Saddle Nose Deformity Reconstruction With a Split Calvarial Bone L-Shaped Strut

Taha Z. Shipchandler, MD; Brian J. Chung, MD; Daniel S. Alam, MD

Objective: To describe a technique for creation of a split calvarial bone L-shaped strut that provides dorsal support while increasing tip projection in patients with substantial septal saddle nose deformities from various underlying inflammatory conditions and surgical resection.

Methods: Case series and review of the literature.

Results: Fifteen patients underwent nasal reconstruction at our institution using the split calvarial bone L-shaped strut technique with postoperative follow-up to 36 months (range, 9-36 months). The causes of septal perforation leading to saddle nose deformity included cocaine use, infection, sarcoidosis, malignant lesion, iatrogenic causes, and Wegener granulomatosis. All cases resulted in an augmented, straightened nasal dorsum and increased tip projection. Results were maintained throughout follow-up with no evidence of graft infection, resorption, or migration.

Conclusions: The split calvarial bone L-shaped strut provides dual benefits of dorsal support and increased tip projection. Numerous techniques have been discussed for dorsal augmentation with varied success; however, the long-term maintenance of this graft in patients with severely compromised vascularity owing to underlying inflammatory conditions such as Wegener granulomatosis highlights its presumed advantages. The procedure can be performed using the external rhinoplasty approach, obviating the need for radix incisions for plating or intranasal mucosal incisions. These advantages make the L-shaped strut technique excellent for nasal reconstruction in patients with substantial septal saddle nose deformities regardless of cause and duration of defect.

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Correction of saddle nose deformities is a reconstructive challenge. The septal saddle deformity, recently classified by Daniel,1 can result from injury to the dorsal and caudal nasal septa. This may lead to a collapsed nasal dorsum and loss of columellar support with resultant underprojection of the nasal tip. Optimizing aesthetic results involves not only correcting the depressed nasal dorsum but also providing additional tip support for reestablishing appropriate tip projection.

Various methods using 1-dimensional (single-piece) synthetic or biologic materials for dorsal repair have been described with mixed success.2 None of these techniques, however, address the underprojection noted in patients with severe septal cartilage loss without the use of a separate columellar strut. Although several techniques use L-shaped struts to address both the dorsal support and underprojection aspects of repair, all describe the use of some type of rigid fixation near the radix or anterior nasal spine, necessitating a separate incision.1,3,4

The ideal repair would address both dorsal collapse and underprojection while eliminating the need for additional incisions or permanent rigid fixation. We report 15 cases of reconstruction of moderate to severe septal saddle nose deformities requiring dorsal and caudal support using a fashioned L-shaped split calvarial bone graft, obviating the need for rigid fixation or additional incisions.

Methods

This study was approved by the Institutional Review Board of The Cleveland Clinic (07-227), Cleveland, Ohio. We conducted a retrospective electronic medical records review of 15 cases from January 5, 2002, to May 17, 2007, in which an L-shaped split calvarial bone graft was used for repair of septal saddle nose deformities. Causes included cocaine use, infection, sarcoidosis, malignant lesion, iatrogenic causes, Wegener granulomatosis, and unspecified granulomatous diseases (Table). Medical records were reviewed for complications such as infection; graft extrusion, resorption, or migration; and loss of support structures. In addition, aesthetic appearance was evaluated by the surgeon and patient at each follow-up visit.

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SURGICAL TECHNIQUE

HARVESTING AND FASHIONING OF THE BONE GRAFT

A scalp incision is made along the superior rim of the temporalis muscle in the nondominant temporoparietal region. A trifurcated incision is then created, extending the incision inferioiy within the hairline to the preauricular sulcus. Dissection in the subgaleal plane is performed, and the periosteum is incised 1.5 cm inferior to the scalp incision. The periosteum is then elevated off the calvarial bone in this region. A 6-mm round cutting bur is used to circumferentially isolate a piece of outer table cortex. Drilling is continued down to the level of the diploic bone. A curved sagittal saw and curved osteotome are used to lift the outer cortex free from the intact calvarium. Further drilling is performed to remove the remaining diploic bone from the donor bed, taking care to maintain the inner cortex. Bone wax is applied as necessary for hemostasis. The periosteum is then closed using polyglactin 910 (Vicryl) sutures, and the scalp is closed using subdermal 4-0 polyglactin 910 sutures and 4-0 chromic locking skin sutures. A suction drain is placed in the subgaleal layer and is removed on postoperative day 1.

The bone graft is divided into 2 pieces that are used to construct a dorsal onlay graft and columellar strut. The dimensions of each are based on the ideal nasal length and projection. The dorsal piece is contoured using 3- and 4-mm coarse and fine diamond burs to recreate the concavity of the natural dorsum. Further drilling is performed to remove the remaining diploic bone from the donor bed, taking care to maintain the inner cortex. The cancellous side is then closed using polyglactin 910 (Vicryl) sutures, and the scalp is closed using subdermal 4-0 polyglactin 910 sutures and 4-0 chromic locking skin sutures. A suction drain is placed in the subgaleal layer and is removed on postoperative day 1.

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The nasal skeleton is exposed using an external rhinoplasty approach through an inverted-V columellar incision with intravestibular marginal incisions. Dissection is carried cephalically to the nasal dorsum. A small portion of the nasal root is filed down to enable smoother placement of the dorsal portion of the L-shaped strut. This also creates a “raw” bony surface for direct bone-to-bone contact, which hypothetically would enhance osseous integration and fusion of the bone graft. The medial crura of the lower lateral cartilages are separated to enable placement of the caudal portion of the graft into a secure pocket. In a manner akin to the placement of a columellar strut, the bone graft is placed into a secure pocket between the medial crura. The base of the L-shaped strut rests on the premaxilla and is secured with a transcrural suture. Once the L-shaped strut is positioned in place, the lower lateral cartilages are advanced over the caudal portion and vertex of the L-shaped strut using intradomal sutures (Figure 2). Two wire-pass drill holes are made in the dorsal bone to place anchoring sutures to fix the lower lateral cartilages in position and maintain the midline position of the graft. The skin and soft-tissue nasal envelope is then closed.

CREATION OF OSTEOTOMIES

If osteotomies are necessary, a No. 11 blade is used to create stab incisions in the cheek-nose junction bilaterally to access the lateral rim of the bony nasal pyramid. Medial and lateral osteotomies are then created near the nasal bone midline and the nasofacial groove, respectively.

DRESSING

Contour taping is placed immediately after closure to shape the external structure of the nose. A 1-piece standard porous cast (ThermaSplint; Whitehall Manufacturing, City of Industry, California) is placed superficial to the tape. The cast and tape are removed 1 week postoperatively.

PLACEMENT OF THE L-SHAPED STRUT

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Table. Causes of Saddle Nose Deformities

<table>
<thead>
<tr>
<th>Patient No./Sex/Age, y</th>
<th>Cause of Deformity</th>
<th>Duration of Follow-up, mo</th>
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<tr>
<td>1/M/53</td>
<td>Sarcoidosis</td>
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<tr>
<td>2/F/32</td>
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Figure 1. L-shaped strut ready for implantation after titanium screw fixation of a columellar piece to a dorsal piece.
REPORT OF CASES

CASE 1

A 17-year-old woman had a large nasoseptal perforation with resultant saddle nose deformity secondary to long-standing Wegener granulomatosis (Figure 3A and B). Three months after starting a regimen to optimize intra-nasal hygiene, she underwent reconstruction of the saddle nose deformity. A fashioned L-shaped split calvarial bone graft was used to reconstruct the nasal dorsum and provide additional tip projection. This method was ideal because it obviated the need for any mucosal cuts in the nasal lining, averting potential exacerbation of sinonasal Wegener disease. Twenty-three months postoperatively, the patient is satisfied with the results of the reconstruction and nasal airway (Figure 3C and D). The graft has shown no signs of resorption.

CASE 2

A 53-year-old man had a severe septal saddle nose deformity resulting from sarcoidosis. At initial examination, the dorsum was collapsed with a substantially sunken-in tip (Figure 4A and B). He underwent L-shaped strut reconstruction using split calvarial bone. Emphasis was placed on the columnellar portion to provide sufficient tip projection. Thirteen months postoperatively, the nasal tip is adequately projected and breathing has improved (Figure 4C and D).

RESULTS

Fifteen patients underwent reconstruction of septal saddle nose deformities using the fashioned L-shaped split calvarial bone graft. The causes of septal perforation included malignant lesion (n=6), Wegener granulomatosis (n=4), infection (n=2), cocaine use (n=1), sarcoidosis (n=1), and iatrogenic causes (n=1). Mean follow-up was 20.8 months (range, 9-36 mo). The mean time between initial evaluation and reconstruction was 2.2 months in patients without cancer and 13.1 months in patients with cancer. No postoperative complications such as infection, extrusion, or graft migration were noted. In addition, no donor site complications including intracranial injuries or wound site hematomas were noted. No graft resorption, as evidenced by loss of dorsal support or tip projection, was noted. Thirteen of 15 patients reported that their nasal breathing had improved substantially after surgery. Two patients reported feeling minor irregularities in the nasal dorsum. They declined revision surgery. Stab incisions used for external osteotomies were unnoticeable by 6 months postoperatively.

COMMENT

When planning the reconstruction of severe septal saddle nose deformities, several aspects of the repair require consideration. A detailed facial analysis must be performed to determine whether a patient has a collapsed dorsum only or a collapsed dorsum with a retracted columella resulting in decreased tip projection. In our patients, saddle nose deformities caused by rheumatologic or neoplastic diseases lacked not only dorsal septal support but also caudal support, owing to large septal perforations. This resulted in the traditionally collapsed dorsum along with a sunken-in and posteriorly displaced nasal tip. In addition, a decision as to whether to address the nasal septal perforation or to focus attention on the dorsal and caudal support structures must be made. The existence of large perforations in our patients with known autoimmune or neoplastic diseases caused minimal symptoms. Primary patient concerns tended to be decreased airflow and poor cosmesis, both of which were adequately improved without addressing the septal perforation.

Use of the 1-dimensional (ie, single-piece) dorsal onlay graft has been well-described in a variety of situa-
We use a 2-dimensional L-shaped strut to address both the dorsal and caudal support structures in patients with septal saddle nose deformities. Previous descriptions of this technique discuss the use of miniplates or wires superiorly near the radix for rigid fixation. Increased risk of infection, the need for additional incisions, and the presence of a fixation device palpable through the skin are noted disadvantages of this method. Demirtas et al recently described the use of absorbable screw fixation for the placement of a split calvarial bone dorsal graft. Their technique required use of a separate radix incision. Our method secures the vertex, columellar portion, and the caudal-most aspect of the dorsal portion of the L-shaped strut by advancing the medial crura over the projected vertex. The lower lateral cartilages are sutured to the graft through 2 small drill holes to anchor it in the midline position. In addition, a tight intercrural pocket stabilizes the columellar end of the L-shaped strut. The dorsal nasal bones, which are traditionally not affected in saddle nose deformities, is filed down slightly to expose the osseous root of the nose to enable the superior segment of the graft to have bone-to-bone contact. It is presumed that this enhances the long-term likelihood of osseous integration of the graft. This also obviates the need for rigid fixation methods sometimes associated with infection, graft extrusion, and undesirable texture or feel of the skin over the fixation device. The use of rigid fixation has been reported to decrease graft resorption; however, we have noted no evidence of graft migration or resorption, and there seems to be palpable bony union over time in our series of patients to date.

Shortcomings of the traditional dorsal onlay graft include formation of an excessively straight nasal dor-
sum, creating an unnatural feel and diminishing the natural flexibility of the distal portion of the nose. Our technique of advancing the lateral crura and placing the graft deeper in the tip prevents pollybeak deformity and creates a desirable supratip break. In essence, we enable the natural tissue (ie, the lower lateral cartilages) to be the most projected portion of the distal dorsum and tip, which creates a more natural shape and feel while creating a narrow columella and well-defined tip. Great care is also taken to contour the dorsal graft to the appropriate shape and curvature using polishing diamond burs. This helps create desirable contour lines from the supraciliary ridges to the lateral tip of the nose. We also thin the cephalic portion of the dorsal segment to enable a smooth transition to the nasal bridge. Our goal is that a finger placed over the graft will not feel any ridges or bumps. Use of temporalis fascia or acellular dermis placed superficially to the graft may be used to soften the feel of the dorsum, but we did not find this necessary. Daniel described the use of a superficially placed aesthetic layer overlying the deeper structural layer. We did not find the need for a superficially placed aesthetic layer but recognize the utility of tip grafts, diced cartilage, and other materials for further definition of the nose after structural support is provided.

Various materials are used for dorsal onlay grafts and for fashioning L-shaped struts. The ideal graft material would be completely compatible with the host, easily shaped, and resistant to graft infection, resorption, migration, and extrusion. Several alloplastic options exist including polyamide mesh, polymeric silicone (Silastic; Dow Corning Corp, Midland, Michigan), waterproof breathable fabric.

Figure 4. A 53-year-old man with sarcoidosis with severe saddle nose deformity. A and B, Preoperative views. Anterior view (A) and profile (B). C and D, Postoperative views 13 months after L-shaped split calvarial bone reconstruction of the saddle nose deformity. Anterior view (C) and profile (D).
Previously in the literature, we believe the unique element principles of this type of technique have been reported previously. While the general concept and principles of this type of technique have been reported previously. Several of these materials, however, enable favorable incorporation of soft tissue into the material itself, in theory, providing a more natural appearance. Thorton and Mendelsohn described the use of a 1-dimensional piece of high-density porous polyethylene to reconstruct the nasal dorsum. The rough inner surface of the material obviates the need for rigid fixation, and the porous material enables ingrowth of natural tissue over time, providing additional stability. This material is also cited for its flexibility and speed of contouring. Lengthening the graft into the tip region, however, caused graft migration in 1 patient, and its use within the tip was subsequently discontinued. Della Santina and Byrne described the use of a temporary alloplastic material while monitoring for cancer recurrence. This averts the harvesting of autogenous tissue in the event that recurrence is noted and further ablative surgery is necessary. This method also maintains the structure of the nasal skeleton and soft-tissue envelope for future permanent implantations such as autogenous bone. We waited a mean of 13.1 months after definitive reconstruction in our 6 patients with cancer to monitor recurrences. As described, use of transparent absorbable material may provide the needed skeletal support during this period to optimize definitive reconstruction later.

We prefer the use of autogenous materials, specifically, split calvarial bone, for several reasons. First, autogenous bone compared with allografts is associated with lower rates of graft infection, extrusion, and resorption. Second, compared with cartilage, bone is more much more abundant. Septal and conchal cartilage does not allow harvesting of a 4-× 2.5-cm graft. In addition, costal cartilage, in our experience, leads to a much higher degree of graft resorption. Iliac crest and rib are additional sources of bone grafts, but the unpredictable nature of graft resorption, loss of shape and volume, and donor site morbidity including postoperative pain make these alternatives less attractive. Rib harvest is associated with the risk of pneumothorax and prolonged pleuritic pain during exercise. Iliac crest harvest is associated with lateral femoral cutaneous nerve injury resulting in visceral herniation, acetabular fracture, meralgia paresthetica, and prolonged postoperative pain at the harvest site. Split calvarial bone is easily harvested with minimal postoperative pain and low rates of resorption. In our series, 5 patients have chronic inflammatory diseases, specifically, sarcoidosis and Wegener granulomatosis. When the status of the recipient vascular bed is questionable in such cases, the use of split calvarial bone may be especially advantageous. The use of cartilage in these patients led to substantial graft resorption. Membranous split calvarial bone requires a minimal blood supply and is not easily susceptible to infection, making it a robust graft option in these patients. While the general concept and principles of this type of technique have been reported previously in the literature, we believe the unique element in the present report is the successful use and long-term survival of these grafts in a precarious patient population. Patients with chronic inflammatory conditions such as Wegener disease are often excluded as acceptable surgical candidates because of concerns about graft resorption and surgical failure. We hope that the findings of this clinical series suggest otherwise.

We use a trifurcated incision within the hairline to maximize exposure and optimize cosmesis when performing the split calvarial bone graft harvest. (In thin-haired individuals, split calvarial bone harvest does not offer a cosmetic advantage, thus, other options should be discussed with the patient.) We then use a broad (6-mm) cutting bur through the superficial cortical layer of calvarium to reach the diploic bone space. This provides room for a curved sagittal saw and curved osteome to be used to isolate the outer table segment of bone for graft harvest. These curved instruments provide protection from possible dural tear, inner table fracture, and intracranial insult. Intracranial injury, though rare, has been reported. Bleeding is easily controlled with subsequent removal of the remaining diploic bone space and the use of bone wax. No intracranial injuries or hematomas were noted in our series.

In our series, 13 of 15 patients believed that their nasal breathing was substantially improved at their most recent follow-up visit, even though the L-shaped strut does not specifically correct the depressed midvault. In patients with severe septal saddle nose deformities, the depressed tip collapses the nasal vestibule, causing obstruction of airflow. After correction of tip position with the L-shaped strut, the natural shape of the nasal vestibule is restored and airflow is increased. This leads to a relatively improved nasal airway.

CONCLUSIONS

The L-shaped split calvarial bone graft for nasal dorsal reconstruction of septal saddle nose deformities provides the following benefits: dorsal support, increased tip projection, improved nasal airflow, and a natural feel and appearance to the nose. The procedure can be performed using the open rhinoplasty approach without the need for radix incisions for rigid fixation or intranasal incisions. In addition, graft donor site morbidity is kept to a minimum. These advantages make the split calvarial bone L-shaped strut technique excellent for nasal reconstruction in patients with substantial septal saddle nose deformities.

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Alam. Critical revision of the manuscript for important intellectual content: Shipchandler and Alam. Administrative, technical, and material support: Shipchandler, Chung, and Alam. Study supervision: Alam. Financial Disclosure: None reported.

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REFERENCES