

Treatment of Orbital Fractures: The Case for Treatment With Resorbable Materials

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The discussion about the “ideal” implant for bridging of orbital floor fractures is perpetuated by the recent development of new biodegradable osteosynthesis materials. This commentary tries to sort things out into black and white instead of leaving them in shades of gray; I have tried to be as biased as possible, and therefore selective and incomplete in citing the literature, because I was asked to do so. However, instead of blinding the reader, I have decided to leave as many questions open as possible to show where the true problems in orbital floor fracture repair lie. Personally, I prefer the term “repair” when describing the procedure undertaken at trauma surgery. This helps me to distinguish it from the term “reconstruction,” which best describes the procedure at secondary, corrective surgery.

Repair of both the rim and deep orbit is the primary issue of surgery; the major sequelae of blowout fractures, enophthalmos, and diplopia, are to be prevented. Converse in 1944¹ and later in 1950² and 1957³ was the first to describe the surgical procedure of repair of the orbit by grafting of bone to the orbital floor. At that time, orbital enlargement was accurately suspected as the main cause of enophthalmos.⁴ Today, this is still true; however, other causes for enophthalmos have been described, such as atrophy of the intraconal orbital fat.^{5,6} Concerning diplopia, fracture size is not the most significant parameter; incarceration of any portion of the ligament or the muscle system produces tethering and restriction of the excursion of the globe and was identified as a major cause for diplopia by Koornneef.⁷

The best proof that orbital floor fractures are not an easy type of fracture comes from Folkestad and Westin.⁸ The authors found permanent postoperative se-

quelae in 83% of patients; “supportive” antral packing without grafting produced permanent diplopia in 36% of patients. A clear consequence of this is that no grafting at all is the worst type of surgical treatment for orbital floor fractures when support of the globe is needed. More recently, this was confirmed by Folkestad and Granstrom in 2003.⁹

There is general consent that the ideal orbital floor inlay material should be inexpensive, readily available in sufficient quantities, adaptable to the regional anatomy (ie, easy to contour and sharpen), easy to position, suitable for all types of defects, able to provide support to the orbital content, biocompatible, nontoxic, noncarcinogenic, free of any potential for disease transmission and other systemic effects, inert, or biodegradable to zero remnant. In the last case, it should disappear without complications such as infection or extrusion. Furthermore, it should be user-friendly so that even inexperienced surgeons can handle it.

In my world, there is no such thing. Is it that we need at least 2 or 3 materials at hand to choose from, depending on the extent of the orbital floor fracture? Let us review the clinical armamentarium: materials used to bridge orbital floor defects are grossly categorized as autologous, allogenic, and alloplastic.

Autologous materials are generally biodegradable and include septal cartilage,¹⁰ ear cartilage,¹¹ bone from the calvaria,^{12,13} the anterior or lateral maxillary antrum wall,¹⁴ mandibular symphysis,¹⁵ mandibular coronoid process,¹⁶ rib,¹⁷ and iliac crest,¹⁸ just to name the most prominent. In a study comparing parietal and iliac crest bone grafts for orbital reconstruction, Siddique and Mathog¹⁸ found no difference between the membranous and endochondral bone grafts. They raised the question of whether there was a possibility that fibrosis from the surgery rather than the graft stabilized the orbit and called for evaluation.

Untested Hypothesis Number 1

The quality of the supportive cicatrix is of critical importance for the initial healing process in respect to the development of complications such as enoph-

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thalmos or diplopia. The main short-term goal of trauma surgery is to obtain a stiff scar and to prevent sagging of the periorbita into the maxillary sinus after resorption of the implant. This should prevent the early development of enophthalmos. However, one must not forget that other causes for enophthalmos have been described, such as atrophy of the intracanal orbital fat. For correct analysis of findings, especially when comparing materials, further studies should try to separate this entity from orbital floor bulging as a cause of postoperative enophthalmos in cases of isolated orbital floor fractures.

Allogenic materials are also biodegradable and include lyophilized dura, lyophilized cartilage, and banked bone.

The reason why dura mater, first reported by Luhr in 1969,¹⁹ has always been an excellent material for orbital floor bridging of fractures of less than 2 cm in diameter was that dura mater is known to resorb and to allow the formation of a rigid scar. Postoperative microscopic evaluation of implanted dura mater has shown that the implants were gradually decomposed from the periphery to the center by macrophages and were replaced with collagenous connective tissue.²⁰ Unfortunately, the use of dura mater has been abandoned because of the general fear of transmitting Creutzfeldt-Jakob disease via the allogenic dura specimen to the patient.²¹ In general, the main concern with allogenic grafts is the risk of disease transmission.^{21,22}

Alloplastic materials are subdivided into biodegradable and nonbiodegradable materials. The most prominent brand names are Medpor (Porex Surgical Inc, College Park, GA), Silastic (Dow Corning, Auburn, MI), polytetrafluoroethylene, polyamide mesh, titanium mesh, vitallium mesh, Marlex (Phillips Chemical Company, Houston, TX), Gelfilm (Pharmacia & Upjohn Co, Kalamazoo, MI), hydroxyapatite block/cement, Vicryl mesh (Ethicon, Norderstedt, Germany), Lactosorb (Biomet Inc, Warsaw, IN), Biosorb (Linvatec, Tampere, Finland), Inion CPS (Inion, Tampere, Finland), Ethisorb (Ethicon), and PDS (Ethicon) implants. This list by no means is complete and may be prolonged ad infinitum. Unfortunately, nonmetallic, nonbiodegradable alloplastic materials are permanent foreign bodies and late complications such as infections or extrusion have been reported.²³⁻²⁵ As it is well described in the excellent review article by Chowdhury and Krause,²⁶ porous polyethylene sheets and methylmetacrylate are hazardous materials and should no longer be used, as is Silastic, which is associated with long-term infection and extrusion complications.

Recently, Jank et al²⁷ showed that in cases of orbital floor fracture diameter of less than 2 cm, there were no long-term differences between the 3 biodegrad-

able materials they tested (PDS, Ethisorb, and lyophilized dura-patches). Based on the results of their impressive study sample (n= 435 patients), they stated that "the results imply that there is no difference between these materials in the long-term follow-up, allowing the surgeon to use the material he or she prefers."

Based on the different types of fracture mechanism, Baumann et al²⁸ subdivided his study patients into 2 groups, blowout orbital floor fractures and orbital floor fractures associated with midface fracture, for correct analysis of findings. Furthermore, he subdivided orbital floor fractures by size (determined on computed tomography scans) into *small*, up to 1 cm²; *moderate*, 1 to 2.5 cm²; and *large*, 2.5 to 4 cm². Unfortunately, patients in the small and large group were few; nevertheless this exemplary setting ought to be copied by authors reporting on this subject. Baumann et al²⁸ found 2 of 25 patients with small and moderate orbital fractures to show an enophthalmos greater than 2 mm; these 2 patients with enophthalmos had concomitant midface fractures, and the reason for the development of enophthalmos in these patients may therefore have been more a failure in repair of the orbital skeleton than a failure of the orbital floor implant. Five of the 6 patients who received PDS implants for bridging of large defects had enophthalmos in the follow-up controls. Baumann et al²⁸ performed endoscopic follow-up examination in 12 of 31 patients at 8 to 12 months postoperatively; patients with large defects of the orbital floor showed marked bulging of orbital content into the maxillary sinus.

Obviously, the scar that formed after implant resorption had been too weak to provide adequate support of the globe. This supports the assumption that resorbable material, which loses mechanical stability early, is unfit for the bridging of large orbital floor defects because there is a significant risk of the development of an enophthalmos. This was also confirmed by Kontio et al,²⁹ who reported enophthalmos/hypophthalmos in almost 50% of patients after the use of PDS implants.

Dietz et al³⁰ published a randomized prospective multicenter trial, which compared perforated PDS foil and titanium mesh in bridging orbital floor fracture defects; maximum defects of the orbital floor were 13.3 mm in the PDS group and 13.9 mm in the titanium mesh group and therefore comparable in both groups. The conclusion drawn by Dietz et al was that PDS foil for reconstruction of the orbital floor is suitable in defects of up to 20 mm but for 2-wall defects of the orbit or multiple fractures of the zygomatic bone, materials like titanium mesh should be used.

Untested Hypothesis Number 2

Treating orbital floor defects of up to 2 cm in diameter probably can be done with any biodegradable material—and this includes autologous bone. The question remains of whether it is more advisable to use autografts or commercially available products; to answer, we need scientific comparison of materials by prospective randomized studies.

For one, autologous materials lack consistent thickness and quality. Anterior or lateral walls of the maxillary antrum, septal, and auricular cartilage may not provide sufficient material for large fractures. Second, autogenous bone grafts undergo a variable degree of resorption. Iliac crest and rib bone as well as split calvaria are associated with potential complications and, at least where I come from, definitely need informed consent, which is not always obtainable from trauma patients. The harvesting procedure itself prolongs operation time or calls for more staff at the operation, if the harvesting procedure is performed simultaneously with orbital floor exposure.

Generally speaking, there is a trend in our days that surgeons would rather like to have something off-the-shelf at hand for implantation and replacement of body substance than to harvest and graft an autologous tissue. This is true for dental implantology, orthopedic surgery, vascular surgery, neurosurgery, etc. Why should this not be true for maxillofacial surgery?

Untested Hypothesis Number 3

In large orbital floor defects, which extend more than 2 cm in diameter, there is insufficient information from the literature; this type of fracture often results in late postoperative enophthalmos, when resorbable materials are used, and this includes autologous bone. In these cases, it may well be that rigid nonresorbable alloplastic materials have a role in orbital floor fracture repair in some individuals. On the other hand, it may well be that alloplastic biodegradable materials including autologous bone create a rigid scar that sustains the orbital content and prevents the development of late enophthalmos.

Titanium, vitallium, or other metallic alloy meshes are known to allow tissue in-growth that may cause tethering of the globe and also makes them very difficult to remove.

Although Sargent and Fulkes^{34,35} described a series of more than 400 orbital reconstructions with titanium and appraised its successful use, it is disturbing to see surgeons permanently obstructing the natural, anatomically given path of least resistance. Because trauma patients are mostly of younger age, it may well be expected that they will have second trauma in

their lifetime and, at least to date, no one has answered the question of what would happen to the orbital content in that instance.

In his retrospective study, Ellis and Tan³⁶ used computed tomography scans to assess whether titanium mesh reconstruction of the orbital floors would be architecturally more accurate for orbital floor fracture than cranial bone grafts. He found that “many of the bone grafts were too thick: decreasing orbital volume compared with the uninjured side. Because of the difficulty in contouring the grafts, several were rated as being placed too high in the anterior region of the orbit, because the medial and lateral edges made contact but the middle of the graft was elevated above the level where the floor should have been reconstructed.”

It may well be that titanium is the best material we have for the repair of large orbital floor fractures. I deeply regret that reports on slowly degrading alloplastic materials, which may well become a substitute for titanium one day, to date have very small patient series and are still in the learning curve.^{37,38} If these materials are capable of inducing a mechanically stable scar, then a true alternative to metallic implants may have been found.

What if we finish the ongoing discussion between the supporters of autogenous bone grafts and those of alloplastic biomaterials by observing a moment of “radio silence” until prospective randomized studies with direct long-term comparison of these 2 materials have been presented?

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