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COMPLICATIONS AND ORBITAL VOLUME ANALYSIS FOLLOWING THE USE OF CUSTOMIZED TITANIUM IMPLANTS FOR ORBITAL FLOOR RECONSTRUCTION: COMPARISON OF TRANSCONJUNCTIVAL VERSUS TRANSANTRAL APPROACHES

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ABSTRACT

Orbital floor fracture reconstruction is considered crucial in restoring the orbital volume and avoiding complications such as diplopia and enophthalmos. Traditionally, transcutaneous or transconjunctival approaches have been implemented to access the orbital floor fractures. However, these approaches suffered the drawbacks of possible visible scars, ectropion or entropion. Recently, the transantral approach has been revisited to access and reconstruct orbital floor fractures with adequate success. This is a retrospective study where transconjunctival and transantral approaches are compared in terms of complications and orbital volume correction after using customized titanium implants for orbital floor reconstruction. Ten patients were included in the transconjunctival group while eight were included in the transantral group. The mean volume of the reconstructed orbits in the transconjunctival group was 2.2% smaller than that of the contralateral intact orbits compared to 0.6% smaller volumes for the reconstructed orbits vs the intact orbits in the transantral group. It can be concluded that the transantral approach is a valid alternative to the transconjunctival approach for orbital floor reconstruction yet with fewer complications.

KEYWORDS: Orbital trauma, computer assisted surgery, patient specific implants

INTRODUCTION

The increased orbital volume following orbital trauma is a main cause of enophthalmos, diplopia and dystopia[1]. Surgical reconstruction of the orbital volume is essential to restore proper function and esthetics. Adequate reconstruction entitles extension of the titanium mesh to the key area posterior to the orbital equator, which could be technically demanding if done freehand. Computer-assisted surgery and customization of the titanium mesh based on a mirror-image of the unaffected side offered better prognosis specially for less experienced surgeons or severely traumatized orbits[2].

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Traditionally, different transcutaneous or transconjunctival approaches have been utilized to gain access to the fractured orbital floor. Such approaches carried the risks of ectropion, entropion and increased scleral show[3,4]. Historically, a transantral approach has been used to approach orbital floor fractures and pack the antrum to support the orbital floor. More recently, the transantral approach; either with or without endoscopic assistance; has been applied to reconstruct the orbital floor using titanium plates[5,6].

In this retrospective research, we compare the orbital volume reconstruction using customized titanium meshes placed through a transconjunctival versus transantral approaches.

PATIENTS AND METHODS

This is a retrospective study where patients were operated upon during the period from March 2020 till April 2023. Patients included in this study were recruited from and operated upon at the department of Oral and Maxillofacial Surgery, Cairo University. Inclusion criteria were patients with unilateral orbitozygomatic fractures with complete records including preoperative and postoperative CT scans available in digital DICOM format.

The preoperative CT data were segmented to select the bony tissue and a three-dimensional volume calculated. The volumes of both the traumatized and intact orbits were calculated by manually segmenting the orbital contents on a slice-by-slice basis. The air in the maxillary sinus was also segmented and used to augment any thresholding artefacts in the paper-thin orbital floors. Then the traumatized orbital floor was virtually reconstructed based on a mirror-image of the contralateral intact orbit (Fig. 1). For both groups, either a model of the reconstructed orbital walls was physically additively manufactured or a virtual mesh designed on the software and milled out of titanium (Fig. 2).

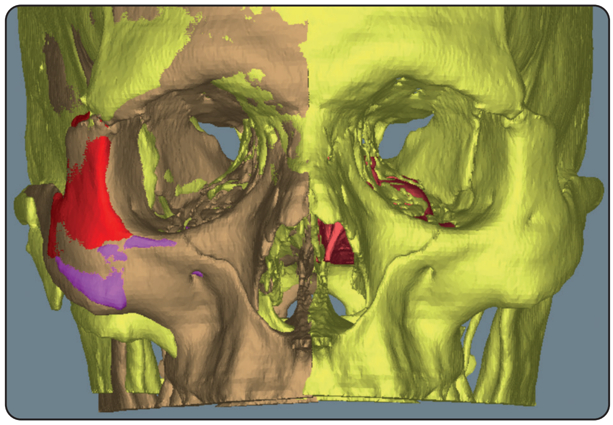


Fig. (1) Virtual simulation showing a mirror-image of the intact zygoma and orbit to reconstruct the fractured side.

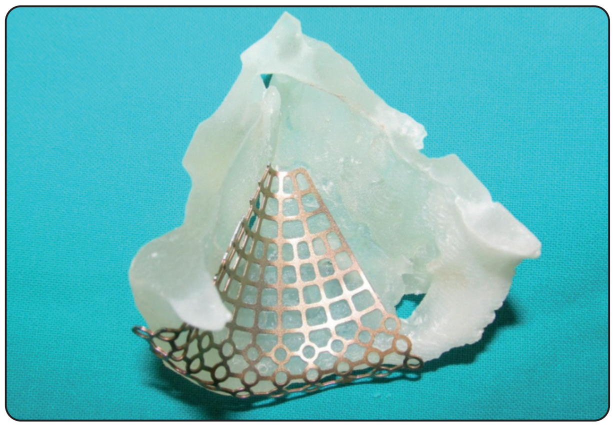


Fig. (2) A stereolithographic model of the reconstructed orbit showing preoperative adaptation and contouring of a stock titanium mesh.

Patients in both groups were operated upon under general anesthesia. The extraoral approach group received a transconjunctival incision with lateral canthotomy for repair of the orbital floor fracture (Fig. 3). Other fracture lines were managed using appropriate approaches such as lateral eye-brow or maxillary vestibular incisions. The zygomatic bone fractures were fixed first followed by insertion and fixation of the customized mesh to repair the orbital floor fracture (Fig. 4). The transconjunctival incision was sutures using 6/0 running resorbable sutures.

Fig. (3): Intraoperative photograph showing a transconjunctival approach to the fractured orbit.

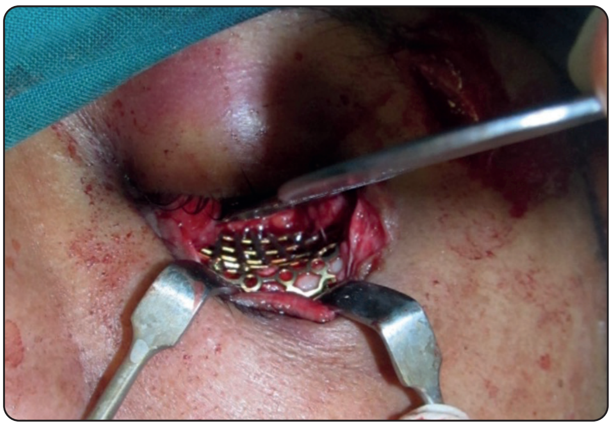


Fig. (4) Intraoperative photograph the pre-adapted mesh inserted through the transconjunctival approach.

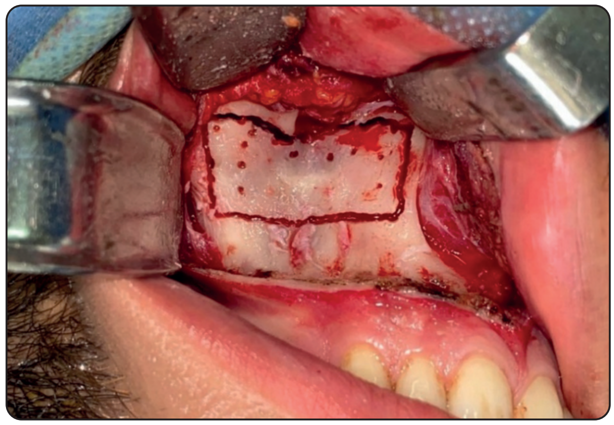


Fig. (5): Intraoperative photograph showing a maxillary vestibular approach and an osteotomy of the anterior sinus wall to gain access to the maxillary sinus.

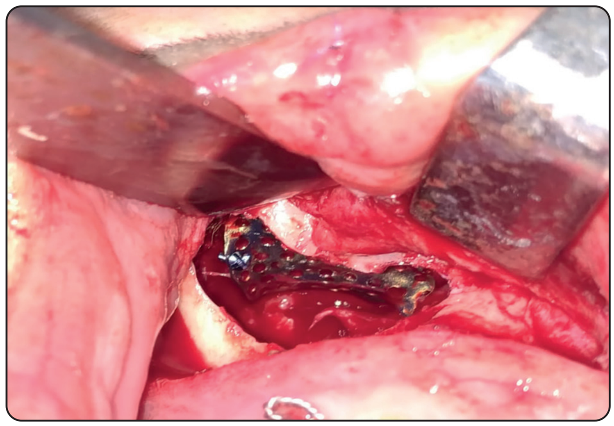


Fig. (6) Intraoperative photograph showing the patient-specific titanium implant in place through the maxillary sinus.

Whereas the transantral group received a maxillary vestibular approach to gain access to the facial wall of the maxillary sinus, a bony window big enough to insert the customized mesh was then osteotomized using rotary instruments (Fig. 5). After dissecting any entrapped muscles free, the customized mesh was then inserted into the sinus cavity and pushed against the fractured orbital floor by means of a blunt instrument to reduce the herniated orbital contents back in place. The mesh was then fixed using 2 to 3 1.5 mm screws to any intact bony walls such as the lateral nasal wall or the posterior wall of the maxillary sinus (Fig. 6). The bony window of the maxillary sinus wall was then repositioned in place and fixed using 1.5 mm screws and plates and the maxillary vestibular incision sutured using 4/0 resorbable running sutures.

Patients of both groups were discharged on the same day of surgery, they received amoxicillin/clavulanic acid tablets for 7 days, diclofenac potassium tablets for 4 days a chlorhexidine mouthwash for 10 days. They all received a postoperative CT scan within the first 48 hours after the surgery; this was used to examine the adequacy of the fracture reduction and to calculate the volume of the reconstructed orbit in the same slice-by-slice fashion (Fig. 7).

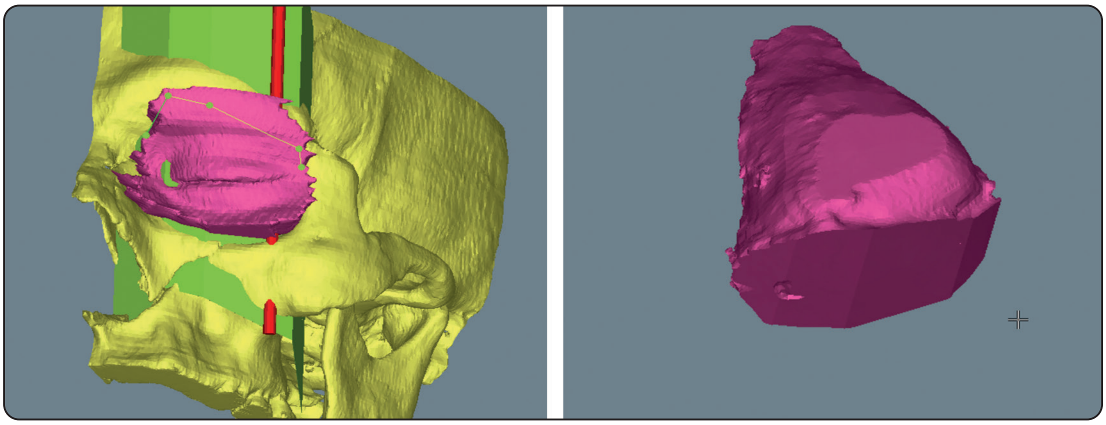


Fig. (7): Orbital volume calculation from the orbital apex till a plane extending across the orbital rims.

Patients of both groups were recalled on the second and fifth postoperative days and then weekly after for two months for follow up. During the follow-up visits, they were checked for signs of diplopia, enophthalmos, entropion/ectropion, ocular motility and infraorbital nerve paresthesia.

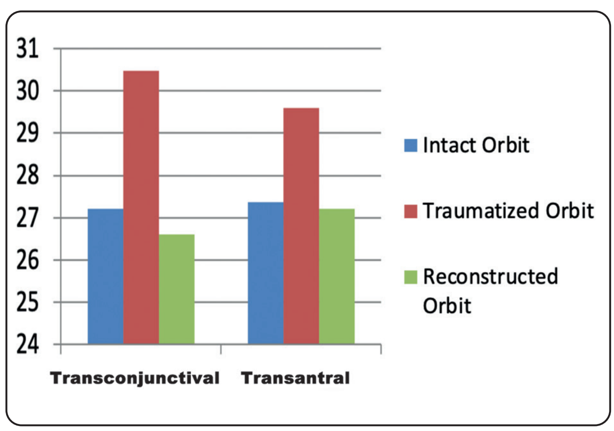
RESULTS

Ten patients were included in the transconjunctival group whereas eight patients were operated upon in the transantral group. Two patients in the transconjunctival group showed signs of entropion and one patient experienced increased scleral show. None of the patients in this group showed signs of enophthalmos/hypophthalmos or decreased ocular motility. Whereas the healing of the transantral group patients passed uneventful. There were no signs of enophthalmos/hypophthalmos or decreased ocular motility in any of the gazes.

For the transconjunctival group, orbital volumes measured on the preoperative CT scans showed means of 30.48 cc for the traumatized orbits compared to 27.21 cc for the intact contralateral orbits. Immediate postoperative CT scans showed the mean orbital volume of the reconstructed orbits to be 26.61 cc, 2.2% smaller than the intact orbits.

Whereas for the transantral group, orbital volumes measured on the preoperative CT scans showed means of 29.59 cc for the traumatized orbits compared to 27.37 cc for the intact contralateral orbits. Immediate postoperative CT scans showed the mean orbital volume of the reconstructed orbits to be 27.21 cc, 0.6% smaller than the intact orbits.

	Transconjunctival Group	Transantral Group
Sample size	10	8
Mean volume of intact Orbit (cc)	27.21	27.37
Mean volume of traumatized orbit (cc)	30.48	29.59
Mean volume of reconstructed orbit (cc)	26.61	27.21
Accuracy of volume reconstruction compared to intact orbit volume (%)	2.2% smaller	0.6% smaller



DISCUSSION

Reaching the most posterior aspect of the orbital floor through traditional transcutaneous or transconjunctival lower eye-lid incisions required considerable dissection of the orbital tissues including, in some cases, severance of the contents of the inferior orbital fissure. The orbital dissection carried the risks of corneal injuries/ ulcers, considerable bleeding that obscures clear vision as well as injury of vital structures such as the infraorbital nerve or lacrimal sac, that is in addition of to the inherent complications of ectropion/ entropion of these approaches. The implementation of computer-guided surgery proved very beneficial in the field of orbital reconstruction due to the peculiar three dimensional orbital anatomy, specifically the area of the orbital floor posterior to the equator which is responsible for achieving adequate globe projection.

By revisiting the transantral approach, most of the drawbacks of the transconjunctival approach could be eliminated as evident by the uneventful healing of this group in our study compared to a 30% complication rate of entropion / increased scleral show in the transconjunctival group. This percentage of complications was similar to those reported by other authors[3].

Many authors have emphasized the importance of overcorrection of the orbital volume by making the reconstructed orbital volume actually smaller than the intact orbital volume to overcome the volume loss that occurs due to post-traumatic orbital fat herniation and atrophy[7,8]. In this research, both groups showed a percentage of overcorrection. The transconjunctival group showed a greater amount of overcorrection compared to the transantral group (2.2 vs 0.6%), this could logically be appreciated due to the fact that the mesh in the transconjunctival group is physically placed inside the orbit itself making it relatively smaller in volume when compared to the extra-orbital mesh placement of the mesh in the transantral group. However, the smaller amount of overcorrection offered by the transantral mesh placement was still clinically enough to achieve adequate globe projection without signs of hypopthalmos or enopthalmos.

Within the constraints of this study and the limited sample size, it can be concluded that the transantral approach of orbital reconstruction using a patient-specific titanium mesh offered clinically comparable results to the conventional transconjunctival mesh placement albeit with less complications.

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