Research Article

Reconstruction of orbital floor fracture using porous polyethylene mesh

Bhatnagar S[1], Khare P[2]

[1]Dr Shweta Bhatnagar, Assistant Professor, Department of Dentistry, [2]Dr Praveen Khare, Assistant Professor, Department of Opthalmology. Both affiliated with Bundelkhand Medical College Sagar,Madhya Pradesh, India

Address for correspondance: Dr. Shweta Bhatnagar, Email: shwetakeshav@gmail.com

....

Introduction: Treatment of traumatic orbital injury has long been a formidable challenge to maxillofacial and oculoplastic surgeon. Significant complication can occur as a result of these injuries including enopthalmus, persistent diplopia, vertical dystopia and restriction of gaze. Surgical techniques have been more aggressive with primary surgical repair directed at restoring bony orbital volume and contour while repositioning the herniated tissues. The study was undertaken to assess the treatment results with alloplastic graft for reconstruction of orbital floor. **Material and methods:** It is a prospective randomized study during the period of January 2010 to December 2012 including the follow up of six months on ten orbital floor fractures. **Results:** Eyeball movement restriction and infraorbital nerve paresthesia improved in all patients. One patient who also had associated head injury and the fracture of supraorbital rim, frontal and temporal bone had persistent enopthalmus, vertical dystopia and diplopia postoperatively. **Conclusion:** We conclude that early exploration of orbital floor minimizes the morbity associated with late reconstruction due to the fibrosis of tissues entrapped. Use of prolene mesh reduces the operating time and donor site morbidity.

Key words: Blow out fracture, Orbital floor fracture, Nonresorbable implant, Porous polyethylene membrane

....

Introduction

Blowout fracture is defined as an outwardly fracture of any of the orbital wall resulting in increase in orbital volume, most commonly involving orbital floor. Orbital floor fractures are common squeal to blunt trauma to periocular region. Such fractures can result in herniation of tissue in to the maxillary sinus and the increase in orbital volume can cause enopthalmus. Muscle entrapment with the restriction of ocular movement, dystopia and diplopia also may result[1, 2]. In these cases with signs and symptoms or evidence of floor Fracture in CT-Scan surgical intervention is necessary to avoid further complications.

The management has been highly controversial with regard to the indication, timing, surgical technique, access and reconstruction material used. The ideal materials used to reconstruct the floor should provide Structural support, Easily cut, shaped , Easily polished and anchored, Possess good biointegration, Nonreactive, Noncarcinogenic, Should not migrate or extrude [2].

In our study we have treated patients with orbital floor fracture with porous polyethylene[3]. We followed the patients for a period of six months. The patients showed reduction in both diplopia and enopthalmus. The purpose of our study was to evaluate the treatment results with use of porous polyethylene (prolene mesh-nonresorbable alloplast) for orbital floor reconstruction

Manuscript received: 24th Dec 2013
Reviewed: 29th Dec 2013
Author Corrected: 15th Jan 2014
Accepted for Publication: 30th Jan 2014

Material and Methods

It is a prospective randomized study during the period of January 2010 to December 2012 including the follow up of six months. Ten patients with orbital floor fracture are included in this study. All of them had impure orbital blow out fracture associated with other facial bone fractures. There were 7 males and 3 females with age range in 25-50 yrs. The causative factor for fracture was road traffic accident in 8 patients, interpersonal violence in 1 patient and cracker burst injury in one patient

Preoperative evaluation of patients include the following

1. Visual acuity
2. Evaluation of diplopia
3. Detection of any damage to infraorbital nerve with consequent paresthesia, through subjective evaluation of the patient.
4. Radiographs in water's projection.
5. CT Scans
6. Ophthalmologic evaluation

The decision to explore orbital floor was based on following condition

1. Diplopia
2. Enopthalmus
3. Limitation of ocular motility
4. Herniation of orbital contents through the defect in the orbital floor seen in radiograph and CT scan.
5. Positive forced duction test

All patients were treated with in two weeks of injury

Surgical technique

The orbit was approached through an infraorbital approach. Local infiltration with 2% lidocaine with 1:100,000 epinephrine was done.

The skin incision was made at the inferior orbital wall in a natural skin fold. The skin dissected from the orbicularis oculi for a few millimeters before splitting the muscle fibers down to the orbital wall, and the periosteum is incised for access to the rim and floor. The incised periosteum elevated and subperiosteal dissection extended posteriorly along the orbital floor. The degree of orbital tissue herniation and the size of the orbital floor defect were then measured. Prolene mesh was used for reconstruction. In patients with associated fracture of the infraorbital rim, F-Z suture region, the fracture was reduced at F-Z region and then at infraorbital region and fixed with mini plates. Prolene mesh was cut and tailored according to the defect size.

Reduction of the orbital contents herniated into the maxillary sinus was performed; prolene mesh was placed to completely cover the margins of defect and was sutured to periosteum using 4-0 vicryl. A forced duction test was then performed to ensure mobility of the ocular musculature. The wounds were closed in layers with 4-0 vicryl interrupted suture for periosteum and 5-0 prolene for skin.

All patients received postoperative antibiotics and analgesics for 5-7 days. A short course of corticosteroids (3-4 days) was also added. The success of the surgical repair and postoperative status were Evaluated at 1 week, 1 month, 3 months, and 6 months.

The follow-up examination consisted of a patient interview, visual inspection and palpation of the former operative site and checking of infraorbital nerve function. In addition diplopia, restricted eye mobility and position of globe are also reviewed.

Results

This study included the randomly selected 10 patients (male- 7, female-3) with confirmed orbital floor fracture who presented during the period of January 2010 to December 2012.

Table No 1: Etiology of Orbital fracture

S No	cause	Number of patients
1.	Road traffic accident	08
2.	Interpersonal violence	01
3.	Cracker burst injury	01

Table No 2: Distribution of Orbital fracture

S No	cause	Number of patients
1.	Panfacial fracture	03
2.	Orbitozygomatic fracture	06
3.	Pure orbital fracture	01

The results were evaluated based on patient interview, visual inspection and palpation of the former operative site and checking of infraorbital nerve function. In addition diplopia, restricted eye mobility and position of globe are also reviewed.

Eyeball movement restriction and infraorbital nerve paresthesia improved in all patients. One patient who also had associated head injury and the fracture of supraorbital rim, frontal and temporal bone had persistent enopthalmus, vertical dystopia and diplopia postoperatively. However, drooping of upper eyelid resolved over a period of six months. The edema at operating site persisted beyond two months for one patient indicating inflammatory response to prolene mesh necessitating the removal of graft owing to the cosmetic disfigurement. However, there was no extrusion of the graft. On surgical exploration, there was a good fibro vascular tissue in growth from adjacent orbital tissue in to the porous polyethylene sheet.

Table 3: Assessment of study parameters pre and post –operative- Prolene mesh

Study parameters		Pre-operative		Post-operative		P value
		No	%	No	%	
Diplopia	Present	10	100.0	1	10.0	0.0014**
	Absent	0	0.0	9	90.0	
Enopthalmus	Present	10	100.0	1	10.0	0.0014**
	Absent	0	0.0	9	90.0	
ION paresthesis	Present	10	100.0	0	0.0	<0.001**
	Absent	0	0.0	10	100.0	
EBM restriction	Present	10	100.0	0	0.0	<0.001**
	Absent	0	0.0	10	100.0	

Inferior alveolar nerve paresthesia and eyeball movement restriction resolved in all patients during six months post op follow up. However, diplopia and enopthalmus persisted in one patient.

Significant figures

+ Suggestive significance $0.05<P<0.10$, * Moderately significant $0.01<P \leq 0.05$, ** Strongly significant $P\leq 0.01$

Statistical software: The Statistical software namely SPSS 15.0, Stata 8.0, MedCalc 9.0.1 and Systat 11.0 were used for the analysis of the data

Discussion

The scientific discussion regarding the treatment of orbital floor blowout fractures concerns indications, timing, and above all modalities of the intervention.

In our therapeutic protocol, the indications for orbital floor repair include clinically evident orbital dystopia, limited extrinsic ocular motility, persistent diplopia, fatty-muscular orbital entrapment or prolapse in to the fracture as evident on CT- Scan which is similar to protocol used by Pedro V. Florencio M., Antonio M. et al[3]

The purpose of surgical treatment for orbital blowout fracture is to reconstruct the orbital wall to its original anatomical position and consequently to restore the shape and volume of the orbital cavity.

There is a controversy about the timing of surgical repairs for blowout fractures. Smith and Regan[4] advocated surgical repair of any blowout fracture within 7 to 10 days. On the other hand, Putterman[5] recommended delaying surgery for at least 4 to 6 months. According to Micheal A. Burnstine[6] a 2-week window of observation has been suggested in the absence of immediate surgical indications for orbital floor fracture repair. However, the surgeon must keep in mind that fibrosis in the orbit begins soon after trauma and progresses over several months, usually making late repair unsatisfactory. In agreement with this fact we have reconstructed orbital floor as soon as possible along with other facial fractures, if there was a CT- evidence of floor fracture.

Before the advent of advanced diagnostic aids like CT-SCAN the surgery was usually delayed till the oedema subsides and the clinical features become evident. At present, if there is CT evidence of blow-out fracture the immediate repair can be undertaken to minimize the fibrosis of herniated contents. In two cases surgical repair was delayed for couple of days because of associated head injury.

A large no. of material has been suggested in literature for reconstruction of orbital floor. They can be broadly categorized in to autografts, allografts and alloplasts.

Autologous material	**Allogenic material**	**Alloplastic materials**	
Bone	Irradiated bone	Nonresorbable	Resorbable
Cartilage	Bovine bone	Titanium	Polylactic/polyglycolic acid copolymer
Fascia lata	Lyophilized dura	Silastic	Polydioxanone
	Lyophilized cartilage	Bioactive glass	
	Fascia lata	Porous polyethylene	
		Teflon	

Auto grafts- Autologous grafts include bone, cartilage, facia lata.

Bone

Bone grafts are usually taken from calvarial bone, maxillary bone, maxillary anterior wall, mandibular symphysis, coronoid process of mandible, rib, anterior iliac crest, and posterior iliac crest [7, 8, 9].

The bone is shaped and fixed in to the defect using miniplates or titanium mesh. The advantage of autologous bone is strength, rigidity and vascularization potential which leads to less infection rates as compared to alloplastic material.

The complications while harvesting calvarial bone are - dural tears, subarchanoid haemorrhage and intracranial haematomas. There is also a remote possibility of hemiparesis following intracranial bleeds [10, 11].

Although the bone is still considered the definitive standard in materials for orbital reconstruction by many experienced craniofacial surgeons, perhaps it is not the ideal material because of its donor-site morbidity, increased operating time, variable resorption, and difficulty in contouring the bone to fit complex defects of the internal orbital skeleton[3].

Cartilage

Nasal septum cartilage, ear cartilage and nasal cartilage are used. The advantage of using cartilage is it is easy to harvest, shape and provide adequate strength and support [12, 13].

However, a very small size can be harvested and thus can be used only for very small defects.

In few cases tensor facia lata has also been demonstrated with good results[14].

Allogenic material - Allogenic materials include irradiated bone, bovine bone, lyophilized cartilage and lyophilized dura.

Bovine bone:

Marx, Hurbli, Smida conducted a study on 20 operated patients and they did not encounter any intolerance, inflammation or infection. They concluded the follow-up is still too short to appreciate the long term integration of this material which has the advantage of being a substitute for autologous bone, avoiding bone graft harvesting[15]

Demineralized bone:

Demineralized bone implants heal by endochondral osteogenesis, inducing a transformation of local cells, as well as by osteoconduction, similar to autogenous grafts. They induce the chemotaxis and transformation of mesenchymal cells into chondroblasts, followed by ossification. They also act as a scaffold, with bone resorption taking place simultaneous with bone formation. Neigel and Ruzicka[16] did retrospective analysis of 31 traumatized orbits with demineralized bone and reported no graft-related complications.

Chowdhury K, Krause GF reported high resorption rate with autologous implants[8]. There is also the possibility of disease transmission, such as HIV and the hepatitis C virus; Creutzfekdt-Jakob disease has been reported in cadaveric dura transplantation[17, 18].

Alloplasts - A lot of alloplastic materials have been documented in literature. They eliminate donor site morbidity, decrease operative time and are readily available. The list of alloplastic materials is long and requires further subdivision into nonresorbable and resorbable materials. Nonresorbable materials are titanium, vitallium, porous polyethylene mesh, sialistic sheets, bioactive glass and Resorbable are Polylactic/ polyglycolic acid copolymer, Polydioxanone, Polyglactin 910 polydioxanone. The advantage of using resorbable material is that they provide sufficient supports and resorbs once there requirement is complete. However they are costly and can be used for only smaller defects[19].

Titanium

It is a rigid, yet malleable material, which undergoes osseointegration it is ideal for the reconstruction of large defects requiring structural rigidity and strength. Gear et al used titanium for reconstruction of orbital floor in 55 patients with 67 orbital fractures underwent orbital reconstruction with titanium mesh over a 5-year period. Associated fractures were reduced anatomically and fixed rigidly. For the analysis, 44 patients with 56 orbital fractures had adequate follow-up (mean, 44 months). An abscess developed in one patient who received high-dose steroids for 72 hours before reconstruction. She was treated with broad-spectrum intravenous antibiotics and bedside incision and drainage, and did not require removal of the titanium mesh. No patient in the current series required removal of the titanium mesh. A single case of uncorrected enophthalmos was treated with bone grafting rather than mesh revision. They concluded that large orbital defects can be reconstructed using titanium mesh with good functional results and minimal risk for infection[20].

Silicone

The use of silastic implants and silicone sheets has been extensively documented in the literature. The positive attributes of this material include low cost, flexibility and ease of handling, while providing adequate support in maintaining orbital contents in large orbital floor fractures. A series by Laxenaire ET al[21] on 137 patients reported significant complication rates, where 13.8% of the patients required removal of the implant. Silicone sheets seem to be more prone to the production of a fibrous capsule around the implant, quite similar to that which occurs with breast implants. Due to the orbit's proximity to the mucosa of the maxillary and ethmoid sinuses, the formation of a capsule is a significant risk factor in the development of fistulas, sinus tracts, cysts and infections[22].

Porous polyethylene sheets

Orbital floor reconstruction remains one of the most common applications of porous polyethylene sheets. The orbital floor can be rebuilt using thin (1.5-mm) or ultrathin (0.85-mm) sheets, with good success in the long run and in a diversity of circumstances[3]. Fibrovascular tissue growth from adjacent orbital tissue into spherical porous polyethylene orbital implants is well established and has been demonstrated using several techniques (histopathologic findings, technetium isotope scanning, computed tomography, and magnetic resonance imaging) [3, 7, 8]. Vascularization usually occurs from the periphery of the implant toward the center of the sphere and aids integration of the implant into host tissues.

This is believed to reduce infection, extrusion, and exposure of the implant. Autogenous calvarial bone grafts do integrate but have variable resorption and involve a second surgical site. In one of our cases where we removed the prolene mesh because of prolonged inflammatory response, on reopening the graft site there was a good fibrovascular ingrowth of surrounding orbital tissue in to the porous polyethylene sheet. Tissue ingrowth in alloplastic implants offers two basic advantages: (1) positional biologic stabilization, which prevents migration or extrusion, making fixation with screws or sutures unnecessary; and (2) resistance to infection once the implants are completely vascularized[3, 24]. Porous polyethylene is a highly biocompatible, durable, and remarkably stable alloplast. Technically, it is easy to work, strong yet somewhat flexible, and offers the possibility of obtaining a precise three-dimensional shape[3]

Haug and et al. evaluated the ability of 13 common materials to resist loads under circumstances that resemble internal orbital reconstruction. They found that porous polyethylene exceeded the requirements to support the weight of the combined internal orbital contents, even in the event of additional or repeated orbital trauma subsequent to the reconstruction[23, 25].

A short course of intraoperative and postoperative intravenous corticosteroids (1 to 2 days) would have a beneficial effect by minimizing the inflammatory response to foreign materials (porous polyethylene) that occurs in the immediate postoperative period[1]. This practice would prevent orbital edema while preserving the optic nerve and preventing eye muscle impairment. In our opinion, this short course does not increase the risk of infection and has no long-term adverse effects. Porous polyethylene implants in repair of orbital wall fracture had good results with few complications[26, 27, 28].

Resorbable materials

Polylactic/polyglycolic acid copolymer, Polydioxanone sheets have been used to reconstruct the orbital floor. Alloplastic, resorbable PDS sheets in most cases were a valuable material for the reconstruction of the orbital floor (medial orbital wall). Mechanical properties of PDS seem to be not sufficient for the reconstruction of extremely large bony defects[29, 30].

Conclusion

We conclude that early exploration of orbital floor minimizes the morbity associated with late reconstruction due to the fibrosis of tissues entrapped. Use of prolene mesh reduces the operating time and donor site morbity.

Funding: Nil
Conflict of interest: Nil
Permission from IRB: Yes

References

1. Chang E.W., Manolidi S. Orbital Floor Fracture Management. Facial Plastic Surgery2005, 21(3) 207-213

2. Potter JK, Ellis E. Biomaterials for reconstruction of the internal orbit. J Oral Maxillofac Surg. 2004 Oct; 62(10):1280-97

3. Villarreal PM, Monje F, Morillo AJ, Junquera LM, González C, Barbón JJ. Porous polyethylene implants in orbital floor reconstruction. Plast Reconstr Surg. 2002 Mar; 109(3):877-85

4. Smith B, Regan WF. Blowout fracture of the orbit; mechanism and correction of internal orbital fracture. Am j opthalmol 1957; 44(6):733-739

5. Putterman AM, Stevens T, Urist MJ. Nonsurgical management of blow out fracture of the orbital floor. Am j opthalmol 1974; 77(2):232-239

6. Burnstine MA. Indications and timing for repair of isolated orbital floor fractures: an evidence-based analysis, Ophthalmology. 2002; 109(7): 1207-1213.

7. Courtney DJ, Thomas S, Whitfield PH. Isolated orbital blowout fractures: Survey and review. Br J Oral Maxillofac Surg. 2000; 38:496–503.

8. Chowdhury K, Krause GF. Selection of materials for orbital floor reconstruction. Arch Otolaryngol Head Neck Surg. 1998; 124:1398–401.

9. Kakibuchi M, Fukuda K, Yamada N, et al. A simple method for harvesting a thin iliac bone graft for reconstruction of the orbital wall. Plast Reconstr Surg. 2003; 111:961–2

10. Young VL, Schuster RH, Harris LW. Intracerebral hematoma complicating split calvarial bone-graft harvesting. Plast Reconstr Surg. 1990; 86:763–5

11. Kline RM, Jr, Wolfe SA. Complications associated with the harvesting of cranial bone grafts. Plast Reconstr Surg. 1995; 95:5–20.

12. Kraus M, Gatot A, Fliss D. Repair of traumatic inferior orbital wall defects with nasoseptal cartilage.J Oral Maxillofac Surg. 2001; 59:1397–401.

13. Constantian MB. Use of auricular cartilage in orbital floor reconstruction. Plast Reconstr Surg.1982; 69:951–5.

14. Dost P. [Orbital floor reconstruction with autologous periosteum transplant] Laryngorhinootologie.1996; 75: 57–8

15. Morax S, Hurbli T, Smida R. Bovine heterologous bone graft in orbital surgery. Ann Chir Plast Esthet. 1993; 38(4):445–50.

16. Neigel JM, Ruzicka PO. Use of demineralised bone implants in orbital and craniofacial reconstruction and a review of the literature. Ophthal Plast Reconstr Surg. 1996; 12(2):108–20.

17. Campbell DG, Li P. Sterilization of HIV with irradiation: Relevance to infected bone allografts. Aust N Z J Surg. 1999; 69(7):517–21.

18. Nakumura Y, Aso E, Yanagawa H. Relative risk of Creutzfeldt-Jakob disease with cadaveric dura transplantation in Japan. Neurology. 1999; 53(1):218–20

19. Hollier LH, Rogers N, Berzin E, Stal S. Resorbable mesh in the treatment of orbital floor fractures. J Craniofac Surg. 2001; 12(3):242–6.

20. Gear AJ, Lokeh A, Aldridge JH, Migliori MR, Benjamin CI, and Schubert W. Safety of titanium mesh for orbital reconstruction. Ann Plast Surg. 2002; 48(1): 1–9.

21. Laxenaire A, Levy J, Blanchard P, Lerondeau JC, Tesnier F, Scheffer P. Complications of silastic implants used in orbital repair. Rev Stomatol Chir Maxillofac. 1997; 98(1):96–9

22. Mok D, Lessard L, Cordoba C, Harris PG, and Nikolis A.A review of materials currently used in orbital floor reconstruction Can J Plast Surg.2004;12(3):134–140

23. Groth M.J. , Bhatnagar A, Clearihue W. Long-term Efficacy of Biomodeled Polymethyl Methacrylate Implants for Orbitofacial Defect. Arch Facial Plast Surg. 2006; 8(6):381-389

24. Yilmaz M, Vayvada H, Aydýn E, Menderes A, Atabey A . Repair of fractures of the orbital floor with porouspolyethylene implants. British j of oral maxillofacial surgery2007; 45(8):640-644

25. Haug RH, Nuveen E, Bredbenner T. An evaluation of the support provided by common internal orbital reconstruction materials. J Oral Maxillofac Surg. 1999; 57(5):564-70

26. Lin IC, Liao SL, Lin LL. Porous Polyethylene implants in orbital floor reconstruction. J Formos Med Assoc, 2007; 106(1):51-57

27. Wang S, Xiao J, Lui L, Long J, Zheng X, Tian W. Orbital floor fracture: A retrospective study of 21 cases. Oral surg oral med oral pathol oral radioi endod 2008;106(3):324-330

28. Jaquiery C, Aeppli C, Cornelius P, Palmowsky A, Kunz C, Hammer B. Reconstruction of orbital wall defects: critical review of 72 patients. International journal of oral and maxillofacial surgery. 2007; 36(3): 193-199

29. Kos M, Brusco D, Engelke W. Results of treatment of orbital fractures with polydioxanone sheet]. Polim Med. 2006; 36(4):31-6.

30. Tuncer S, Yavuzer R, Kandal S, Demir YH, Ozmen S, Latifoglu O, Atabay KJ. Reconstruction of traumatic orbital floor fractures with resorbable mesh plate.Craniofac Surg. 2007 May;18(3):598-605.

....

How to cite this article?

Bhatnagar S, Khare P. Reconstruction of orbital floor fracture using porous polyethylene mesh. *Int J Med Res Rev* 2014;2(1):26-32, 10.17511/ijmrr.2014.i01.06

………