Use of Demineralized Bone Sheets in Reconstruction of Orbital Floor Trap Door Fracture

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Abstract: In this study medical history and computed tomography (CT) scans of 12 patients with pure orbital floor trap door fracture were recorded. The age range was 13-30 years. They were all from the out patients of the Research Institute of Ophthalmology, Cairo – Egypt. All patients were investigated and recorded. Among the cases 10 patients were recently traumatized and suffering from soft tissue (inferior rectus muscle) entrapment and only 2 patients were delayed and suffering from fibrous tissue ingrowths at the fracture site. Limitation of ocular motility was graded on a numerical scale of 0 to -4, with 0 representing no limitation and -4 representing no movement in the field of gaze. Surgery was determined mainly on the basis of clinical evidence of muscle entrapment and CT confirmation of trapdoor fracture. Surgical repair was performed through transconjunctival incision under general anesthesia. After dissecting in the preseptal plane to the inferior orbital rim and elevating the periosteum off the floor, the entrapped tissue was gently freed from fracture site. In delayed cases with fibrous tissue formation, dissection and removal of the fibrous tissue was done. Forced duction test was repeated at this point to confirm if tissue entrapment was released completely. Demineralized bone sheet was damped in normal saline for ten minutes and formed to be adapted and positioned to the fracture site. Postoperatively the patients were treated with systemic antibiotics and anti-inflammatory drugs for 1 week. Postoperative follow up, with clinical examination, after one and two weeks, then after one, two and three months was done, then CT. Coronal scan three months postoperative. Results: Clinical examination of the patients after one week revealed mild edema and periorbital ecchymosis of the eye lids, slight subconjunctival hemorrhage. Full range motility with slight restriction in upward gaze of the eye was encountered and slight diplopia remains in all patients. Two weeks later clinical examination revealed resolution of edema, ecchymosis and the subconjunctival hemorrhage. Diplopia was relieved in the first ten patients, who were immediately presented to the hospital and operated as soon as possible, however, it remains only in the two delayed cases. One month later diplopia was relieved in all patients and there was no other complication throughout the follow up period. Radiographic examination using CT coronal scan revealed intact orbital floor without any herniation in all cases). Conclusions: Early surgical repair within 7 days or 14 days of injury resulted in more rapid improvement of ocular motility and diplopia. Meticulous freeing of the entrapped tissue, taking care of the infraorbital neurovascular bundle, positioning appropriate implant material as Demineralized human bone sheets and shortening the operation time could prevent any complication and relieves motility restriction and diplopia. This form of the material is very thin to reconstruct the thickness of the orbital floor when enophthalmos exists and weak to support the ocular tissue when the gap exceeds one mm.

Key words: Orbital Floor trap door fracture, transconjunctival incision, diplopia, CT coronal scan.

INTRODUCTION

Trauma to the orbital region can result in facial deformity with affection of vision, eye movement, and the sensory and motor innervations of the face. Rehabilitation of the patient requires an understanding of the alteration in form and function of the orbit, including the intra-orbital and intraocular tissues, and the different materials available for repair[9]. The indications for surgery in orbital floor

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Fractures are controversial. Strong indications include enophthalmos greater than 2mm, significant hypoglobus, diplopia, herniation of orbital tissue, and entrapment of the extraocular muscles (inferior rectus muscle) or their fascia into a fracture gap in the orbital floor causing motility limitation\(^2\). De Man and coworkers have suggested that young patients with severely restricted eyeball motility, an unequivocally positive forced duction test, and CT findings indicating a blow-out fracture of the orbital floor should undergo operation as soon as possible after injury, whereas a wait and see policy, keeping the patient under observation, seems to be appropriate for blow-out fractures in adults\(^3\).

Several materials are available for reconstruction of orbital floor, and there is no consensus about which is preferable; however, there is consensus that the ideal material should be biocompatible, and strong enough to support the orbital content\(^4\). Autogenous bone were among the first materials used, calvarial, iliac crest, mandible, maxilla and rib have been used\(^5,7,9,10,11\). Currently, calvarial bone seems to be the best choice for orbital reconstruction\(^12,13\). Many other materials used as cartilage, dermis, dura mater, fascia – autogenous, allogenic and xenogenic grafts\(^14,15,16,17\). Alloplasts were also used either in resorbable form\(^18\) as biodegradable polymers and nonresorbable form as titanium, silicon, hydroxyapatite and bioactive glass\(^19,20,21\). All these materials have advantages and disadvantages\(^22,23,24\). Demineralized bone matrix (DBM), a form of allograft, possesses the properties of osteoinductivity and osteoconductivity. A large body of data obtained from extensive preclinical studies has clearly supported the utility of DBM in human clinical settings. However, it is now recognized that various DBM configurations may differ considerably with regard to their bone inductive activity\(^25\). Demineralized bone sheet was used to bridge a large circumferential osteoperiosteal gap in the diaphysis of the ulna of rabbits, the animals revealed bone formation and complete bridging of the gap. The new bone was laid on the surface and in the substance of the matrix, suggesting that the inductive principle was acting locally. Demineralized bone-matrix proved to be a highly osteoinductive and readily osteoconductive material. The graft did not evoke any appreciable local foreign-body or immunogenic reaction. The high degree of success in bridging massive bone defects justifies further serious studies and hopes for a useful substitute for massive autologous bone grafts\(^26,27\). The aim of our study was to evaluate the role of Demineralized bone sheets, as a reconstructive material, for orbital floor trap door fracture.

**MATERIALS AND METHOD**

Medical history and computed tomography (CT) scans for 12 patients with pure orbital floor trap door fracture were recorded (Fig.3). Patients age range was 13-30 years (Table 1). They were all from the out patients of the Research Institute of Ophthalmology, Cairo – Egypt.

The cause of injury, clinical signs and symptoms, radiologic finding, associated ocular injury and the time interval between injury and presentation to the institute was recorded. Among the 12 cases, 10 patients were recently traumatized (since 2-3 days) (Fig.1) and only 2 patients were old cases (since 6 and 12 months) (Fig 7). The main complain of all cases was restriction in the ocular motility, mainly the upward gaze and diplopia with absence of any other sign and symptoms. Limitation of ocular motility was graded on a numerical scale of 0 to -4, with 0 representing no limitation and -4 representing no movement in the field of gaze\(^28\). Severe limitation of ocular motility was defined as -3 or -4.

![Fig. 1: Preoperative photo showing motility restriction of the left eye](image)

![Fig. 2: Forced duction test during the operation.](image)

When patients were admitted to the hospital, surgery was scheduled as soon as possible (within 3-4 days). Surgery was determined mainly on the basis of clinical evidence of muscle entrapment and CT confirmation of trapdoor fracture. Surgical repair was performed under general anesthesia; forced duction test was performed at fist before the incision. Then transconjunctival incision was performed, followed by dissection in the preseptal plane to the inferior orbital rim and elevating the periosteum of the floor. The

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Fig. 3: Preoperative CT. Coronal cut showing muscle entrapment in the orbital floor fracture line.

Fig. 4: Postoperative CT. of the same case sagittal view

Fig. 5: Postoperative CT. of the same case coronal cut. Entrapped tissue was gently freed from fracture site in the recently traumatized cases. While in the delayed cases fibrous tissue formation was prominent at the trap door fracture site in comparison to the recently traumatized cases, dissection and removal of the fibrous tissue was done. Forced duction test was repeated at this point to confirm the release of tissue entrapment and fibrous union. (Fig.2). Demineralized bone sheet (Pacific Cost Tissue Bank. size 15X 40mm. Thickness 100-300 micron)* was damped in normal saline for

Fig. 6: Postoperative photo showing free movement in the upward gaze.

Fig. 7: Preoperative photo showing motility restriction of the right eye in the upward gaze.

Fig. 8: Postoperative photo showing free movement of the right eye.
ten minutes and formed to be adapted and positioned to the fracture site without any fixation, only the eye content rest over the bone sheet helps in its fixation. Then the wound was closed and the patients were treated with systemic antibiotics and anti-inflammatory drugs for 1 week postoperatively.

Postoperative follow up, for one and two weeks, then at one, two and three months postoperatively. Using the clinical evaluation of upward eye movement according to the previously mentioned scale.

Three months postoperative. CT. Scan (Coronal cut) for all cases was done.

Results:

One Week Postoperatively: Clinical examination of the patients revealed mild edema and periorbital ecchymosis of the eye lids, slight subconjunctival hemorrhage.

Full range motility with slight restriction in upward gaze of the eye was encountered and slight diplopia remains in all patients.

Two Weeks Postoperatively: Clinical examination revealed resolution of edema, ecchymosis and the subconjunctival hemorrhage. Diplopia and eye movement restriction was relieved in the first ten patients who were immediately presented to the hospital and operated as soon as possible; however, it remains only in the two delayed cases.

One Month Postoperatively: Diplopia and limitation in eye movement was relieved in all patients and there was not any other complication throughout the follow up period.

Radiographic Examination Using CT Scan: Coronal cut revealed intact orbital floor without any herniation in all cases (Fig.4, 5, 9)

Discussion: Before puberty trapdoor fracture is predominant, and risk of muscle or soft tissue entrapment is higher. It is postulated that at this age, a large area of the orbital floor consists of immature bone that overlies a small maxillary sinus. Because of this greater elasticity of the orbital bone, when it is subjected to force, it is more likely to bend and break in a linear pattern along the obliquely situated infraorbital canal resulting in trapdoor type fracture. The antromedial floor then goes inferiorly to the posterozolateral floor. As the orbital rim moves back into its natural position, the prolapsed orbital tissue is caught and trapped in the fracture site. The most common symptom associated with trapdoor fracture is restriction of ocular motility, supraduction limitation is more severe in patients with trapdoor fractures than in those without trapdoor fractures. Nausea and vomiting are other important symptoms. Nausea and vomiting coupled with severe restriction of ocular motility suggests the increased possibility of the trapdoor fracture in pediatric patients, and are promptly relieved after surgery. Indications for surgery are clinical evidence of muscle entrapment and CT confirmation. However, if there is no clinical evidence of muscle entrapment, existence of the trapdoor fracture is not an indication for surgery. In this study, ten patients, who presented immediately to the hospital and had trapdoor fracture with soft tissue and muscle entrapment with severe gaze limitation, undergo surgical intervention as soon as possible. In those patients, gaze limitation and diplopia was resolved early than in the other two patients who presented 6-12 months after trauma, as fibrous tissue ingrowths at the fracture site appeared to be the main reason for the gaze limitation. This delay could be attributed to the time in which the long term entrapped muscle needs for rehabilitation after being free.

In trapdoor fracture, entrapment of muscle or soft tissue induces not only limitation of ocular motility but also ischemia of the extraocular muscle by impaired blood supply and results in subsequent loss of muscle function and permanent gaze restriction, therefore, earlier surgical intervention should be considered.

Demineralized human bone (DHB) sheets, were selected for covering the trapdoor fracture as it is biocompatible, resorbable sheets that is available in sufficient quantities. It was also proved that DHB in all its forms are an osteoinductive and osteoconductive material in agreement with Drosos, GL et al. and Tuli SM et al. Moreover, they provide a source of type I collagen which is the sole organic component of bone in agreement with Hoexter DL. In addition to that the demineralization process may expose a particular protein bone morphogenic protein (BMP), which is known for its osteoinductive properties.
as it was proved by Schwartz Z. et al. It accelerates bone formation at the site of the trapdoor fracture, prevents any fibrous tissue ingrowths through the orbital floor from the underlying structures and interferes with any adhesions that may restrict the eye movement during healing.

Conclusions:
- Early surgical repair within 7 days or 14 days of injury resulted in more rapid improvement of ocular motility and diplopia.
- Meticulous freeing of the entrapped tissue, taking care of the infraorbital neurovascular bundle, positioning appropriate implant material as Demineralized human bone sheets and shortening the operation time could prevent any complication and relieves motility restriction and diplopia.
- This form of the material is very thin to reconstruct the thickness of the orbital floor when enophthalmos exists and weak to support the ocular tissue when the gap exceeds one mm.

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REFERENCES


