Role of Titanium Mesh as a Reconstruction Material for Orbital Floor Defects in Cases of Orbital Blowout Trauma

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Abstract

Aim: The purpose of this study is to evaluate the use of titanium mesh as a reconstruction material in cases of orbital blowout fractures, and its advantages, disadvantages. **Methods:** From January 2014 to December 2016, 24 patients with orbital blowout fractures managed surgically using titanium mesh were evaluated for improvement, degree of success, persistence of symptoms, complications. The recorded data included age, gender, cause of trauma, diplopia, enophthalmos, ocular motility, preoperative and postoperative orbital CT, preoperative and postoperative ophthalmological evaluation. **Results:** 15 of 24 were males and 9 were females. Motor vehicle accident was the most common cause of trauma, aggression was the second cause, and industrial injury was the third cause. 11 of 12 patients with diplopia improved and one patient had persistent diplopia. All patients with enophthalmos or ocular motility disorders improved, only one patient developed late enophthalmos and treated using iliac bone graft. Titanium mesh was highly effective for sealing of orbital wall defects, improvement of symptoms, with no major complications. **Conclusion:** Titanium mesh is a good orbital reconstruction material, avoiding a lot of the drawbacks of autogenous sources such as bone and cartilage.

Key Words: Titanium mesh, Orbital floor defects, Reconstruction material

Introduction

Orbital fractures account for 30% to 55% of all facial fractures. The most frequent etiology varies according to gender: in men, these fractures are more frequently the result of aggression, whereas in women, the frequent cause is an accidental fall. Fractures can be classified differently according to the degree of displacement [1], the degree of gravity and the fracture pattern [2], the degree of segmentation and comminution [3], and the strength applied against the bone [4], as well as according to the combination of their location, the number of fragments and the soft tissues affected [5].

The most outstanding feature that distinguishes blowout fractures from other maxillofacial fractures is the way that they fragment like egg-shells, and there is a need for a suitable material to reconstruct the orbital floor, This reconstructing material to be ideal material should be thin, light, enduring, easily shaped, and radiopaque but not be prone to infection that could interfere with further investigations [6], and also It should not be carcinogenic and have no potential for transmission of disease [7].

Autografts, allograft, and alloplastic materials are used to reconstruct the orbital floor, but there is no consensus on which material is the best [8-11]. The most important complications of alloplastic materials are infection, foreign body reaction, and exposure [12,13]. Also alloplastic materials such as titanium mesh has been traditionally limited to transfacial approaches [14]. The biggest disadvantages of allografts are their potential for transmitting disease and their cost [15]. Several donor sites have been described for autologous grafts, but the extended duration of operation, donor site morbidity and resorption of the graft, has limited their use [16]. However, several studies have shown the reliability and safety of titanium in reconstructing internal orbital defects [17,18].

Titanium has excellent biocompatibility and demonstrates integration in adjacent bone, which results in low infection rate and rare postoperative migration of implants after titanium reconstruction. Titanium can be contoured to fit virtually any internal orbital defects because of its significant tensile strength and malleability. In addition, titanium is easily visualized on postoperative CT. These characteristics determine titanium to be well established as an implant material in orbital and adjacent craniofacial skeleton reconstruction [19].

Materials and Methods

This is retrospective study carried out on 24 Egyptian patients, diagnosed with unilateral orbital blowout fractures, between January 2014 and December 2016, at Assiut university hospital. Five patients (21%) had isolated orbital blowout fractures (pure blowout fracture), Nineteen patients (79%) had associated orbital rim and midfacial fractures (impure blowout fracture). The exclusion criteria were patients with bilateral orbital blowout fractures (to compare the injured side to the normal one), patients with severe panfacial comminution, patients younger than 18 years old and patients with orbital blow in fractures. Complete head and neck examination (including full ophthalmological evaluation pre & postoperative) was routine for all patients. Facial computed tomography (CT scan) *Figures 1-5* was performed for all patients (preoperative and postoperative). Patients were classified according to their CT examination into pure orbital blowout fracture (fracture of the orbital floor and/or the medial wall with intact orbital rims), and impure orbital blowout fracture (associated orbital rim fractures). All

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patients' data were collected such as their ages, gender, cause of trauma, side of injury.

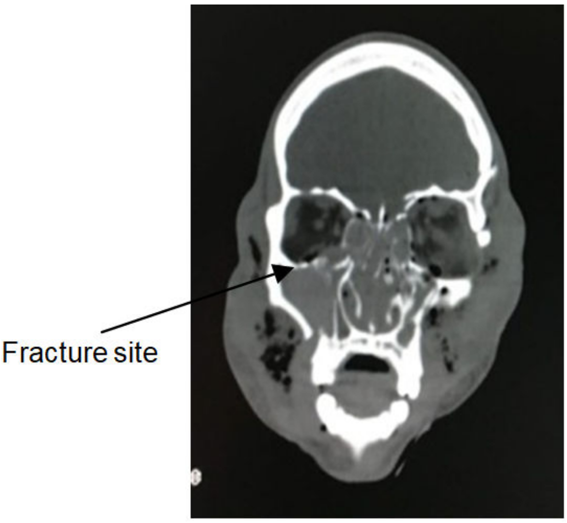

Figure 1. Preoperative Coronal CT view.

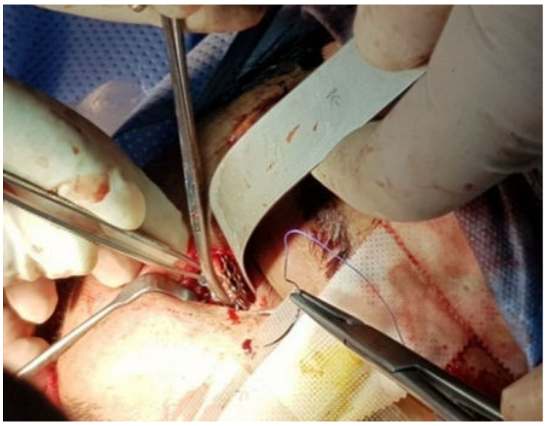

Figure 2. Intraoperative view.

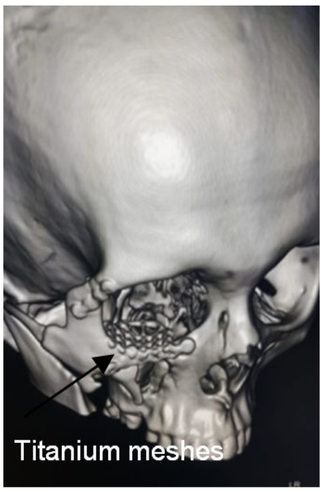

Figure 3. Post Op 3D view

Figure 4. Coronal View Post Op

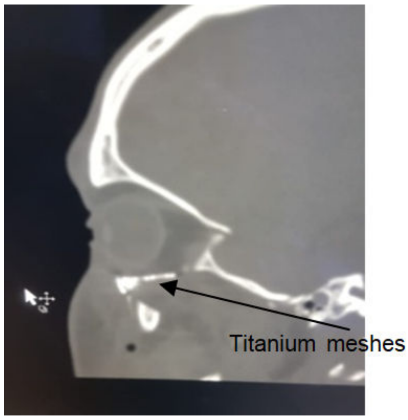

Figure 5. Sagittal View Post Op

The indications for surgical interference were presence of diplopia, enophthalmos, entrapped muscles, CT evidence of a big orbital floor defect (more than half of the orbital floor).

Surgical Technique

The procedure was undertaken general anesthesia, within 5-10 days after trauma .The surgical approach was subciliary in 18 patients and direct on infraorbital rim (subtarsal)in 6 patients, this depends on the fracture site and the surgeon preference , leaving both eyes uncovered. Starting soft tissue dissection up to the infraorbital rim, opening periosteum and subperiosteal dissection deep to orbital floor, deep in the orbit a malleable retractor is used to elevate the orbital tissues and improve visibility to properly identify the orbital fracture defect, reduction of the herniated orbital contents from side to side to avoid penetration of the orbital tissues, then identify the stable defect borders to support the mesh, manipulation of the titanium mesh to fit size, shape and completely cover the defect, we should pay careful attention to simulate the curves and slopes of the floor and medial wall of the orbit *Figure 2*, the size of the mesh should not be much larger than the defect as it can affect globe motility and position, fixation of the mesh by screws to the orbital margin, proper periosteal closure is necessary, forced duction test was done for all cases before surgical closure of the incision (to make sure of total release of the herniated orbital tissues) .

All patients received postoperative dexamethasone 5 mg q8 hourly for 3 days postoperatively (if not contraindicated) Postoperative check CT done for all patients.

Results

During the period of this study, 24 orbits were reconstructed by titanium meshes. Fifteen patients (62%) were males, nine patients (37%) females. The age range from (18 to 66) years old. Motor vehicle accident was the most common cause (71%), aggression was the second cause for (21%), sport injury for one case (4%), industrial accident for one case (4%).

Surgical outcomes were summarized in *Table 1*. All patients with preoperative diplopia improved postoperatively except one case had persistent diplopia for four months postoperatively and the patient referred to higher center for possible revision.

Table1. *Number of operated cases according to their symptoms.*

Indication of surgery	Number of patients	Number of improved cases	Persistence of Symptoms
Diplopia	12	11	1
Enophthalmos	8	8	0
Muscle entrapment	2	2	0
Huge orbital floor defect	2	2	0

All cases with preoperative enophthalmos improved clinically (by achieving clinically visible symmetric eyeball projection after surgery) and as detailed by ophthalmological evaluation, but one case developed late enophthalmos (after six months, his CT revealed proper position of the mesh with good sealing of the defect but he had atrophy of the retrobulbar fat and this patient needed second surgery and revision done with placement of autogenous iliac bone graft and the patient improved. All cases diagnosed by CT as large orbital floor defect improved completely by comparing preoperative and postoperative CT scans. Patients with definite muscle entrapment improved with no evidence of restriction of globe movement.

One patient with lower eyelid incision (subtarsal approach) developed ectropion and revised by secondary lid surgery and improved, but all patients with subcilliary approach Improved without any approach related complications.

There were no intraoperative complications such as damage to the globe or the optic nerve or unexpected hemorrhage.

There were no postoperative complications like bleeding, vision loss, infection, and implant extrusion, or malposition, orbital congestion, epiphora. All postoperative CT scans showed well positioned titanium meshes and maintenance of the floor reconstruction (*Figures 3-5*). Most of patients were satisfied with their final results and function, *Table 2* summarized incidence of complications.

Table 2. *Complications.*

Complication	No. of cases
persistent diplopia	1 (4 %)
Late Enophthalmos	1 (4 %)
Ectropion	1 (4 %)
Optic nerve injury	0 (0 %)
Retrobulbar hemorrhage	0 (0 %)
Vision loss	0 (0 %)
Infection	0 (0 %)
Extrusion of implant	0 (0 %)
Implant malpostion	0 (0 %)
Orbital congestion	0 (0 %)

Discussion

Since orbital floor fracture was first described by Lang in 1889, the most suitable material for reconstruction of the orbital floor has been controversial, and different authorities have suggested different materials [20].

Although bone has good strength, no sharp edges, can be fixed to adjacent bone and is radiopaque, it can have a variable degree of resorption that can be problematic, and its lack of pliability creates a significant difficulty for adequate molding into complex shapes [21].The calvarium, iliac crest, nasal, maxillary and mandibular bone have been used as donor sites, with the first two being the most commonly used [22].

The main disadvantages of autologous materials are donor site morbidity, and the prolonged duration of the operation. Theoretically, alloplastic materials are of limited use because of complications such as foreign body reaction, infection and exposure, obstruction of the lacrimal canal, retrobulbar hemorrhage, oculomotor nerve palsy, high cost and difficulty in obtaining, shaping and contouring them [23].

With respect to materials, titanium mesh can be easily fixed with little incidence of slippage. However titanium mesh is hard and iatrogenic injury is likely to occur if it is not appropriately implanted [24,25]. We used titanium mesh to repair orbital floor defects and titanium plate to repair fractures of the orbital margin; consequently, no complications of iatrogenic injury, infection, discharging and displacement were reported.

Only one case developed persistent diplopia, and was referred to higher center, that means that the reconstruction material has no relation to development of persistent diplopia, in this we agree with Boyette JR, et al, who mentioned that, the frequency of persistent postoperative diplopia varies between 8% and 42%, and causes of persistent diplopia are muscle trauma and fibrosis, and paresis of the oculomotor nerves [26].

All patients with preoperative enophthamos improved as detailed by ophthalmological evaluation. But one patient presented six months later by late enophthalmos, his CT revealed that titanium mesh is in place, defect is sealed completely, ophthalmological consultation reported atrophy of the retrobulbar fatty tissue and advised reinforcement by a retroequatorial bone graft, iliac bone graft used to augment the orbital floor and the patient improved.

Postoperative intraorbital hematoma is a very rare complication, and some studies have recommended the placement of a negative pressure drain to prevent it [27]. In this study, we did not use a negative pressure drain and none of our cases had intraorbital hematoma.

Regarding the surgical approach, we found that the subciallary approach is better than subtarsal approach, with less associated rate of approach related complications (ectropion, obvious scars), however some authors prefer the more aesthetic trans- conjunctival approach but it needs additional lateral canthotomy especially in extensive fractures [28]. Recently Suzuki et al applied the endoscopic approach to the orbital floor and medial wall. This technique has increased, as surgeons try to avoid eyelid complications and improve visualization of the orbital walls; however the transcutaneous approaches are more predictable for managing orbital floor fractures [29,30].

Titanium is highly biocompatible, easily adjusted to architecturally fit simple and complex orbital defects, provides strong support, does not alter its shape or location over time, and it can be easily fixed to adjacent bone. It has well recognized osseo- integration, is easily sterilized and readily available, although at high cost. Unfortunately, the holes in the plates allow tissue ingrowth that may make removal more difficult, and the cut edges are prone to snaring periorbital soft tissue during placement [31].

The use of titanium implants for reconstruction of orbital floor defects can greatly improve the aesthetic and functional outcomes, so it is considered one of the best options for orbital floor reconstruction.

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