

Autologous Bone Graft Versus Titanium Mesh in Management of Large Post-Traumatic Orbital Floor Defects

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ABSTRACT

Introduction: The goal of an orbital floor implant is basically to renovate the traumatic defect, lifting the globe into its right position and thereby avoiding enophthalmos. Finding the ideal material for orbital floor reconstruction is not an easy job. Countless implants are available today on the market to treat orbital floor fractures.

Aim of the Work: The aim of this study is to compare the results of using autologous bone grafts with those of using titanium mesh in reconstruction of large post traumatic orbital floor defects.

Patients and Methods: A randomized controlled comparative study was conducted at the Plastic and Maxillofacial Department at Cairo University Hospitals including 30 patients having orbital floor fractures associated with orbital floor defects either isolated or with other maxillofacial fractures, coming to the outpatient and emergency services of the department from June 2012 to December 2013. Patients were subdivided into two groups, 15 cases were managed using autologous bone grafts for reconstruction of the orbital floor defects (group A), and 15 cases were managed using titanium mesh (group B).

Conclusion: Autologous bone grafts cause no immunological problems, but there are limited donor sites. In addition, problems related to second site morbidity, mismatching in mechanical properties with the host bone, and a tendency towards resorption may occur. Titanium mesh as a synthetic biomaterial is a good alternative and can overcome these limitations although it is expensive.

Key Words: Posttraumatic - Orbital - Floor - Defects - Bone Grafts - Titanium - Mesh.

INTRODUCTION

Orbital floor fractures can cause numerous problems, including disfigurement and dysfunction such as diplopia, ocular muscle entrapment, and enophthalmos. Orbital floor reconstruction is necessary to manage these problems. The aim of the

surgery is to avoid anatomical and functional defects [1].

The management of orbital floor fractures has historically been divided into conservative treatment (with delayed intervention for unresolved sequelae) and early surgical intervention.

Reconstruction of pure orbital floor fractures involves reconstruction of the whole floor back to the posterior projection. Reconstruction of impure fractures furthermore must identify and reconstruct the entire inferior orbital rim from stable part medially. This is vital to avoid postoperative dystopia and enophthalmos. The position of the globe is inadequate determinant of accurate reduction of the fracture because a poorly reduced fracture may be masked by edema. Thus, anatomic re-establishment of the skeletal framework is of vital importance. Reconstitution of the orbital floor requires a thin spacer to support and separate the orbital contents from the maxillary sinus [2].

An ideal implant biomaterial should be (i) biocompatible, (ii) available in sufficient quantities, (iii) strong enough to support the orbital content and the related compressive forces, (iv) easy to shape to fit the orbital defect and regional anatomy, (v) easily fixable in situ, (vi) not prone to migration, (vii) osteoinductive and (viii) bioresorbable with minimal foreign body reaction. To find a proper material for orbital floor reconstruction is not an easy task. This has been proved by the wide number of substances of biological or synthetic origin that have been tested over the last 50 years, in the hope that a truly functional biomaterial will eventually materialize. Today a myriad of implants is at the surgeon's disposal and available on the market to treat orbital floor fractures [3].

The aim of this study is to compare the results of using autologous bone grafts with those of using titanium mesh in large posttraumatic orbital floor defects reconstruction.

PATIENTS AND METHODS

A randomized controlled comparative study was conducted at the Plastic Surgery department at Cairo University Hospitals. The present study included 30 patients having orbital floor fractures associated with large orbital floor defects either isolated or with other maxillofacial fractures, attending the outpatient and emergency services of the department from June 2012 to December 2013.

Patients were subdivided into two groups, 15 cases were managed using autologous bone grafts for reconstruction of the orbital floor defects (group A), and 15 cases were managed using titanium mesh (group B). The patients were selected randomly irrespective of age, sex, and other social categories.

Patients fulfilled the following inclusion criteria: (1) Clinical diagnosis of orbital floor defects; (2) Imaging showing orbital floor defects, i.e., bony integrity of the orbital floor was destroyed and local soft tissue thickening or displacement in the maxillary sinus resulting in a teardrop appearance; and (3) Surgical treatment had never been undertaken before our management.

Exclusion criteria include orbital floor fracture without bone defect or patients who had prior unsuccessful surgery.

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

- Restricted ocular movement.
- Alteration of ocular level (dystopia).
- Enophthalmos.
- Deepening of supratarsal fold.
- Narrowing of palpebral fissure.
- Development of diplopia - especially upward gaze.
- On palpation, step deformity at infraorbital margin.
- Paresthesia in the distribution of infraorbital nerve.

All patients were ophthalmologically examined on the day of admission, preoperatively, postoper-

atively after the swelling had ceased, and during follow-up if necessary.

Associated injuries were recorded and assessed and confirmed by their different specialties.

The research and ethical committee approved the study.

On admission all patients underwent imaging examination, including axial, coronal and sagittal computed tomography (CT) with 3-dimensional reconstruction.

Informed consent was obtained from all patients and all of them were operated under general anesthesia.

Subciliary incisions were used in all cases. Other incisions were also used as needed (bicoronal incision in one case, intraoral vestibular incision in 22 cases and eye brow incision in 6 cases).

Open reduction with rigid fixation and orbital floor reconstruction were undertaken in all cases. The plates were placed mainly on the midfacial buttresses, including the exterior margin of the orbit, zygomatic arch, zygomaticomaxillary suture and edge of the anterior nasal aperture. This was in order to recover the normal height, width and profile of the midface.

Three points fixation was considered in zygomatic fractures. Inter maxillary fixation, open reduction and rigid fixation by at least two plates per fracture were also considered in cases with mandibular fractures. When reducing and fixing the orbital floor, prolapsed orbital contents such as the peri-orbital fat, the inferior rectus and inferior oblique muscles were freed from the maxillary sinus to ensure that eye movement was not restricted.

The infraorbital nerve was located and protected. The fracture site was exposed and visualized through the incision, and the chosen reconstructive material was implanted under the periosteum of the orbital floor.

In group-A, defects of orbital floor larger than 1.5cm² were reconstructed by bone grafts. In group-B, similar defects were reconstructed using titanium mesh (Fig. 1).

Closure of the periosteum then resuspension of the orbicularis oculi muscle and lastly closure of the skin was done in all cases.

Intra-operative recording of the surgical steps and technical difficulties was done. Intra-operative digital photos were taken.

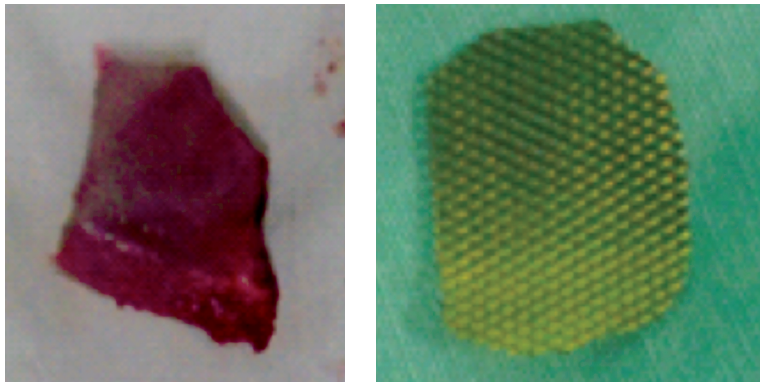


Fig. (1): Materials used in the study for orbital floor reconstruction, Left: Autologous bone graft (iliac bone), Right: Titanium mesh.

Postoperative patient care included intravenous fluids, analgesics, soft diet (according to the condition of accompanying other fractures), and strict hospital discharge instructions regarding hygiene, home care, and follow-up.

Patients were examined in our clinic at 1, 3, and 6 months. Moreover, digital photos were taken at the time of injury, pre and post operative and with follow-up.

Examination criteria at baseline and at follow-up:

- 1- Orbital floor reconstruction (judged by clinical examination and CT plus ophthalmological examination).
- 2- Appearance recovery (symmetry, malformation and scars were considered).
- 3- Function recovery (dysfunction completely disappear means recovered, less residual means improvement, no improvement means inefficacy).
- 4- Complication existence.

RESULTS

Each patient had an orbital floor reconstruction to sustain the volume of the orbital cavity and the continuity of the orbital floor.

CT scans provided a 100% accurate diagnosis in all 30 cases.

All patients had a significant improvement in esthetic appearance. The injured side and uninjured side or both sides were symmetrical and well formed except in two cases (one in each group) with mild asymmetry due to inadequate reduction of the vertical buttress of the mid face.

Two cases (one in each group) had ectropion postoperatively and were operated upon again with significant improvement.

Of 25 cases presented with diplopia, 21 recovered completely during the 6 months after surgery, 3 improved, and 1 was insufficient (group A).

Of 21 cases with enophthalmos, 15 recovered completely and 2 improved. 4 cases treated by bone graft had resorption within 6 months postoperatively and the patients presented by enophthalmos.

16 cases with restricted eye movements recovered completely postoperatively.

Of 12 patients with infraorbital numbness, 9 recovered completely during the 6 months following surgery and 3 were still numb 6 months post surgery (two in group A and one in group B).

Common complications such as hemorrhage and infection did not occur in this study.

One case (in group A) had field defect in the operated eye a week postoperatively, this was reported by an ophthalmologist and was referred to ischemic neuropathy of optic nerve, but the condition has improved in one and half month later on.

All patients were satisfied with their therapeutic results except the one with recurrence of enophthalmos due to bone resorption and the two cases with ectropion.

Table (1): Postoperative complications.

Postoperative complications	Number of patients
<i>Ectropion:</i>	
Early	2 (group A:1)
Late	(group B: 1) 0
Enophthalmos	4 (group A) (within 6 months)
Diplopia	1
Telecanthus	0
Nerve injury	0
Incomplete repair	1 (group A)
Loss of vision	0
Field defect	1 (group A) (improved spontaneously)
Infection	0
Asymmetry	2



Fig. (2): Left: A bone graft used for orbital floor reconstruction after inseting of the graft. Right: Titanium mesh used for orbital floor defect renovation.

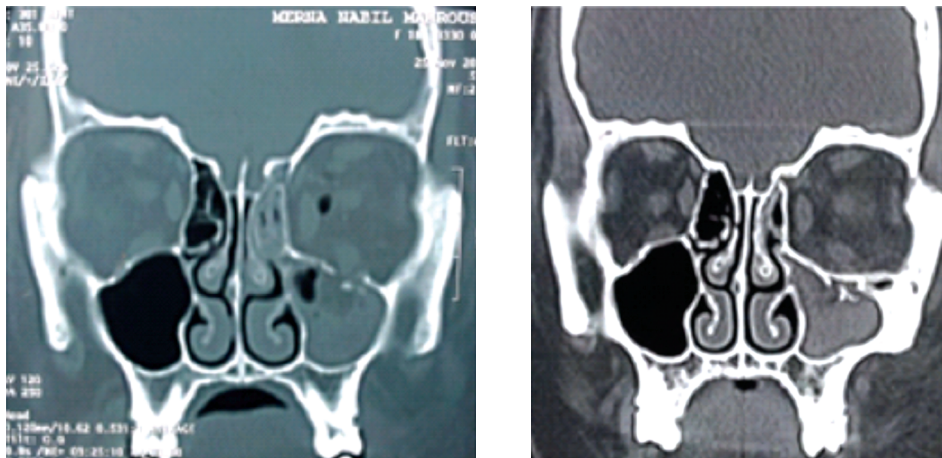


Fig. (3): Preoperative (to the right) and postoperative (to the left) coronal CT of left orbital floor fracture reconstructed by bone graft.

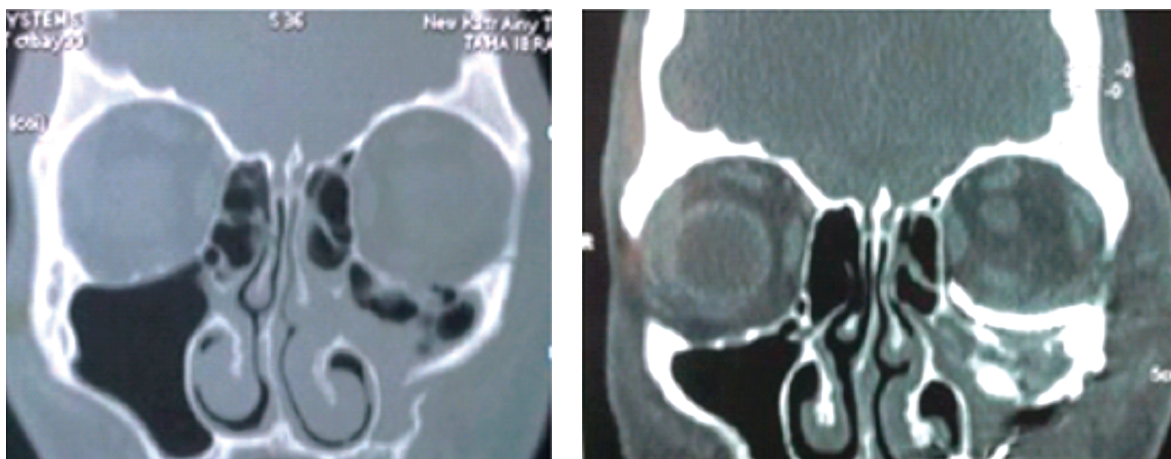


Fig. (4): Preoperative (to the right) and postoperative (to the left) coronal CT of left orbital floor fracture reconstructed by titanium mesh.

DISCUSSION

The choice of approach incision is important when dealing with fractures of the orbit. Over the past 20 years, there has been increased interest in use of the transconjunctival approach due to the

increasing evidence of the relatively high risk of lower eyelid retraction using the subciliary approach [4].

Unlike many other studies, although we had used subciliary incision in 100% of patients lower

eye lid, ectropion was 6.6%. Barbon, et al., found a 20% incidence of ectropion associated with subciliary approach [5].

It can be said that, the proper reduction, incision and closure with respect of all layers including the periostium plus soft tissue suspension would decrease the incidence of ectropion with subciliary incision.

Because of the diversity of problems that may present in orbital reconstruction and limitations of each material used for this purpose, currently no single material is ideal. Rigid materials are best suited for reconstruction of large defects to prevent displacement of orbital contents into the maxillary sinus [6].

Autologous tissue is the first and, to some extent, the best implant choice. The main disadvantages are morbidity of the donor site, increase in operating time, limited availability (especially in large fractures) and modeling properties of the graft. On the other hand, bone grafts provide good stability and reduced cost. Moreover, these materials do not cause adverse reactions, but donor site risks can be a problem [7]. Moreover, bone resorption can lead to hypoglobus and enophthalmos.

The main disadvantages of alloplastic materials are long-term infections frequently requiring removal of the implant, extrusion or migration, foreign-body reactions and encapsulation. In addition to these problems, it is very difficult to remove titanium mesh if infection occurred. The advantages are readily available, fractures of any dimensions can be treated, they can be moulded and surgical time is reduced. Titanium mesh is preferred because of its shaping features and greater biocompatibility [8].

The choice of an optimal material for orbital skeleton repair is influenced by many factors, including the specific characteristics of the injury, cost, the patient's clinical history and the experience/opinion of the surgeon. It is worth underlining once more that a careful history and physical examination of the patient is vital for the diagnosis of orbital floor fractures and, accordingly, for the choice of a suitable implant material, if required. Axial and coronal CT scans should be obtained in order to detect the extent of the orbital cavity injuries, as well as any other facial fractures that might be present. The two most important characteristics of the fracture to be determined are the size/shape of the damage and whether or not any orbital content has prolapsed through the fracture into the maxillary sinus.

Francesco Bairo reviewed the biomaterials that were available for orbital floor reconstruction to provide insight into their selection and application. Asking the question does an ideal biomaterial exist? [3].

The first extensive comparative study on the performance of different biomaterials for orbital floor repair was reported in 1998 by Chowdhury and Krause, who concluded that when a blow-out fracture with a clinically significant orbital floor defect occurs autologous material, is preferable for the orbital floor graft [7].

On his own clinical experience Kellman, also in 1998, suggested that autologous grafts should be in general preferred to synthetic materials, as he encountered minimal post-operative inflammation and no extrusion of autologous bone. However, Kellman also underlined that bone grafts can undergo resorption, thereby resulting in delayed changes in globe position that may require a second surgery [9]. This is matching with the results of this study.

Ellis & Tan, and Al-Sukhun & Lindqvist, compared autologous bone with biodegradable mesh and titanium and also suggested avoiding the use of bone grafts due to the long operation duration and the post-operative graft resorption seen on CT scanning [10,11].

Shetty et al., treated 10 patients suffering from orbital blow-out fractures with different materials and concluded that calvarial graft, titanium mesh and porous PE appear to have equal potential to offer stable and safe reconstruction of the fractured orbital floor [6].

Very recently Tabrizi et al., evaluated orbital floor reconstruction in 101 patients using autogenous bone and different alloplastic materials (Medpor®, Medpor® Titan™, titanium mesh and resorbable plates). The authors concluded that autologous bone grafts elicited minimal post-operative infection and were an excellent choice for treating major orbital defects; titanium mesh, Medpor® and Medpor® Titan™ provided excellent structural support and could be successfully used in large orbital floor defects; resorbable plates were good alternative materials in pediatric patients [12].

In our study we found that the use of titanium meshes in large orbital floor defects was superior to the use of bone grafts, as in our study we did not encounter any infection or reaction due to titanium mesh usage. The only problem that limiting us from the use of titanium mesh is its cost.

Conclusion:

From the results and suggestions reported in the literature we can conclude that, at present, an ideal biomaterial does not exist, but the choice of orbital wall implants has to be carefully individualized. Size and shape of the fracture, presence of adequate surrounding stable bone and the need for orbital rim reconstruction are all factors that play a crucial role in the decision-making process.

In this study, results could give privilege to titanium mesh usage in reconstruction of large orbital floor defects. Autologous grafts cause no immunological problems, but can be collected in only limited amounts. In addition, problems related to second site morbidity, mismatching in mechanical properties with respect to host bone, and a tendency towards resorption may occur. Titanium mesh as a synthetic biomaterial is a good alternative and can overcome these limitations although it is expensive.

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