Options in orbital floor reconstruction in blowout fractures: a review of ten cases

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Abstract

Objective The purpose of this case series was to assess the aesthetic and functional outcome of orbital floor reconstruction performed with calvarial bone graft, titanium mesh or prolene mesh.

Methods Ten cases of orbital blowout fractures treated at our centre from October 2006 to July 2008 were considered for this study. Clinical examination, patient satisfaction and radiographic investigations were used to assess repaired fractures.

Results Prolene mesh was used in four cases, titanium mesh was used in four cases and calvarial graft used in two cases. Nine patients had significant improvement in their esthetic appearance. Symmetry was restored in all cases. All ten cases had a noticeable improvement in the function. Of total ten cases six had diplopia, three recovered completely during the six months after the surgery. Three cases showed improvement later. All ten cases with enophthalmos recovered completely. Of the nine patients with infraorbital numbness, all recovered completely during the six months following surgery. One patient where the reconstruction was done with calvarial bone graft showed mild discrepancy in the ocular level.

Conclusion For small, linear defects measuring less than 2cm with enophthalmos and restricted ocular movements, prolene mesh (four cases) was used. For larger defects and impure blowout fractures involving the infraorbital rim, calvarial graft (two cases) or titanium mesh (four cases) was used. The outcome of surgery with all three materials was satisfactory. No postoperative complications were seen except for mild hypoglobus in a case reconstructed with calvarial graft. All three materials, calvarial graft, titanium mesh, prolene mesh, have the potential to be useful reconstructive materials in orbital floor blowout fractures.

Keywords Orbital blowout fractures · Bone graft · Alloplastic material · Reconstruction of floor

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Introduction

The orbit's close proximity to the nose, paranasal sinuses, nervous system along with its important role in support and function of the eye as well as facial aesthetics makes it a vital anatomical structure. A variety of injuries ranging from subtle orbital floor blowout to gross comminution may result in disruption of this anatomically complex region of the middle third of the face. With inadequate treatment, permanent orbital deformity, incapacitating visual dysfunction and

unsatisfactory esthetics may handicap an individual functionally, esthetically and socially [1].

Orbital floor fracture results in a disruption of bony continuity permitting bone fragments, orbital contents and torn periosteum to herniate (Fig. 1) beyond the original bony orbit [2,3] leading to enophthalmos, dystopia infraorbital paresthesia and hypoglobus. Soft tissue incarceration or entrapment may also occur, causing restricted ocular movements [4]. Of these, entrapment, diplopia and hypoglobus with or without enophthalmos

have traditionally been considered to be indications for surgical intervention [4].

With Computed Tomography (CT) scanning permitting better visualization of location and extent of orbital floor defects and associated soft tissue prolapsed [3,5] surgical techniques to free entrapped tissue, reposition herniated orbital tissues and restore original orbital volume have become increasingly more aggressive as it is recognized that a failure to do so will predispose to atrophy and cicatricial contracture of herniated and incarcerated intraorbital soft tissues.

Numerous materials - both naturally occurring and synthetic substances - are available for reconstructing damaged orbital walls to restore orbital volume. The ideal material is that whose biomechanical properties most closely replicate those of the tissue it replaces. There is little consensus as regards the choice of material which has been, and remains, controversial with many workers enumerating the relative advantages and disadvantages of each class of material. Autogenous materials remain the gold standard to which other materials are compared yet alloplasts have gained popularity for orbital wall reconstruction for their ease of use and elimination of the need for a second operation and its associated morbidity [5].

In our study, the functional and esthetic outcomes of ten patients were evaluated to present our experience with autogenous bone grafts (calvarial bone graft) and alloplastic materials (prolene and titanium) for orbital floor reconstruction. We have also attempted to compare autogenous and alloplastic materials for orbital floor reconstruction.

Materials and methods

This study was conducted at the Department of Oral and Maxillofacial Surgery, Manipal College of Dental Sciences, Mangalore. Patients who reported to our centre from October 2006 to July 2008 with orbital injuries were considered for inclusion in this study.

Inclusion criteria

- A clinical diagnosis of orbital floor fracture.
- CT and radiograph imaging showing orbital floor defects, specifically, a loss of bony integrity of the orbital floor and displacement of soft tissue into the maxillary sinus resulting in 'tear drop' appearance (seen in a Water's view of the skull).

Exclusion criteria

Patients suffering from uncontrolled diabetes, rheumatoid arthritis, metabolic bone disease, immunocompromised status and previous facial trauma were excluded from this study.

History was recorded and nature and severity of injury assessed with a thorough search made for:

Fig. 1 Coronal CT slice showing herniation

Fig. 3 Postoperative view of stable calvarial graft

Fig. 5 Prolene mesh placement at orbital floor

Fig. 7 Posttreatment correction of floor defect

- Restricted ocular movement
- Alteration of ocular level (dystopia)
- Enophthalmos – after seven to ten days
- Deepening of supratarsal fold
- Narrowing of palpebral fissure
- Development of diplopia – especially upward gaze
- On palpation, step deformity at infraorbital margin

Fig. 2 Calvarial graft positioned at orbital floor

Fig. 4 Titanium mesh fixed with screws

Fig. 6 Enophthalmos and hypoglobus present preoperatively

- Paresthesia in the distribution of infraorbital nerve

Ten patients who fulfilled the inclusion criteria were selected for this study. After routine work-up, all patients underwent imaging examination which included radiographs (paranasal sinus view) and/or CT scan with Osteo-Meatal Complex (OMC) and coronal cuts to detect and measure defects of the orbital floor.

All the patients were operated under general anesthesia and were given antibiotics and 8 mg of dexamethasone intravenously one hour prior to surgery. Open reduction and orbital floor reconstruction was performed in all cases using miniplates to reconstruct the vertical and horizontal bony buttresses of the face thereby restoring the normal height, width and projection of the midface. Infraorbital approach was used to obtain surgical access to the orbital floor.

Three materials were considered for the reconstruction of defects in the orbital floor: calvarial bone graft in two cases, titanium mesh in four cases and prolene mesh in four cases. A bicoronal flap was elevated in the subgaleal plane and the graft harvested from the outer table of the parietal bone. This was shaped, contoured and stabilized at the orbital floor defect with 0.35mm wire. Prolene and titanium mesh were fixed at the defect with stainless steel screws and titanium screws respectively.

Pupillary reflexes were monitored postoperatively and the fundus was examined periodically. Patients were discharged after suture removal and recalled for review after one, three, and six month intervals.

Results

Ten patients (8 males, 2 females) of ages ranging from 7 to 45 years were included in this study. The fractures were recent (less than 4-weeks-old) in 9 cases and old (more than 4 weeks) in one case. In addition to orbital floor blowout fracture, in 5 cases there was associated zygomaticomaxillary complex fracture and in 2 other patients, frontal bone fracture was also present. Diplopia was noted in six cases, limitation of ocular movements as well as enophthalmos in all ten cases and infraorbital numbness in nine cases.

All 10 patients enrolled in the study consented to participate; there were no dropouts. After orbital floor reconstruction to restore volume of the orbital cavity and continuity of the orbital floor, CT scans and clinical examination were used to evaluate patients on follow-up visits. Nine patients had significant improvement in esthetic appearance. Injured and uninjured sides had acceptable symmetry. One case of calvarial bone graft reconstruction had mild discrepancy in ocular level possibly since graft size was not enough as compared to extent of the defect. However ocular movements and vision were normal and no noticeable enophthalmos was present.

All ten cases had a noticeable improvement in function. Three of six cases with diplopia recovered completely within six months of surgery. The other three improved later. All ten cases with enophthalmos recovered completely and normal ocular movements were restored. All nine patients with infraorbital numbness recovered completely during the six months following surgery.

Two patients underwent orbital floor reconstruction with calvarial bone graft where outer cortex was harvested from the parietal bone without intraoperative complications or postoperative complications. Prolene mesh could not be checked radiologically because it is not radiopaque enough to be visualized in CT or radiographs. Although none of the patients revealed any abnormality or relevant findings radiologically, clinically one case with calvarial graft had mild, residual hypoglobus.

Complications such as infection, extrusion, implant migration, recurrent haemorrhage and residual diplopia did not occur in our study cases and all patients were satisfied with the results of their surgery.

Discussion

In the reconstruction of orbital floor, timing is vital to restore lost globe support and to normalize orbital volume to prevent a functional and cosmetic defect. Delayed surgery permits cicatricial contracture of herniated or incarcerated intraorbital contents [5]. If diplopia is caused by the inferior rectus or the inferior oblique muscles being caught in the fracture, urgent surgery is required to free them within three weeks or these delicate muscles will atrophy since timely reduction of orbital soft tissue limits the degree of ischemia caused by entrapment.

Of ten patients, nine were operated upon for reconstruction of the orbital floor within two weeks from the day of the trauma. Only one patient was operated upon after three weeks because of frontal bone fracture with subdural hematoma and surgery was attempted only after neurosurgical clearance.

The indications for surgical exploration of the fractured orbital floor include (1) enophthalmos, (2) limitation of extraocular muscle function, (3) a large orbital floor defect with herniation of soft tissue into the maxillary sinus on CT (4) step deformity along the infraorbital margin with parasthesia of the infraorbital nerve causing numbness [6]. Our selection of choice material for orbital floor reconstruction was based on the above mentioned indications and additional patient-related factors: one patient refused alloplasts and underwent grafting. Patients who considered the comorbidity of graft harvest unacceptable were randomized to either of two groups: titanium mesh or prolene mesh in consideration of the size of defect.

Jason K. Potter reviewed the biomaterials that were available for orbital floor reconstruction to provide insight into their selection and application [5]. Because of the diversity of problems that may present in orbital reconstruction and limitations of each material, currently no single material is ideal. Rigid materials are best suited for reconstruction of large defects to prevent sagging and displacement into the maxillary antrum.

Ilankovan V and Jackson IT conducted a study with 222 patients. 279 calvarial bone grafts were placed for orbital reconstruction. From this study it is seen that orbital reconstruction can be performed using calvarial bone to obtain satisfactory aesthetic and functional results. This can be accomplished with minimal donor site morbidity. Compared with the rib and ilium, calvarial bone has slight advantages [7]. In our experience, cortical bone from the calvarium (Fig. 2) satisfies the requirement of rigidity. Its curvature is useful for floor reconstruction but rigidity makes contouring nearly impossible. Verification by a postoperative CT scan (Fig. 3) is possible to look for resorption subsequently.

Titanium mesh has good biocompatibility and is easily adjustable. It is easy to trim and mould exactly to the orbital contour. Because of the mesh structure, connective tissue can grow around and through the implant, preventing its migration. It can be reliably fixed with screws (Fig. 4) in areas such as the infraorbital border. Titanium mesh has good physical strength in thin sections and it produces less artifacts on CT scans than other metals. It can be sterilized in conventional autoclaves. However, the mesh structure makes removal difficult. Ingrowth of fibrous connective tissue through mesh pores has been documented in atleast one recent study [8].

Literature is aplenty with several studies where titanium has been compared with various other materials. Edward Ellis III performed a study to assess the adequacy of internal orbital reconstruction in pure blowout fractures using either cranial bone grafts or titanium mesh implants and concluded that orbits reconstructed with titanium mesh showed better overall reconstructions than those reconstructed with bone grafts [9]. However, subsequent orbital trauma may displace titanium mesh toward the orbital apex endangering the optic nerve [5]. Hence, the resorbability of calvarial bone graft may be considered to be a potential advantage [10].

In our study four patients underwent orbital floor reconstruction with titanium mesh. Preoperatively all the four patients showed signs of enophthalmos and restriction of eye movements. Postoperatively, the orbital volume of all the four patients was restored with resolution of enophthalmos. Normal eye movements were restored. None of the patient showed signs of infection nor extrusion of the implant. The mesh was stable on CT evaluation without any dislodgement.

The advantages of alloplastic materials like polyethylene, polypropylene include good biocompatibility, mild rejection reactions, and easy contouring. Autogenous tissue can grow into the porous material, biologically integrating the material with the soft tissues and orbital floor. Advantages include decreased operative time, reduced pain, avoidance of donor site complications, and the ability to adjust the volume of filling as needed, particularly in cases of enophthalmos. Non-resorbable alloplastic implants are permanent foreign bodies and reports of late complications such as infection, extrusion, implant migration and residual diplopia are plentiful in the literature [11]. However, it is salutary to note that such complications are not predictable as a recent study of 26 orbital floor fractures reconstructed with porous polyethylene demonstrated no extrusion even though mesh was not fixed to bone with screws [12].

Prolene mesh was used to chosen to reconstruct the orbital floor in four of our patients. This material is strong yet flexible (Fig. 5) and easy to contour and shape using scissors or a scalpel, and it can be contoured into the desired shape. This material was selected because the defect in the floor of the orbit was small, linear and without gross comminution. Postoperatively, the defect was reconstructed, and the orbital volume was effectively restored. But the main disadvantage for reconstruction of the internal orbit with porous prolene mesh is that it is not radiopaque so its position cannot be easily visualized on immediate postoperative scans.

Goals of orbital floor fracture repair are to free incarcerated or prolapsed orbital tissue from the fracture defect and to span the defect with an implant to restore the correct anatomy of the orbital floor and the pretrauma orbital volume. These goals may be achieved by interposing an autologous graft or alloplastic material between the residual orbital floor and the soft tissues prolapsed into the maxillary sinus, suitably repositioned inside the orbit. Our

experience with ten patients in orbital floor reconstruction with three types of reconstruction materials (calvarial bone graft, titanium mesh, and prolene mesh) has been encouraging and the results obtained were equal across the 3 groups.

Conclusion

No consensus exists on the choice of implants for orbital floor reconstruction and several materials are available. The ideal material for the reconstruction of the orbital skeleton is influenced by many factors including specific characteristics of the injury, cost, patient choice and experience and opinion of the surgeon. For small linear defects measuring less than 2cm with enophthalmos (Fig. 6) and limitation in ocular movements due to entrapment of the extraocular muscles, prolene mesh (four cases) was used. For larger defects and impure blowout fractures involving the infraorbital rim, with gross comminution of the orbital floor and herniation of the orbital contents into the maxillary antrum, calvarial graft (two cases) or titanium mesh (four cases) was used. Indeed, autogenous biological tissue appears to be well-accepted by the body as a graft [13]. When the results were assessed postoperatively, all three materials were found to be satisfactory (Fig. 7). No postoperative complications were seen except for mild hypoglobus in a case reconstructed with calvarial graft.

We conclude with the opinion that calvarial graft, titanium mesh and prolene mesh appear to have equal potential to offer stable reconstruction of the fractured orbital floor. However, the criteria for choice of implant material for reconstructive material is empirical in even recent literature [14] and therefore, there is now a real need for multicentric, randomized controlled trials using a large sample size as well as meta-analysis of such trials to derive definite opinions regarding the most appropriate materials for reconstruction of orbital blowout fractures which would pave the way for definitive protocols to guide the maxillofacial surgeon in decision-making.

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