Reconstruction of a blowout fracture with a pre-molded titanium mesh

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KEYWORDS: Blowout fracture; Biomodel; Titanium Mesh.

SUMMARY

Orbital fractures are not unusual at facial trauma services and represent a great challenge for surgeons due to its delicate anatomy as well as clinical repercussions. The main goal of an orbital wall reconstruction is to reestablish the orbital volume by repositioning the surrounding soft tissue of the eyeglobe and correctly replacing the fractured orbital wall, guaranteeing that all structures affected (muscles, ligaments or nerves) are well positioned and functional.

One of the biggest challenges consists at shaping the chosen reconstruction material to simulate the orbital anatomy as well as covering all the defect that has been caused by the trauma, guaranteeing support of at least two sides of the reconstruction.

In this case report we present a right eye blowout fracture of a traumatized patient after an accident fall of his own height. Due to the increased size of the defect and difficulty on contouring the S-shape of the orbital floor, a biomodel of the fractured orbita was printed using the initial diagnosis Computerized Tomography (CT) in order to premold a titanium mesh which was afterwards positioned using a transconjunctival access under general anesthesia.

INTRODUCTION

The orbits are four walls pear-shaped pyramids, responsible for protecting and supporting the eyes[1]. The orbital floor is composed of three bones: the orbital surface of the maxillary bone, the orbital surface of the zygomatic bone and the orbital process of the palatal bone, forming a thin and easily breakable papyraceous wall.

The orbital fractures can be divided in two sections: anterior, when it involves the orbital rim and posterior, when it involves the orbital walls such as the medial and lateral walls, as well as the orbital floor. The posterior wall fractures are usually referred as Blow-in, when the fragments are dislocated inside the orbita cavity and increasing the risks of direct lesion to the eye globe and its surrounding structures and the Blow-out, when the fragments are expelled out of the orbita, creating a wall defect and possible herniation of the soft tissues as well as an increase of the orbital volume. The Blowout fractures are the most common amongst the orbital wall fractures and its exact mechanism is uncertain, eventhought it is proven to be related to the trauma energy dissipation and consequent bone hydraulic forces[2].

Orbital fractures may result in ophthalmic complications as well as diplopia, enophthalmos and vertical diplopia[2]. The indication for the reconstruction is based on the size of the defect as well as the clinical repercussions and is usually planned for 3 to 7 days post trauma so the spontaneous improvements can be observed and the swelling is diminished, facilitating the intra-operative surgical approach[3]. Because of its thin nature, usually the orbital floor comminutes, making the reduction almost impossible and therefore, reconstruction the missing bone is the best way to go.

There are several ways to treat a blowout fracture with variations starting on the indication of the reconstruction, surgical approaches such as transconjuctival or transcutaneous (subciliary, subtarsal and infraorbital)[4] and reconstruction material. There is still no consensus on which material is better, having each of the autografts, allografts and alloplastic material its own advantages and disadvantages[5]. Despite the lack of consensus, the titanium mesh is used most for larger defects due to its excellent biocompatibility and integration in adjacent bones with low infection rate. In addition to that, titanium can be easily contoured and it is visualizes on the postoperative CT.

With the advance of image acquisition and virtual planning, the possibility of a more accurate orbital wall reconstruction while decreasing the intra-operative time has become a reality. The creation of biomodels allows the surgeon to print the fractured orbita as well as the non-fractured mirrored orbita easily at a clinic, making it possible to obtain a better visualization of the defect and premold a chosen material before the implantation.

CASE REPORT

A 62-year-old male patient attended a local hospital due to a fall of his own height occurred after abuse of alcohol. The precise information about the trauma couldn't be collected due to alcohol intoxication and the initial neurological examination was affected as well.

On the first evaluation, the patient was lethargic but lucid and oriented in time and space, denied vomit episodes or nausea and referred pain on the inferior border of the left clavicle as well as the left side of his chest, indicating a lateral trauma. The patient referred as previous medical condition arterial hypertension and use of candesartan and sertraline.

At the physical examination, it was noticed a small blunt wound on the superior left palpebra, no sign of exo or enophthalmos, no diplopia and no restriction of orbital mobility. The patient also refered a hypoesthesia of the infraorbital nerve. A multidisciplinary team was also triggered with an orthopedic and ophthalmologist evaluation and, after examination and complementary exams, both teams excluded alterations.

A facial and cranial computerized tomography was requested for further examination and an orbital floor fracture on the left orbita was noted. Despite no early signs of sequel, it was determined the necessity of the floor reconstruction due to the size of the defect as well as herniation of the periorbital content (Figure 1-4).

Figure 1: 3D reconstruction with orbital floor fracture in evidence.

Figure 2: Related to the fracture, a hematosinus can be noticed in the left maxillary sinus.

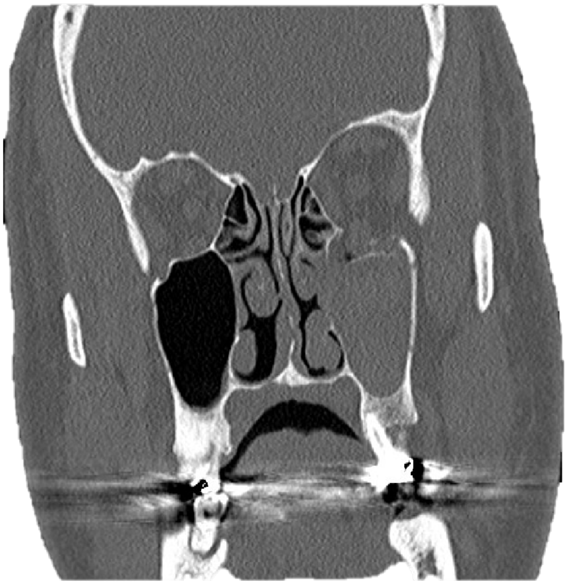

Figure 3: Dislocated segment

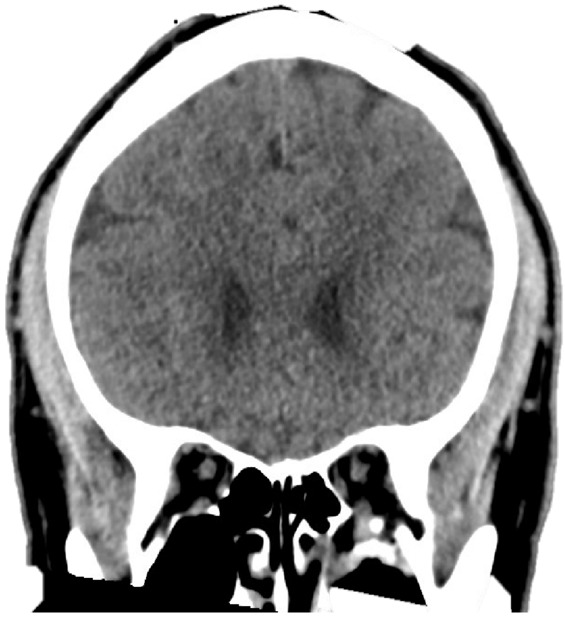

Figure 4: Infraorbital muscle without support

After two days at the local hospital due to the alcohol intoxication and for neurological observation, the patient was discharged and referenced to the Universitätsklinikum of Marburg (UKG) ambulanz for treatment of the orbital fracture and, after evaluation, the procedure was scheduled in two days.

MANAGMENT AND OUTCOME

The case was discussed at the daily staff meeting and it was decided that a pre-mold titanium mesh was the best and most predictable treatment. Using the first CT performed, a biomodel of the blowout fracture was made with the Meshmixer programme and afterwards printed in order to guide the shape and position of the mesh (Figure 5-6).

Figure 5-6: Blowout fracture and the reconstruction titanium mesh

The surgical procedure was performed at the UKG Marburg with the patient going under general anesthesia. A transconjutival approach was made to acess the fracture and, after the repositioning of the herniated soft tissue, the titanium mesh was placed in position. During the surgical planning, it was decided to keep a fixation point of the mesh, as seen in Figure 6, but during the procedure it was decided to be cut due to the stabilization of the mesh without any need of screws attachment (Figure 7-8). After the suture done with vycril, the patient had an eyepatch placed for the 24 hours post operative. The procedure went as planned with no intercurrences noted.

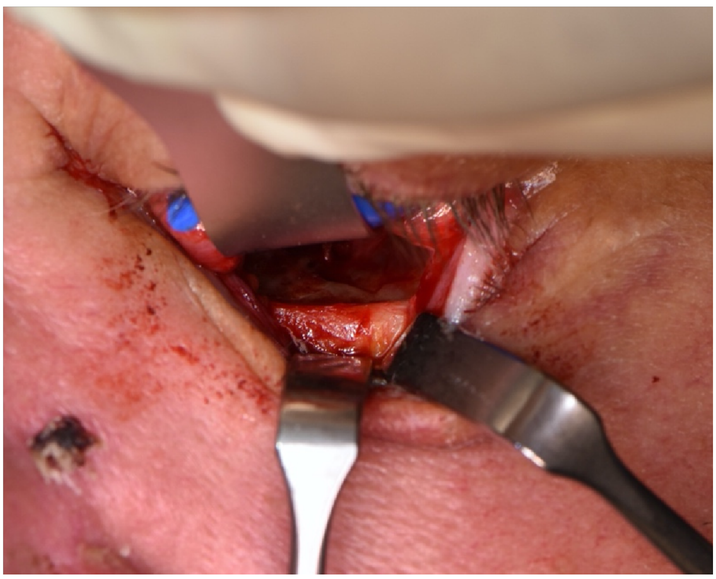

Figure 7: Orbital floor fracture

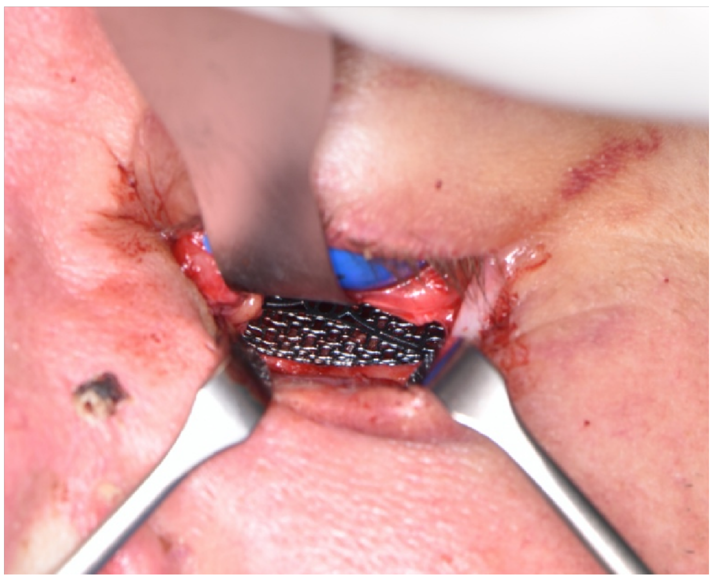

Figure 8: Titanium mesh in position

An immediate post op CT was requested to check the mesh position and adaptation, as shown on Figures 9-11. The images show a good replacement of the periorbital content and good adaptation of the mesh.

Figure 9: Titanium mesh in position

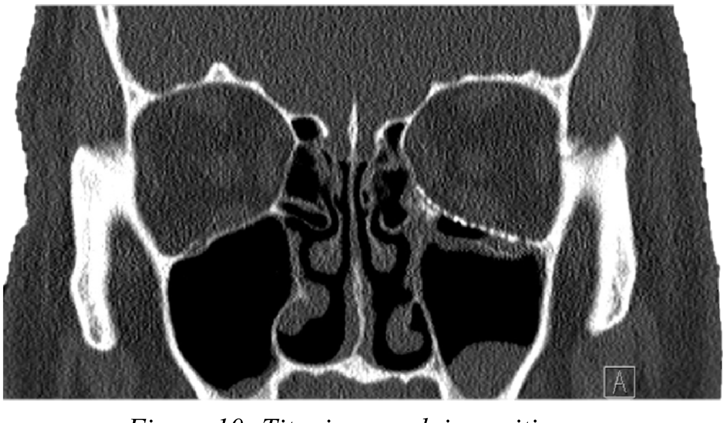

Figure 10: Titanium mesh in position

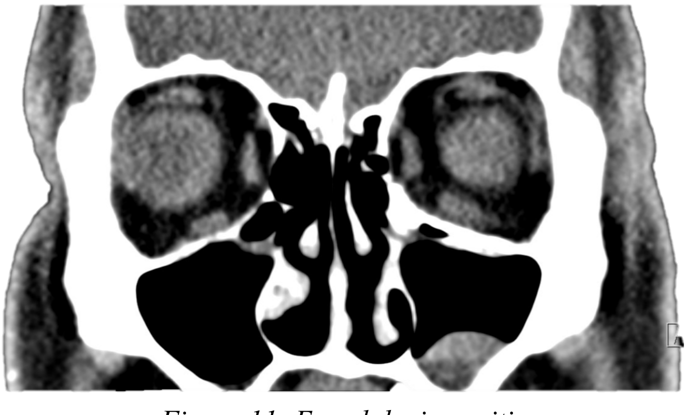

Figure 11: Eye globe in position

After a 48 hours post-operative observation, totalizing 7 days from the trauma, the patient was discharged after a new consult with the ophthalmologist, which reported diplopia of the left eye on abduction movement, expected at the post-operative trauma swelling.

On the 7th post-operative day, the patient was reevaluated and reported that the infraorbital nerve hypoesthesia was already gone, there was no restriction of orbital mobility, no exo or enophtalmia and a good healing of the transconjuctival approach. The patient had a persistent diplopia at infraversion movement, which can be expected from remaining swelling and will be followed up by both Oral and Maxillofacial team and ophthalmologist teams.

DISCUSSION

Amongst the failures of an orbital wall reconstruction, two moments can be highlighted as most critical: the surgical planning and the exposure of the fracture. During the procedure, the failure to perform an adequate dissection of the orbit with complete delineation of the bone defect is one of the main causes of unsatisfactory results[6,7] and, regardless of the chosen surgical approach, depends directly on the surgeon's skills and practice. On the other hand, the planning of the reconstruction can be easily adjusted to have a more predictable result at a faster and safer surgery, not depending directly on the surgeon's skill.

Nowadays, there are many virtual resources for planning an orbita wall reconstruction: reposition of the segments on specific softwares, the possibility to mirror a non-fractured orbita for reference, the confection of personalized reconstruction material and, the most used and accessible option, the confection of biomodels for study of the fractures as well as premolding a reconstruction material before implantation. Despite the advance and routine use of those resources, there are few articles comparing the precision of the customized prebend titanium mesh with inventory mesh. It has been stated though that the industrial titanium meshes adapt without any needs of alteration in 50% of the cases and the other half require a modification to adequate the tridimensional position and correctly reestablish the orbital volume[10].

The choice of the best reconstruction material is still one of the biggest discussions amongst surgeons and it has evolved a lot through the years. Autogenous materials were considered for a long time the gold standard to which other materials are compared, but the alloplasts have gained popularity for orbital wall reconstruction for their ease of use, elimination of the need for a second operation and its associated morbidity, scaring, postoperative pain, variable degree of resorption and the bone graft rigidity[3,11]. There are many options on the market such as Polyethylene sheets (PPE), Medpor and titanium meshes and the alternative of the reasorbable material Polydioxanone (PDS). The choice of the material will depend on the size of the defect as well as availability to the Oral and Maxillofacial surgeon. The only consensus that can be noted amongst the most recent studies is that in cases of large defects, bigger than $2cm^2$, the titanium meshes are the most biocompatible of all available alloplastic materials, show better results due to malleability, allowing the mesh to be easily adapted to the shape of the orbital defect, the same time it has ridgity to hold the orbital contents in its places and, because of its structure, allows connective tissue to grow around and through the implant, preventing migration and permiting the drainage to the facial sinus.

The conclusion of this case report is that the orbital wall fractures have multiple indications, surgical approaches, surgical planning and reconstruction material that have to be constantly updated. The new technology involving 3D image acquisition, virtual planning and virtually assisted procedures are already a reality and it is up to the surgeon to keep updated to give its patient the best specific planned treatment possible, alongside the support teams needed.

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