Internal Orbital Wall Fracture Repair Using Porous Polyethylene/ Titanium Mesh (MEDPOR TITAN) Implants

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Introduction:

The complex nature of bony orbital fractures and their impact upon orbital soft tissue structure and visual function presents a particular challenge to the orbital surgeon. The tenants of surgical management of symptomatic orbital fractures involve open reduction of the fracture, release of the entrapped tissues, repositioning of the herniated orbital soft tissue within the orbit, and repair of the post-traumatic defect with an orbital implant as needed. The orbital implant restores the structural integrity of the orbital wall by bridging the defect and preventing orbital contents from herniating into the adjacent periorbital sinuses. The implant should prevent extra-ocular motility limitations by minimizing scar tissue adhesion with orbital contents. These implants can also serve to augment the orbital volume by compressing the intraorbital contents to correct enophthalmos.[1] Current implants include autogenous grafts, human donor grafts, xenografts and alloplastic implants. The ideal alloplastic implant has been described as readily sizeable, sterilizable, strong, inert, non-allergenic, durable, non-carcinogenic, easily manipulated and shaped, and suitable for single stage reconstruction.[2] Implants should be accepted and well integrated into the surrounding tissues with minimal inflammatory response, foreign body reaction, or risk of infection. The implant should provide mechanical support strong enough to hold up the orbital contents, and have the ability to be easily anchored to the surrounding bone to prevent migration and extrusion. Finally, it should be readily available in larger quantities if necessary, at a reasonable cost.

Porous polyethylene orbital sheets offer strength and stability, with porous channels that allow fibrovascular ingrowth. The implants exhibit memory upon bending, which must be considered during placement in the orbit.[3] Fenestrated and mesh titanium implants also allow excellent strength and stability characteristics without memory after the material has been conformed to fit the orbital contours and defect. However, removal of the implant can prove to be a difficult task once tissue ingrowth has occurred.[4] Scarring to the exposed metallic mesh with dysmotility is an additional reported complication.[5]

Recently, a porous polyethylene sheet with titanium mesh has been available for use in non-weight bearing applications as seen with internal orbital fractures (MEDPOR TITAN Implants, Stryker CMF). We evaluated the utility of this material in large floor and combined floor/ medial wall fractures. (Figs. 1 - 2)

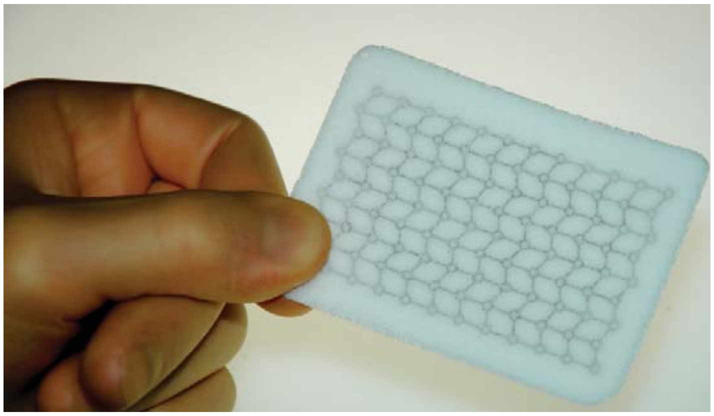

Fig. 1. MEDPOR TITAN orbital implant with porous polyethylene coated titanium

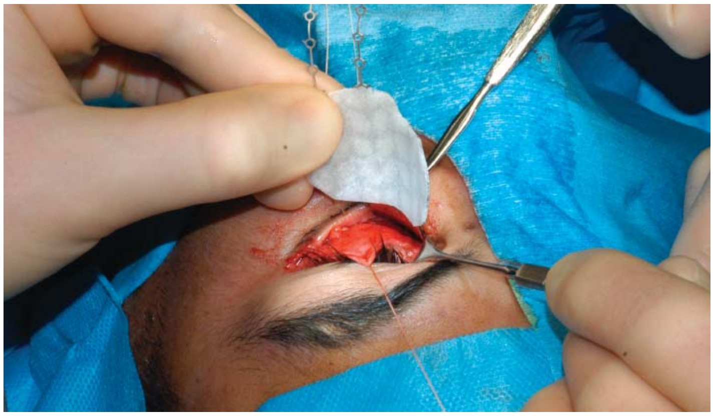

Fig. 3. Intraoperative TITAN plate cut and pre-bent to cover an orbital floor and medial wall defect

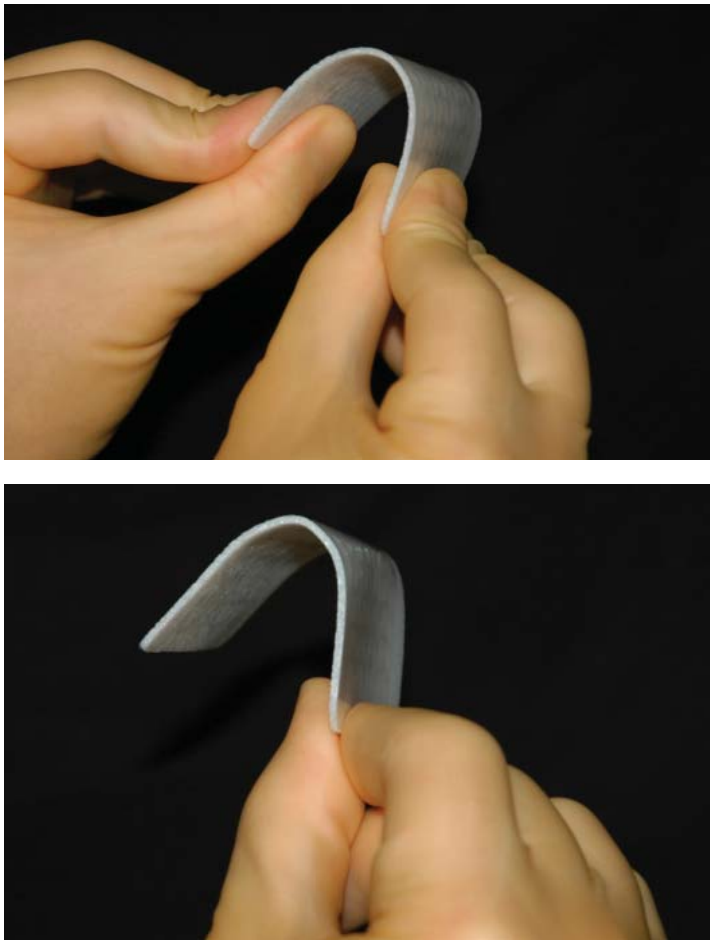

Fig. 2. MEDPOR TITAN orbital implant bent to demonstrate lack of implant "memory"

Materials/Methods:

Fourteen patients with extensive orbital floor (8 patients) fractures (with minimal posterior support) and combined orbital floor and medial wall (6 patients) fractures underwent surgical repair between 9/04 and 4/05. Each patient had the orbital fracture reduced using the TITAN orbital implant (Stryker CMF. Kalamazoo, MI). The patients were followed postoperatively for a minimum of six months. In addition to clinical evaluation of ocular position (globe dystopia, enophthalmos), ocular function was evaluated at each visit.

In all cases, the implant was placed through a swinging eyelid transconjunctival approach with or without a transcaruncular incision. (Fig. 3) In each patient, a single-sided barrier facing the orbital soft tissue was used to avoid potential scar adhesions to the implant. The plates were fixated in position using screw fixation to the orbital rim. The patients were examined preoperatively at (at least) one day, one week, and one, three and six months postoperatively. In each case, a postoperative computed tomogram was obtained to verify implant position (as the titanium mesh was easily visible) (Figs. 4 - 7).

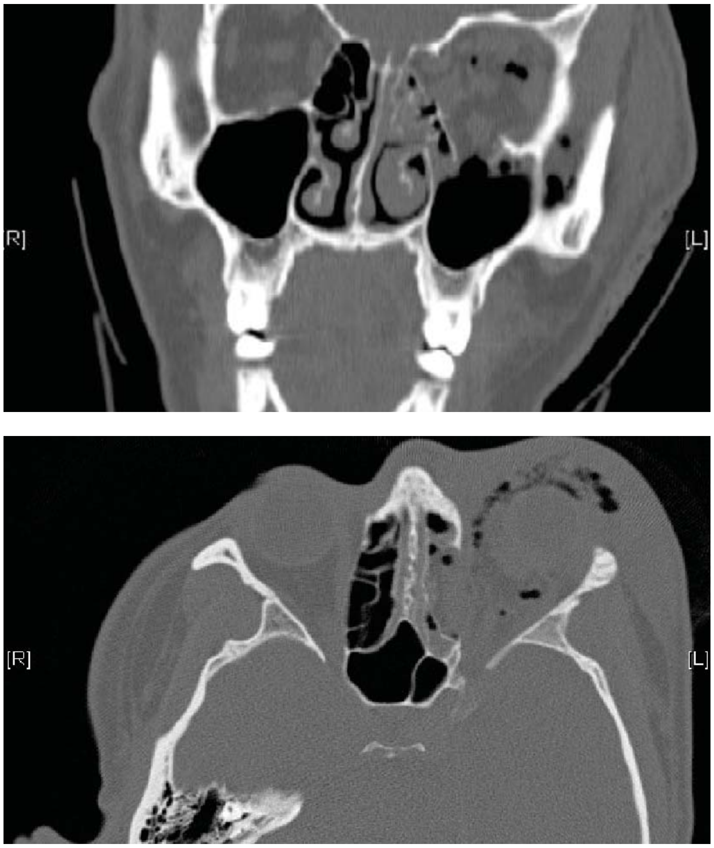

Fig. 4. Preoperative coronal and axial computed tomography views of patient (Case 7) with a combined medial orbital wall and floor fracture affecting the left orbit.

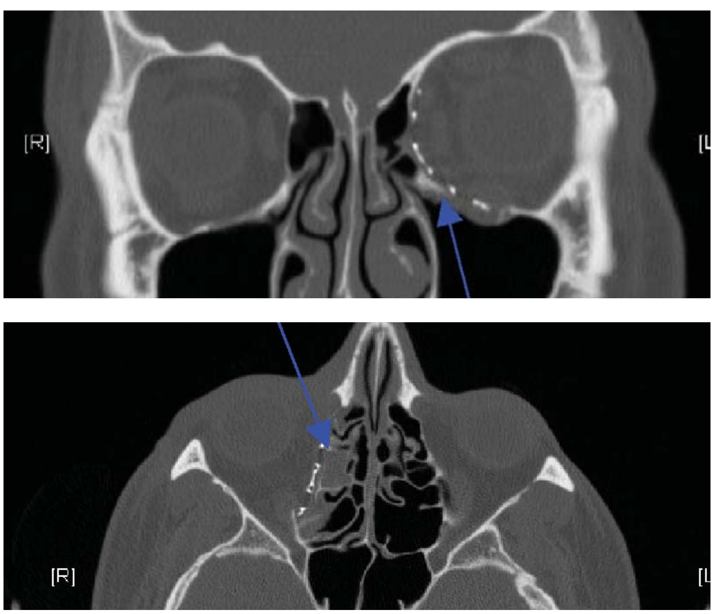

Fig. 5. Coronal and axial views of computed tomogram (Case 7) demonstrating TITAN placement in medial wall and orbital floor fracture repair (arrows).

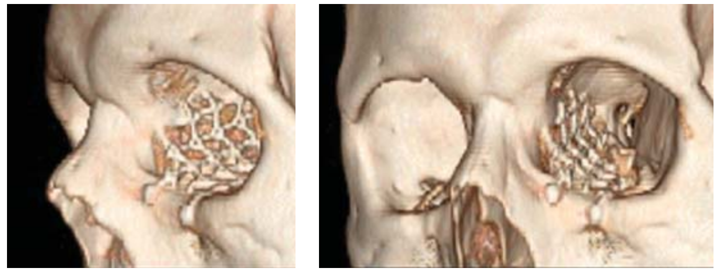

Fig. 6. 3-D computed tomogram demonstrating TITAN implant position (Case 7) after a combined medial wall and floor fracture repair.

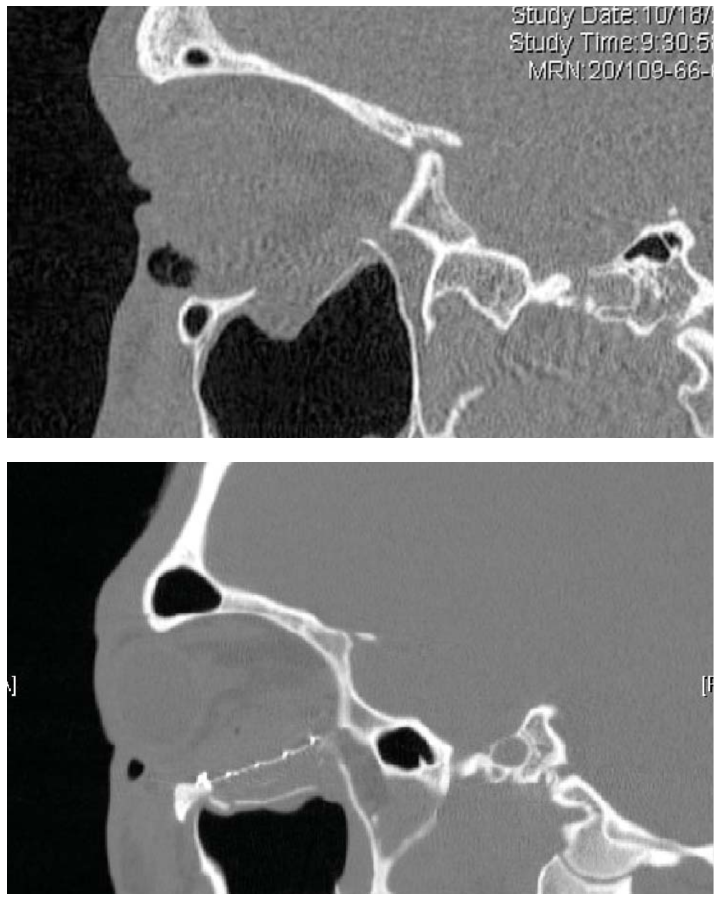

Fig. 7. Sagittal postoperative view (Case 2) of combined orbital floor and medial wall fracture demonstrating adequate posterior placement of TITAN implant (bottom image).

Results:

Intraoperatively, the porous polyethylene covering of the titanium mesh allowed smoother edges of the titanium mesh after cutting facilitating implant placement.

Additionally, the implant was bent to conform to the contours of the intact bony ledges surrounding the fracture site. The titanium mesh minimized the memory of the bent implant, facilitating placement.

Postoperatively, none of the implants required removal or repositioning. Postoperative computed tomography verified implant placement in all cases. In one patient (Case 7), verification of correct implant position was useful to avoid a return to the operating room in a patient with unimproved postoperative dysmotility. In this case, the lack of improvement was related to inferior rectus trauma (and hematoma), and has slowly improved over the six months postoperatively. In one patient (Case 4), 1.0mm of hyperglobus was noted postoperatively, which was not concerning to the patient, and she refused additional surgery. This patient received a 1.5mm thick implant.

Conclusions:

Porous polyethylene covered titanium mesh results in increased implant strength and decreased memory. These characteristics offer distinct advantages over traditional alloplastic implants in the management of internal orbital fractures. The increased strength of the implant from the titanium mesh allows a thinner implant (it is available in thicknesses ranging from 0.85-1.6mm) that avoids the abaxial displacement that may be seen with thicker implants such as the channeled porous polyethylene implant (thickness 2.3mm). The lack of memory associated with bending porous polyethylene sheets allows greater implant stability using the TITAN implants. Care must be taken to correctly conform to the orbital defect, as "overbending" the implant may result in soft tissue incarceration. Immobilization of the implant using screw or suture fixation also provides increased implant stability. The implant is available with an impermeable barrier surface on one (MTB) or both (BTB) sides, and also without a barrier surface (MTM). The orbital barrier surface may also inhibit adhesions from orbital soft tissue to the surface of the implant, while the posterior surface facing the sinus mucosa may vascularize offering additional implant stability. Additionally, the titanium mesh allows postoperative imaging to verify implant placement, which may be critical in those situations where adequate postoperative soft tissue release needs to be demonstrated.

Isolated single orbital wall fractures with adequate intact bony ledges for implant coverage may be easily and successfully repaired with most currently available implant materials available at reduced costs. However, the TITAN orbital implant sheets provide a distinct advantage in large single wall fractures, multiple internal wall fractures (orbital floor and medial wall) or those floor fractures with inadequate posterior support requiring an implant with greater strength.

Table 1. Cases of TITAN use. M-male; F-female; MVA-motor vehicle accident; IED-improvised explosive device; MTB-MEDPOR/titanium/barrier; BTB-barrier/titanium/barrier; MTM- MEDPOR/titanium/MEDPOR

Case	Age	Gender	Mechanism of injury	Diagnosis	Additional injuries	Implant	Date of Surgery	Compli-cations	Follow-up (mo's)
1	34	M	Sport injury	Large floor fracture	None	1.0mm MTB	10/04	None	12
2	27	M	MVA	Large floor fracture	Facial lacerations	1.0mm MTB	10/04	None	12
3	37	M	Assault	Posterior Floor Fracture	None	1.0mm MTB	11/04	None	11
4	36	F	Assault	Orbital floor/ medial wall fracture	None	1.6mm MTB	11/04	1.0mm hyperglobus	11
5	27	M	IED	Orbital floor/ medial wall fracture	Traumatic optic neuropathy	1.0mm MTB	12/04	None	10
6	42	M	MVA	Posterior floor Fracture	None	1.0mm MTB	1/05	None	9
7	25	M	Assault	Orbital floor/ medial fracture	Facial lacerations	1.0mm MTB	1/05	None	9
8	36	M	Sports injury	Orbital floor/ medial wall fracture	None	1.0mm MTB	1/05	None	9
9	75	F	Fall	Large floor fracture	None	1.0mm MTB	2/ 05	None	8
10	23	M	IED	Orbital floor/ medial wall fracture	Orbital foreign bodies	1.0mm MTB	2/05	None	7
11	24	M	MVA	Posterior floor fracture	Lid laceration	1.0mm MTB	3/05	None	7
12	26	M	MVA	Orbital floor/ medial wall fracture	Facial lacerations	1.0mm MTB	4/05	None	6
13	23	M	Assault	Large floor fracture	None	1.0mm MTB	4/05	None	6
14	38	M	MVA	Large floor fracture	Facial laceration	1.0mm MTB	4/05	None	6

References:

1. Costantino PD, Hiltzik DH, Friedman CD, et al. Alloplastic plating techniques in orbital fracture repair (Chapter 20). In Holck, Ng Eds.: Evaluation and Treatment of Orbital Fractures, a Multidisciplinary Approach. 2005, Philadelphia, Saunders-Elsevier.

2. Nguyen PN, Sullivan P. Advances in the management of orbital fractures. Clin Plast Surg. 1992;19(1):87.

3. Choi JC, Fleming JC, Aitken PA, Shore JW. Porous polyethylene channel implants: a modified porous polyethylene sheet implant designed for repairs of large and complex orbital wall fractures. Ophthal Plast Reconstr Surg. 1999 Jan;15(1):56-66.

4. Sugar AW, Kuriakose M, Walshaw ND. Titanium mesh in orbital wall reconstruction. Int J Oral Maxillofac Surg. 1992; 21: 140-144.

5. De Sutter E, Dhooghe P, Baert C. Marlex mesh in the reconstruction of blow-out fractures of the orbit. Bull Soc Belge Ophtalmol. 1988; 228: 47.

U.S. Patent #7,655,047. Literature Number: 9410-400-202 Rev. None