Reconstruction of Orbital Floor Fractures With Maxillary Bone

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Objective: To evaluate the use of autogenous maxillary bone for the repair of orbital floor defects secondary to blunt facial trauma.

Design: Retrospective case series of 41 patients with a mean follow-up of 1.7 years.

Setting: Major metropolitan teaching hospital.

Patients: Forty-one consecutive patients who underwent repair of orbital floor fractures with maxillary antral wall bone grafts.

Main Outcome Measures: Presence of diplopia, orbital dystopia, implant extrusion, enophthalmos, infection, and donor site complications.

Results: On follow-up clinical examinations, none of the 41 patients presented with any evidence of orbital dystopia or complications relative to the implant or donor site. Two patients had persistent enophthalmos, and 4 had persistent infraorbital nerve paresthesia. Postoperative computed tomographic scans in 12 patients revealed an adequate maintenance of orbital volume without any evidence of resorption of the graft.

Conclusion: The use of maxillary antral wall bone for the repair of orbital floor fractures is a highly reliable technique that carries minimal morbidity.


The ideal management of orbital floor fractures has been highly controversial. Some fractures require only observation, while others require surgical reduction. The goal of surgery is 2-fold: to reposition the herniated orbital fat and tissue back into the orbit and to reconstruct the traumatic defect.1-3

Many implants, both autogenous and alloplastic, have been used to span the defect. Autogenous grafts include bone, cartilage, and fascia.4,5 Alloplastic implants can be divided into nonabsorbable types, such as those made of silicone, polytef, hydroxyapatite, tantalum mesh, or titanium, and absorbable types, including those made of polyglactin 910 or gel film. Whether an autogenous or an alloplastic implant is used, the ideal implant should be nonreactive, provide good structural support, be easily positioned, and be readily available.6

Most alloplastic implants in use today possess these qualities; however, reported incidences of early and delayed complications vary between 0.4% and 7%. Mauriello et al7 described 3 patients in whom proptosis and diplopia developed owing to cystlike encapsulation of polytef implants at 13, 16, and 20 years after surgery. Sewall et al8 reported a similar finding in a patient treated with a silicone graft 13 years earlier. Alloplastic complications, which are infrequent and are usually reported as isolated cases, include orbital infection, implant migration, dacryocystitis, hyperophthalmia, fistula formation, visual loss, and proptosis secondary to hemorrhage into the fibrous capsule. However, alloplastic implants are relatively inert and develop a fibrous capsule early (weeks to months), giving the surgeon a false sense of security.

Traditionally, autogenous bone has been the implant material of choice for the past 30 to 40 years for the reconstruction of orbital blowout fractures. Some investigators have advocated the use of iliac crest bone grafts, rib grafts, and tibial grafts.4,5 However, the added operative time required to harvest and mold the graft and the donor site morbidity may make these
PATIENTS AND METHODS

Forty-one patients who underwent repair of orbital floor fractures with maxillary antral bone grafts at our institution between 1977 and 1996 were included in this study. Hospital and clinic records were reviewed for patient characteristics, time between injury and surgery, concomitant facial injuries, and preoperative findings of diplopia, infraorbital nerve paresthesia, enophthalmos, and vertical dystopia.

Indications for surgical exploration of the orbital floor included enophthalmos, persistent diplopia, or vertical dystopia with radiographic evidence of herniation of orbital fat and a positive forced duction test result (Figure 1). Postoperative and long-term complications of diplopia, vertical dystopia, enophthalmos, implant extrusion or infection, and donor site complications were recorded. Postoperative follow-up information after hospital discharge was obtained from the senior surgeon’s office records, phone contact, and/or direct examination. All patients for inclusion in this study had a minimum of 1 year of follow-up.

All surgical procedures were performed by the senior surgeon (W.L.). All floor fractures were approached via a subciliary or transconjunctival incision. The periorbita was then incised, and the prolapsed orbital contents were elevated back into the orbit. Once the floor defect was assessed, either an ipsilateral or a contralateral maxillary antral wall bone graft was harvested via a gingivobuccal incision. An appropriately sized maxillary graft was outlined with the drill and subsequently harvested. At this juncture, the antrum was inspected and aided in the reduction of the fracture. A drill hole was then placed through the implant and the corresponding area of the inferior orbital rim to anchor the graft with a polygactin 910 (Vicryl) suture. A forced duction test was performed to ensure the mobility of the inferior extraocular muscles, and, finally, an inferior meatal antrostomy was performed for drainage of the maxillary antrum.

GRAFTS UNLIKELY CHOICES FOR ACUTE REPAIR. Alternative sites advocated as a source of autogenous bone include the mandibular symphysis, parietal cortex, and maxillary antral wall bone. Autogenous grafts have been criticized for their variable resorption, donor site morbidity, limited availability, and lack of malleability.

Zins and Whitaker demonstrated in a rabbit model that membranous bone grafts revascularized earlier than endochondral bone grafts. Thus, membranous bone grafts maintain their volume and lead to less resorption. One such membranous bone graft is the maxillary antral wall bone graft. We report our extensive experience with this reconstructive technique and critically evaluate the use of autogenous maxillary antral wall bone for the repair of orbital floor defects secondary to blunt facial trauma.

RESULTS

Fifty-four patients underwent repair of an orbital floor fracture with an ipsilateral or a contralateral maxillary antral wall bone graft between 1977 and 1996. Thirteen patients were eliminated from the study owing to inadequate follow-up. Of the 41 patients included in this study, 32 were male and 9 were female. The patients ranged in age from 17 to 84 years, with an average of 31.7 years. Time to repair of the fractures ranged from 5 to 10 days. There were a total of 26 pure blowout fractures and 15 patients with an associated zygomaticomaxillary or orbital rim fracture. The size of the defects ranged from 0.5 to 2 cm. Thirty-one patients underwent surgical repair via a subciliary approach, and 10 underwent repair via a transconjunctival incision. Follow-up ranged from 1 to 8 years. Twenty-two of the patients were available for a follow-up interview and physical examination, and 12 of the 22 patients consented to undergo a postoperative computed tomographic scan.

Forty-one patients with diplopia and 14 patients with vertical dystopia had complete resolution of their symptoms after surgery (Table). However, 4 of the 22 patients with infraorbital nerve paresthesia and 2 of the 10 patients with enophthalmos had persistence of their symptoms after surgery. It is of interest that those patients with persistent infraorbital nerve paresthesia and enophthalmos also had concomitant zygomaticomaxillary fractures.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Preoperative Incidence</th>
<th>Resolved</th>
<th>Persistent</th>
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<tbody>
<tr>
<td>Diplopia</td>
<td>41</td>
<td>41</td>
<td>0</td>
</tr>
<tr>
<td>Infraorbital nerve paresthesia</td>
<td>22</td>
<td>18</td>
<td>4*</td>
</tr>
<tr>
<td>Enophthalmos</td>
<td>10</td>
<td>8</td>
<td>2*</td>
</tr>
<tr>
<td>Vertical dystopia</td>
<td>14</td>
<td>14</td>
<td>0</td>
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*Combined fractures.

Figure 1. Coronal computed tomographic scan of a patient with a left orbital floor fracture.
There were no donor site complications with respect to cosmetic deformity, infection, or rhinosinusitis. Furthermore, there were no postoperative or long-term complications of extrusion, hemorrhage, or displacement of the implant. High-resolution computed tomographic scans were obtained in 12 cases. Coronal views revealed adequate integrity of the orbital floor without any evidence of resorption of the bone graft (Figure 2). Furthermore, axial views demonstrated new bone formation of the anterior wall of the maxillary sinus donor site (Figure 3).

**COMMENT**

In 1966, Kaye reintroduced the concept of using bone from the anterior wall of the maxillary antrum. Since then, this useful technique has had relatively little recognition in the literature. Rowe and Kiley described a somewhat different version: they used a remaining fragment of orbital floor to bridge a defect by rotating the fragment so that it rested on a stable base.

There are distinct advantages to using maxillary antral bone, as initially outlined by Kaye. The bone can be readily harvested because it lies in continuity with the orbital floor defect. This procedure obviates the need for a 2-team approach, which is often required for iliac or rib bone grafts, and thereby decreases operating time. Furthermore, in combined zygomaticomaxillary complex fractures, the need for 3-point fixation and exploration of the maxillary buttress necessitates an intraoral exposure; therefore, there is no additional morbidity when this donor approach is used.

There are no external incisions or scars with the intraoral approach of harvesting the graft. The additional exposure, via a gingivobuccal incision, can aid in visualization and reduction of the prolapsed orbital contents and allow the evacuation of blood and debris from the antrum. The postoperative pain and the potentially disastrous complications that can occur with harvesting of bone grafts from distant anatomic sites are also eliminated.

In our study, there was no evidence of resorption of the graft, as confirmed by the presence of the graft on computed tomographic scans in 12 cases. The cortical nature of the bone, with its associated increased resorption rate, seems more theoretical than practical. The use of similar membranous bone of equivalent thickness makes the antral wall bone graft ideally suited for reconstruction of the orbital floor. Certainly, osseous tissue from the maxilla is more biocompatible than most alloplastic implants in use today.

There are certain limitations to the use of this reconstructive technique, however. Although the antral wall bone graft is ideal for reconstructing an orbital floor defect in the acute setting, because of its insufficient thickness it is not the method of choice for correcting late enophthalmos. The quantity of maxillary bone is limited.
and lacks the bulk that can be provided by other autogenous bone donor sources. Its usefulness may also be limited in cases of severely comminuted fractures or defects larger than 2.5 cm, and in the unusual instance of a hypoplastic maxillary antrum. The uninvolved contralateral side, however, may still provide an excellent additional source of bone.

In our series of 41 patients, there were no complications with respect to the donor site or the implant itself. Persistent enophthalmos, measured as significant by Hertel exophthalmometry, occurred in 2 patients with combined zygomaticomaxillary complex and orbital floor fractures, the severity of which could have led to significant atrophy and loss of periorbital fat and tissues. In these 2 cases, the enophthalmos resolved after secondary reconstruction with cranial bone grafts.

The infraorbital nerve paresthesias did not resolve, however, and persisted in 2 other patients in the study as well. Minimal exploration of the infraorbital nerves at the time of bone graft harvesting revealed the nerves to be intact. Certainly, caution was exercised in harvesting the antral wall bone grafts so as not to cause any additional injury to the nerves. Any loose or sharp bone fragments were judiciously removed from the perimeter of the infraorbital foramen.

**CONCLUSIONS**

The anterior antral wall bone is the ideal implant material for the reconstruction of orbital floor defects in the severely injured patient. The bone is thin and membranous and possesses characteristics that are similar to those of the bone of the orbital floor. Because of its biocompatibility and lack of donor site morbidity, the use of an antral wall bone graft is a superior reconstructive option.

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**REFERENCES**