- and partial-thickness calvarial bone grafting for nasal reconstruction, particularly its utility in total nasal reconstruction.

Conchal Cartilage Grafting for Nasal Valve Collapse

The nasal valve is classically described as being formed by the inferior border of the upper lateral cartilage laterally and the nasal septum medially (Bridges, 1970). Physiologically the normal valve remains stationary during normal respiration but will have some mild inward collapse during periods of extreme exercise and rapid breathing. The diagnosis of valve collapse is established by a careful history, which often includes previous nasal surgery and a physical examination employing the Cottle maneuver (Goode, 1985) in which the cheek is pulled laterally to open the valve. Age is also important since in elderly persons there is a weakening of the nasal ligaments, dilator muscles, and cartilage, which may result in collapse of the valve on inspiration. Nasal rhinomanometry has also been employed to quantify flow changes but is often unnecessary in light of a strong history and confirming physical findings.

A typical patient has undergone at least one and usually several previous nasal surgical procedures with overzealous trimming or resection of the lower lateral cartilages, which have resulted in a blunting of the angle of the upper lateral cartilage with the septum and nasal valve obstruction. There may be significant scarring and webbing in the area of the valve angle from an imprecise reapproximation of incisions or the inappropriate placement of endonasal incisions.

Once a proper diagnosis is made, it is usually best to replace excised tissue with like tissue. The nose may be approached via an external rhinoplasty incision so that a complete evaluation of the deficiencies is easily accomplished. When cartilage is absent and structural support is lost, a conchal cartilage graft is placed to restore support to the valve. This graft is harvested through an anterior incision in the conchal bowl just inside the anthelix following local anesthetic infiltration. Local anesthesia is used even during general anesthesia, using the hydraulic effects for elevation of the perichondrium from the cartilage. Care is taken to inject centrally where the perichondrium is adherent to the skin, allowing the infiltration to gradually move more peripherally. The entire conchal bowl cartilage may be removed with no significant auricular deformity. This affords an adequate amount of cartilage to bridge a bilateral defect (Fig. 49-1), which is commonly found. A minimum dimension of 3.0 cm in length by 1.5 cm in width is

necessary. The graft is symmetrically shaped in size to fit into the tissue defect. The entire periphery of the graft is feathered by thinning and softening the cartilage with a nasal resp or an emery board autoclaved at the onset of surgery (Fig. 49-2). The continuity and intrinsic cartilage recoil are not violated or damaged by morselization or placing any incisions into the cartilage.

Direct sutures may be placed to provide tip rotation when desired. Percutaneous mattress sutures are employed to fix the graft in position and to obliterate the dead space and prevent blood accumulation with subsequent scarring. The sutures (No. 4-0 nylon) are brought out within the nasal ala sulcus. The suture is oriented vertically in the endonasal superior valve area to ensure a sharp angle, but it is brought out over the skin horizontally so as to lie in the sulcus and allow maximum camouflage. The suture may be tied over a small bolster to remain in place for approximately 10 days (Fig. 49-3). Scarring from the suture is usually not a problem because of the orientation within the nasal alar crease. Taping and cast application are performed carefully to avoid placing direct pressure over the surgical knots. Typically, both valves are involved, and therefore a single graft is used that bridges over the cartilaginous dorsum. This occasionally requires generous excision of supratip soft tissue to allow accommodation for the graft without creating a bulging appearance. Occasionally a small amount of dorsal septum will require trimming. Additionally, any endonasal webbing or scarring must be managed before the placement of the graft, usually with Z-plasties to break up the scar. Visible cartilage edges may persist, even several years after the procedure. Palpable edges are most common but are not considered a problem if they are not visible. Postoperative edema tends to be more prolonged than with a routine rhinoplasty. A secondary debulking of the graft is possible via an external rhinoplasty approach but should not be undertaken before 6 to 12 months have elapsed. Revision surgery following this technique revealed viable conchal cartilage in the two patients in whom it was carried out (Fig. 49-4). Other surgeons have experienced satisfying results (Haye, 1965; Walter, 1975).

Perichondrial Cutaneous Graft for Tip Defects

For partial nasal tip loss with adequate underlying cartilage support, we have employed a perichondrial cutaneous graft harvested from auricular conchal bowl for reconstruction of the defect. Originally described by Brent (1978), a perichondrial cutaneous graft offers easily accessible tissue that has been shown clinically and experimentally to be able to regenerate cartilage (Portuese and Stucker, 1989). The indications for use of this graft include any nasal tip defect that involves skin and perichondrium with or without a cartilage defect. It is impractical for full-thickness nasal defects.

The technique of obtaining the graft is quite simple. Local anesthesia is infiltrated in the conchal area in a manner to elevate perichondrium and skin from the cartilage by hydrodissection. As described earlier, care is taken not to separate the skin from the perichondrium, or a simple full-thickness skin graft results. This is most easily avoided by not advancing the injection peripherally until the central portion of the graft is elevated. If necessary, a larger graft can be obtained by continuing superiorly over the inferior crus into the fossa triangularis. A typical graft measures 2.5 by 4.0 cm. To obtain the graft, an incision is made

through the conchal skin approximately 2.0 mm inside the conchal rim, down to the cartilage, and through the perichondrium. A Cottle elevator separates the perichondrium from the cartilage. Dissection is carefully advanced anteriorly into the meatus. If a larger graft is needed, the dissection is carried superiorly over the inferior crus and the upper incision becomes strategically placed for cosmesis. Placement of the graft is initiated by preparation of the recipient site. In many instances, if greater than one third of the nasal tip aesthetic subunit is involved, the entire unit should be sacrificed to achieve the best possible result.

A minimum number of No. 6-0 nylon sutures is used at the margin of the graft. Several interrupted No. 5-0 chromic sutures fix the graft to the underlying bed. The use of these basting sutures avoids the need for a bolster dressing (Fig. 49-5), or the graft can simply be rolled with a cotton-tipped applicator as frequently as necessary to prevent the collection of serum beneath the graft. The donor site closure is accomplished by removing a generous window of conchal cartilage to accommodate a postauricular island flap. The island flap is designed to include the postauricular muscle underlying it, with the base of the flap intersecting between the postauricular muscle band and the sulcus. The flap is cut to fit the defect size and the slipped through the conchal cartilage defect to close skin deficits. The postauricular donor site is closed in a straight line (Fig. 49-6). Unlike a split-thickness skin graft, and to a lesser extent a full-thickness graft, the perichondrial cutaneous graft shows no tendency to contract. Additionally, perichondrium has been shown to have chondrogenic potential.

The graft finds particular utility in pediatric patients. Because of their skin tension and turgor, these patients are poor candidates for local flaps. Since partial- (split-) and full-thickness skin grafts tend to contract, these also are not suitable. We have found that the perichondrial cutaneous graft not only has minimal contraction, but also will grow with the patient. The suitability and primary indications for the perichondrial cutaneous graft are limited to two situations: nasal reconstruction, the nose being the dominant site for this technique (Fig. 49-7), and eyelid reconstruction. Since the graft shows virtually no tendency to contract and is substantially thicker than a full-thickness skin graft, it also offers unique advantages over conventional skin grafting techniques on the face.

Local Nasal and Nasolabial Flap Reconstruction

Nasal reconstruction using local flaps is extremely useful in repairing many nasal defects. The advantage of using tissue that is similar in texture and color is that it frequently provides better aesthetic results than grafts. Nonetheless, when considering repairs of nasal defects with local flaps, it is important to first carefully analyze the defect in order to match it with the most appropriate flap available.

Small partial-thickness defects in the area of the nasal dorsum can be restored taking advantage of the relative laxity of the dorsal skin. Simple advancement flaps or transposition flaps such as rhomboid or bilobed flaps are useful (Fig. 49-8).

Moderate-sized dorsal defects can be managed with a variety of flaps. The sliding nasal dorsal flap borrows from the relatively relaxed skin of the glabella and upper dorsum, rotating or sliding the flap to fill middle and lower dorsal defects (Fig. 49-9). Although this flap is considered random by some, Rieger (1967) felt the main blood supply was derived from the angular artery at the medial canthus. Because of this pedicle, the amount of downward rotation is limited. A glabellar extension of the flap is well suited for repair of upper lateral nasal defects as well as defects in the areas of the medial canthus. Harvest of this extension should preserve in place both supratrochlear vessels to maintain the potential for the future use of a midline forehead flap.

Defects of the lower nose and alar rim are better managed by nasolabial flaps. These flaps are ancient in origin, listed in the Hindu "Sheushrata Samhita", and are still considered by many to be the most versatile and useful flaps for nasal reconstruction (Nichtor et al, 1983). The nasolabial flap was popularized in the nineteenth century by German and French surgeons, particularly Dieffenbach (1845). Pierce and O'Conner (1938) described a large series of applications for these flaps.

The blood supply for the flap is derived from the angular and transverse branches of the facial artery, with contributions from the infraorbital superior labial vessels as well. The venous drainage is principally via the angular and facial veins. The flap can be harvested as a myocutaneous flap with incorporation of the underlying facial musculature. In general, however, it is harvested with only 2 to 3 mm of subcutaneous tissue, thus rendering it a random flap. Hynes and Boyd (1988) have found that the small vessels of the subdermal plexus are oriented along its long axis, giving it axial characteristics and thus providing a very reliable flap. The flap can be based superiorly or inferiorly and can be an island or a pedicle. It can be tunnelled beneath or transposed over intervening tissues.

The ala and lateral dorsum can be reconstructed by rotation of a superiorly based nasolabial flap. The tip of the flap can be turned in to provide inner nasal lining (Fig. 49-10), or similar defects with an intact ala can be managed by laser deepithelializing a small intervening area of pedicle (Fig. 49-11).

Full-thickness alar defects are nicely managed by either superiorly or inferiorly based nasolabial flaps. Here, the flap is designed so that one edge is adjacent to the defect to leave the lateral alar crease intact. Spear et al (1987) described a useful method of designing the flap with its base close to the site of the proposed ala. A full-length (thin 2 to 3 mm of subcutaneous fat) flap is incised. It is then flipped over medially and sutured as internal lining. A distal (inferior) portion is rotated 90 degrees and trimmed to line the outer defect. Upper lip and columellar defects can be managed by either unilateral or bilateral nasolabial flaps (Fig. 49-12). In general, we stage the reconstruction. First, bilateral alotomies are performed, elevating the flaps and then rotating the flaps into place. If only a columella is to be reconstructed, then after 2 weeks the proximal portions of both flaps are returned or discarded. The elevated alae are carefully and symmetrically replaced. When the major upper lip and columellar complex is to be reconstructed, we believe it is advantageous to rotate bilateral flaps to reconstruct the lip; then 2 to 3 weeks

later the inevitable excess of tissue at the distal portion of the flaps can be rotated upward to form a columella.

Employing a similar technique, we have relined the internal nose. Unilateral or bilateral nasal alotomies are needed depending on the defect, with delayed inset of either one or both inferiorly based nasolabial flaps. After 2 to 3 weeks the proximal portions of the flaps are returned or discarded and the alae are reset. Although flap survival is excellent, the flaps tend to maintain their bulk, thus occasionally making it too thick for a comfortable nasal passage.

When utilizing nasolabial flaps, we often incorporate several adjunctive techniques. Often, closure of the donor site defect is facilitated by a cheek advancement flap. The medial border is the lateral nasolabial flap donor site defect. The cheek flap is incised superiorly along the infraorbital crease and generously undermined. As the flap is medially advanced, excess bunching of tissue will occur at the lateral canthus. This is relieved by excision of Burow's triangle. Often, nasolabial flaps, despite being transposed and twisted, will maintain their bulk. Whereas this is a testament to their viability, often the result is a trap-door deformity (Fig. 49-13, A). Secondary defatting is often necessary. It has been suggested that the skin and subcutaneous fat be removed in toto, defatting the tissue, and replacing the skin as a full-thickness skin graft. This appears to be an unnecessary gamble. We have found that simply defatting the graft with circumferential undermining of the adjacent tissue is all that is needed (Fig. 49-13, B).

Total Nasal Reconstruction

Total nasal reconstruction implies a deficit that includes soft tissue, cartilage, skin, and bone. In many cases there is the absence of all nasal bone, cartilage, and cutaneous coverage. When confronted with total nasal reconstruction, a thorough initial assessment is critical. What tissue is gone and what remains must be carefully assessed. Often the dorsal profile offers a significant hump of the remaining nasal bone, which when reduced allows for easier reconstruction later (Fig. 49-14). The steps involved can vary, but we recommend obtaining internal lining first, waiting 2 to 3 weeks, and then placing the skeletal support and external coverage in one or two stages. Currently we employ a dorsal and columellar segment of calvarial bone with dowel fixation (Fig. 49-15). This is almost always followed by touch-up modifications, usually involving the tip columellar complex. Previously described techniques often involve either an L-shaped graft or a cantilever bone graft. Both of these techniques offered good reconstruction of the dorsum but were not ideal when lateral support was lacking. Difficulty with fixation at the frontal bone can result in late lateral shifting. Previously, we employed an iliac crest cantilever graft but presently employ either the dowelled reconstruction or two full-thickness calvarial bone grafts in a "tent" configuration. Calvarium is membranous bone, unlike iliac crest, tibia, and rib, which are endochondral bone. Numerous investigators not significantly less absorption with membranous grafts, both experimentally and clinically (Tessier, 1982; Zins and Whitaker, 1983). Additionally, these other donor sites are often associated with significantly more postoperative pain and morbidity. Finally, exposure for placement of the (tent) grafts is facilitated by the coronal incision necessary to harvest the calvarial graft.

Our technique for graft harvest employs a gentle S-shaped incision that begins 1 to 2 cm above the insertion of the helix, well hidden in the hairline, and extends coronally. Invariably, we extend the incision to the midline sagittal plane, unless a bicoronal flap will be employed for craniofacial reconstruction. Maximal exposure is advantageous. The incision is carried through galea, but the pericranium is kept intact. Wide undermining is next performed. A tinfoil template is then designed for the future nasal bone. An extra 0.5 cm is added to the entire circumference of the template and can be outlined on the pericranium using a needle with gentian violet. An incision is made in the pericranium, and the pericranium is elevated in all directions away from the graft. Care should be taken not to cross cranial suture lines, because dural sinuses tend to run under them. Initially, we employed an otologic high-speed drill with a cutting burr through the outer cortex until diploë was reached, then switched to a diamond burr until the dura was uncovered (Fig. 49-15). The dura was carefully elevated with a Penfield elevator, and then curved osteotomes were placed around the graft and carefully elevated off the dura. If a small dural tear occurred, it was closed using a No. 4-0 Neurolon suture. If only outer table was employed, osteotomes were placed in the diploë and the outer table was split from the inner table. The outer table was then replaced onto the cranium and fixed using compression plates with 2.0 mm screws or sutured after placement of drill holes (Fig. 49-16). We now employ the high-speed Midas Rex drill to harvest cranial grafts using an acorn-shaped burr drill (A-5 attachment) until a small bone window is carefully made to identify dura. Then a footed piece (B-1 footed) is used to cut out the entire cranial graft. The outer table is then separated and replaced as before. These attachments allow for greater protection of the dura and have significantly reduced harvesting time. Additionally, the use of small cylinder drills (M-3 and M-4 attachments) has greatly facilitated modeling of the bone graft (Fig. 49-16).

In general, for total nasal reconstruction two parallel grafts are harvested. We prefer thick calvarium, so either a thin inner table is replaced or full thickness is employed and not replaced. Our neurosurgical colleagues' experience assures us that this is routine and safe. Tessier (1982) also commented on calvarial regeneration from adjacent intact pericranium. One notes that 6 months after surgery the defect is barely perceptible. If a defect persists longer than 6 months, then a molded acrylic plate is fashioned and wired to adjacent bone, or a second graft is harvested and split and used to reconstruct the donor and recipient site. A small-bore suction is placed with its catheter exiting out behind the ear. The scalp is closed in two layers employing No. 3-0 Vicryl or Dexon to approximate galea and surgical staples or No. 3-0 Proline to close skin.

Shaping of the graft depends on the defect, but in general the two mirror image grafts are shaped to correspond to lateral nasal walls. Small perforations are made along the graft's edges, which allows fixation along their dorsal edge by a No. 24 gauge wire. The deep surface and the lateral edges of the graft are then contoured to provide as broad surface contact as possible with the frontal bones and residual nasal bones and maxilla. Typically, the midline forehead flap has already been rotated down for inner lining, and the graft is then placed along the area where it will ultimately be positioned (Fig. 49-17). A small groove is drilled in the diploë of the graft, and a ledge is created along the retained maxillary and frontal bone to further stabilize the graft. Small perforations are made along the free edges of the graft, which are aligned with similar

neighboring perforations in maxillary and facial bone. The graft is then secured to adjacent maxillary and frontal bone with a No. 24 gauge wire or, more recently, with noncompression microplates. A second set of perforations is made along the apex of the graft. A double-needled Kieth suture is then passed through the graft apex perforation, through the previously turned midline forehead and then out the flap, and through the graft again. At least three sets of these sutures are then passed, which when tied will allow apposition of the turned-in flap to the undersurface of the bone. Perforating holes are then made along the edges of the graft. The graft pericranium is sutured to the maxillary and frontal bone periosteum covering the wires or plates. Once the graft is secured, the distal pedicle of the midline forehead flap is divided and rotated 180 degrees to give external coverage, creating a "graft sandwich". If inadequate midline forehead flap stump is available, a nasolabial flap, converse scalping flap, Washio postauricular flap, deltopectoral flap, or a free flap with microvascular anastomoses can be employed for additional external coverage. One can gain extra distance from the midline forehead flap by placing a 250 cc skin expander before midline forehead flap elevation. Also, an oblique orientation of midline forehead flap will provide additional length to allow for complete external coverage. This involves thorough preoperative planning, which should be undertaken before undertaking reconstruction. Once the skin flap is closed for external coverage, the previously three paired Kieth needle sutures are then passed through the overlying skin flap and tied over bolsters. A columella reconstruction can be added by making an L type of extension to be designed calvarial grafts. In this case the nasolabial flaps are usually employed to give adequate coverage to the reconstructed columella. Two rounded Silastic tubes or two No. 5 French endotracheal tubes are placed in the neonostrils. The bolsters and tubing remain for 2 to 3 weeks during which time the patient uses moisturizing drops intranasally and oral antibiotics. If there is adequate lateral nasal wall support, then an L-shaped curvilinear graft is employed. The cranial end is secured by inserting it onto a drilled opening in the frontal sinus. The cephalic end is secured into the maxilla (Fig. 49-18). As with the previous method, bone reconstruction is generally staged after an internal lining has been secured. A simple method utilizes the dowel principle using either calvarial or iliac bone parts.

A maxillary base, especially of the primary palate, can also be constructed by using a third piece of full-thickness calvarium to bridge the maxillary defect. We have employed this technique for three total nasal reconstructions in the past 2 years with good success. Interestingly in two of these, exposure of bone graft did not result in loss of graft, attesting to the viability of this bone.

Summary

Nasal reconstruction involves careful preoperative planning and a thorough understanding of facial anatomy, nasal physiology, and reconstructive techniques. Additionally, an aesthetic appreciation is necessary to reconstruct an organ that tends to be the natural focus of attention in social intercourse. The reconstructive surgeon not only must be resourceful and innovative, but also must understand the patient's sense of disfigurement. We encourage a strong, supportive, yet honest approach that undoubtedly will pay long-range dividends.