Vomer Bone Graft to Augment the Deficient Cleft Maxilla

Peter J. Taub, MD, Joshua A. Lampert, MD, Lester Silver, MD, and Alex Greenberg, DDS

Abstract: Patients with clefts of the lip and palate commonly develop maxillary hypoplasia. In addition to orthognathic surgery, augmentation of the anterior maxilla may be necessary in these patients to restore symmetry to the nasomaxillary complex. Bone graft may be obtained from numerous sites. All require a separate incision at the donor site and may result in additional morbidity.

The authors describe a 16-year-old with a complete right unilateral cleft of the lip and palate who underwent maxillary advancement at the Le Fort I level. Pronounced sagittal deficiency of the maxilla necessitated osseous augmentation. The patient’s deformity resulted in deviation of the superior vomer bone. This bone was of adequate quality to be used as an onlay graft for the maxilla. This is the first report documenting the use of vomer as a bone graft for maxillary augmentation.

Key Words: Bone grafting, craniofacial morphology, nasal morphology, nose, orthognathic surgery

Bone grafting is fundamental in the management of patients with clefts involving the lip and palate. Placement of bone graft enables osseous closure of oronasal fistulas, adds stability to maxillary segments, provides substance into which the developing dentition may erupt, and offers support to the nasal alar base and the teeth adjacent to the cleft. Multiple donor sites for the harvest of bone graft are accepted.

The anterior iliac crest remains the most popular bone graft donor site. The iliac crest is used primarily by approximately 83% of North American craniofacial teams. Iliac crest can be harvested simultaneous to exposure of the cleft alveolus, provides ample bone, and is generally well tolerated. Associated morbidities include hypertrophic scarring, postoperative pain, delay in ambulation, and risk of injury to the lateral femoral cutaneous nerve. A recent British analysis of traditional iliac crest harvest in 73 patients reported a median time to normal ambulation of 7 days, a median scar length of 60 mm, 1 hypertrophic scar, and 1 case of persistent numbness. In addition, methods have been described using a trephine to core out bone graft, as well as curetting cancellous bone milled before placement.

Calvarial bone harvest was popularized by Tessier. As a membranous bone, it was found to have less reabsorption than endochondral bone in animal models. Harvest of calvarium allows the scar to be hidden beneath hair-bearing scalp, produces less postoperative pain, and has, arguably, similar success rates depending on the technique. It can be harvested as split-thickness calvaria or as full-thickness bone split on a back-table. The harvested bone can be used as an inlay graft or an onlay graft or milled before placement. Calvarial bone harvest has a very low incidence of major complications among experienced surgeons. Still, wound infections, dural tears, neurologic disturbance, intracerebral hemorrhage, and laceration to the superior sagittal sinuses have all been reported. In addition, absence of the diploë in patients younger than 1 year hinders using calvarium for primary alveolar cleft bone grafting.

Rib bone provides sufficient stock for grafting. Reported rib bone harvest in 211 infants without a single pleural violation, pneumothorax, or pulmonary complication. Laurie et al. described 44 patients with 9% sustaining pleural laceration that required chest tube placement and 6.8% with persistent chest pain 2 years later, although most had only mild chest wall contour defects and well-healed inframammary scars.

Tibial bone graft was first described by Drachter for palatoplasty. More recently, a prospective study using the trephine technique in 30 patients for both iliac crest and tibial bone harvest demonstrated similar results in regard to the quality and quantity of bone graft acquired. Tibial harvest was faster by 6 minutes, on average, with 9 mL less for average blood loss. Patients reported less pain and less difficulty walking with tibial harvest. Postoperative tibial fractures have been reported in 2 of 75 consecutive cases. Growth plate injury is also a concern that only long-term follow-up can elucidate.

Effective graft donor sites have also been described using mandibular bone, pubic bone, a titanium bone graft scaffold, and bone marrow stem cells deposited into a sponge of collagen medium. In addition, bone morphogenetic proteins, or BMPs, may provide an adequate alternative to bone graft.

Bone morphogenetic proteins are part of the transforming growth factor β superfamily. They have been used in recombinant forms for their osteoinductive properties. Bone morphogenetic proteins promote new ectopic bone formation by stimulating osteoblasts into an increased rate of cell division and chemotaxis. Bone morphogenetic proteins have also been shown to spur immature pluripotent cells toward differentiation into cartilage and bone precursors. In multiple animal studies, BMP implants have demonstrated enhanced bony regeneration in mandible defects both with and without distraction. Short-term prospective studies in the orthopedic spine literature have shown promising results for BMP as an effective replacement for iliac bone graft. The use of these growth factors in craniofacial surgery provides a promising technological advancement.

Still, autogenous bone graft currently remains the most commonly used option. Among these more traditional means, studies using micro–computed tomography both support and contest the superiority of membranous bone graft. Demirtas et al. reported membranous bone to be far superior to rib and iliac crest...
for grafting in the craniofacial skeleton. They found no resorption with split parietal bone grafting for reconstruction of saddle nose deformities.

The authors report the use of vomer, a membranous bone, as a donor site for autogenous bone graft to augment the maxilla in a patient with a cleft of the lip and palate.

**CLINICAL REPORT**

A 16-year-old girl was followed up by the cleft team with a complete right unilateral cleft of the lip and palate. As an infant, she underwent primary repair of the lip by a rotation-advancement technique followed by repair of the palate by straight-line intravelar veloplasty at approximately 12 months of age. She subsequently underwent placement of iliac crest bone graft to the alveolar ridge in the period of mixed dentition.

At the time of skeletal maturity, she was evaluated for further surgery. On examination, she was noted to have a healed lip and an intact palate. The nose demonstrated a typical cleft deformity in the presence of a sagittally deficient maxilla (Figs. 1A, B). The workup revealed maxillary hypoplasia in the absence of any mandibular pathology (Figs. 2A, B).

The patient underwent maxillary advancement at the Le Fort I level. Pronounced sagittal deficiency of the maxilla necessitated osseous augmentation. On down-fracture of the maxilla, at the time of surgery, it was noted that the superior portion of the vomer bone was deviated to the right at approximately 90-degree angle (Fig. 3). The bone stock was noted to be of adequate quality to be used as an onlay graft for the maxilla.
The superior portion of the bone was removed in the sagittal plane with a reciprocating saw. This allowed the cartilaginous septum to be moved to the midline and provided sufficient bone to augment the anterior maxilla (Fig. 4). Care was taken to augment the bone surrounding the piriform aperture and still allow sufficient opening for the nasal aperture. The augmentation was necessary to elevate the ipsilateral alar base and restore symmetry to the nasal complex (Figs. 5A, B). Postoperatively, she has recovered uneventfully. Further revision surgery on the cleft nasal deformity is planned.

DISCUSSION

Autogenous bone graft is currently the material of choice to stabilize the dental arch and augment the deficient maxilla in patients with clefts of the lip and palate. It provides adequate material into which the developing dentition may erupt. For this, iliac crest is a frequent donor site. Other choices include tibia, which has sufficient cancellous bone to be spared as graft material. Additional bone graft is necessary to augment the sagittal position of the anterior upper jaw in the face of maxillary hypoplasia. Again, iliac crest, rib, split calvarium, or other bone is used, in addition to less desirable alloplastic products. Furthermore, growth factors such as bone morphogenetic proteins have shown promise as an alternative to autogenous or allograft bone.

The vomer is part of the bony septum. It sits midline below the septal cartilage and the perpendicular plate of the ethmoid. The vomer also articulates with the sphenoid, the right and left palatine bones, and the right and left maxillary bones. The name is derived from the Latin word for “ploughshare,” which best describes the shape of the vomer. The vomer has been used in the permanent correction of the deviated septum as a cartilaginous strut. It has also been used as a nasal-tip graft for projection. Its use as a source of bone graft for the maxilla has heretofore not been described in the literature.

Deviations of the midline structures from the median sagittal plane are commonly seen in complete, unilateral clefts of the lip and palate. Inherently, the septum provides the central nasal support structure, whereas the nasal sidewalls and lower lateral cartilages reinforce laterally. This tripod arrangement rests on the maxillary platform. With unilateral clefting of the maxilla, the hypoplastic base is shifted. This disturbs the structure asymmetrically, forming what is commonly referred to as Hogan’s tilted tripod. The lower lateral cartilage on the cleft side sprints out laterally, but seemingly remains without hypoplasia. In these patients, the cartilaginous nasal septum deviates toward the noncleft side, whereas the inferior bony septum veers in the direction of the cleft. This worsens with increasing severity of the deformity.

Recent magnetic resonance imaging studies demonstrated such cartilaginous septal deviation, ranging from 5 to 22 degrees. This was directly proportional to the cleft width. Bilateral clefts showed no such deviation. Evaluation of 30 unilateral complete clefts of the lip and palate demonstrated this same pattern in conjunction with a deviation of the maxillary nasal spine toward the noncleft side. This suggests that the cartilaginous nasal tip and septum develop directed by the articulating maxillary nasal spine and maxillary crest.

Prior studies compared posteroanterior cephalometric radiographs from patients with unilateral cleft lips and palates to those with incomplete clefts of the lip. The unilateral complete clefts of the lip and palate demonstrated a reduced maxillary height of the cleft segment. Also, a decreased width of the maxilla at the dentoalveolar level was noted. Furthermore, the anterior nasal spine curved toward the nonclear side to a degree, suggesting a vertical tilt of the premaxilla. Furthermore, large septal deviations can lead to sleep apnea after closure of the unilateral cleft lip. Successful management with such nasal airway obstruction using conservative septoplasty in young children has been reported. The patient discussed had significant bony and cartilaginous septal deviation. Ample membranous bone, in the form of vomer, was resected to move the cartilaginous septum more medially. This also provided an excellent source for much-needed bone graft. Peer postulated that membranous bone, such as the vomer,
provided better grafting material with less fibrous replacement than highly regenerative endochondral bones. This was supported with early animal studies in rabbits and primates. Further studies with onlay grafting by Hardesty and Marsh led to their hypothesis that membranous bone is superior because of its thicker cortical plates and relatively thin diploë versus the thick intercortical cancellous layer contained in endochondral bone. Accordingly, the membranous vomer should provide an equal, if not superior, source of bone graft for craniofacial surgery. Its use, when available, may obviate the morbidity associated with an additional donor site.

REFERENCES