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EVALUATION OF THE USE OF TITANIUM MESH IN THE RECONSTRUCTION OF ORBITAL FLOOR DEFECTS

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ABSTRACT

BACKGROUND: Orbital floor fracture is one of the most common maxillofacial fractures. Hence, many clinical methods were implemented for improvement of the techniques used.

OBJECTIVE: To evaluate the clinical performance and the accuracy of orbital volume correction by comparing the postoperative measurements with both the uninjured side and the preoperative values in the reconstruction of a traumatic orbital defect with titanium mesh.

MATERIALS AND METHODS: A group of 10 patients who suffered from recent fractures in the floor of the orbit participated in this study. All patients underwent orbital floor reconstruction using titanium mesh implants. Clinical Postoperative evaluation was conducted. Additionally, radiographic investigations were employed to compare the measurements of the orbital volume postoperatively with both measurements of the preoperatively injured and normal side.

RESULTS: The study was conducted on ten patients with orbital zygomatic complex (OZC) fractures. Regarding the primary outcome of this study, the comparison of the orbital volume measurements of the preoperatively affected and unaffected side revealed a statistically significant difference ($P < 0.001$). Conversely, the comparison of the measurements of the postoperative side to the unaffected side did not reveal a significant difference ($P = 0.211$). The postoperative records showed a 5.09% reduction in orbital volume compared to the preoperative values, which was statistically significant ($P = 0.003$).

Regarding the clinical evaluation, postoperative results showed that none of the patients developed ectropion, entropion, enophthalmos, ocular motility impairments, wound infections, or dehiscence. A highly statistically significant change in the sensation throughout the distribution of the infraorbital nerve was conducted ($p<0.001$).

CONCLUSION: Comparing orbital volume measurements is a valuable method for quantitatively assessing the success of managing (OZC) fractures. Moreover, titanium mesh has proven to be an effective and safe material for reconstructing orbital floor defects with minimal postoperative complications.

KEYWORDS: titanium mesh, orbital floor fractures, orbital volume, reconstruction.

RUNNING TITLE: Evaluation of titanium mesh in orbital floor reconstruction.

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INTRODUCTION

Frequently occurring among craniofacial traumas, the OZC fracture predominantly appears on the midface's lateral aspect, affecting areas like the zygoma, maxilla, and the orbit (1) Typically, fractures of the orbit, which represent a significant portion of midfacial injuries, account for over 40% of such incidents (2) These injuries usually involve the orbital floor and medial wall, either individually or together (3). Changes in the orbital volume, which can either increase or decrease, result from these injuries due to the orbital cavity's alteration(4) Factors such as the defect's magnitude, specific location, the count of walls affected, and the repair's complexity significantly influence the amount of orbital damage (5).

Orbital floor defects result in orbital volume expansion. Some clinical symptoms, as diplopia, limited eye movement, change in the globe level, enophthalmos, visual damage and numbness or change in the infraorbital nerve function along its distribution, are predominant complications of orbital floor fractures. Such complications indicate the need for urgent surgical intervention to correct the volume, anatomy, and function of the orbit (6).

There's significant debate among surgeons regarding orbital floor reconstruction methods (7). Material selection is influenced by the fracture's dimensions and intricacy.

Numerous studies in the literature explore a variety of materials, including autologous, allogeneic, and alloplastic options (8). Years ago, surgeons used autogenous grafts to repair orbital fractures. Their main advantages were biocompatibility and a reduced risk of infection, exposure, and foreign body reactions. However, these grafts have several drawbacks, including donor site morbidity, longer surgery times, unpredictable resorption rates, and challenges in reshaping to match the orbital floor's unique shape (9).

Resorbable alloplastic materials tend to present fewer late-stage complications, such as infections and extrusions. However, they are less strong, often require additional adjustments, lack osteoconductivity, and might lead to delayed enophthalmos (7).

Currently, the prefabricated titanium mesh stands as the predominant choice for reconstructing the orbital floor (10). This material is favored for its exceptional compatibility with human tissue and widespread application, attributable to its malleability, which facilitates accurate adaptation to the orbital floor's specific anatomy (11).

Restoring the volume of the orbital globe is essential for the recovery of both vision and eye movement. The assessment of this restoration is one of the main objective methods in evaluating the success of OZC fracture treatments (12).

The ideal measurement tool for orbital volume should be readily available, have an easy learning curve, and be quick to administer (12).

Hence, this study was designed to introduce the orbital volume as a quantitative measure for the assessment of the success of titanium mesh in restoring orbital anatomy after OZC fractures.

MATERIALS AND METHODS

Study design and Patients selection

Ten patients with orbital floor fractures who needed surgical intervention participated in the prospective clinical trial over a period between August 2023 and June 2024. Patients were selected from the Alexandria University Teaching Hospital's outpatient clinic and treated in the department of oral and maxillofacial surgery at the university's faculty of dentistry. The study procedure was approved by the Ethics Committee of Alexandria University's Faculty of Dentistry (IRB:00010556-20/9/2023). Complete and specific consents were gathered from the study participant patients. Sample size was calculated to be 10 patients based on a 5% alpha error and 80% study power. The sample size calculation was based on an effective size of 1.112, with a mean preoperative value of 23.99 ± 0.66 and postoperative value of 22.63 ± 1.03 (12).

Adult patients with no preference for one gender who were eligible for open reduction and internal fixation had a unilateral orbital floor fracture, either separated, or coupled with another orbito-zygomatic complex fracture, and consented to attend follow-up appointments for at least three months following surgery participated in this study. Patients suffered from Orbital wall defects with orbital soft tissue herniation into the maxillary sinus were evidenced on CT imaging, monocular diplopia or enophthalmos greater than 2 mm were also incorporated into the research. Patients who had a bilateral orbital floor fracture, old fracture, medically compromised patients, or patients with blindness or raptured globe were excluded from the study.

Materials

Prefabricated Titanium mesh (MESA®:www.mesaitalia.it., Italy) with a thickness of 0.4 mm was utilized for the reconstruction of orbital floor defects additionally, mini plates with a thickness of 2.0 mm and mini screws ranging from 5 to 7 mm in lengths were used when required.

Methods

Pre-operative assessment and examination (13):

The circumstances surrounding the traumatic occurrence, including the cause, time, location, and type of assault, were acquired together with all personal data. Patients' past medical and dental histories were documented, along with a thorough evaluation of their overall health. Every patient was examined for signs of edema, flattened cheeks, subconjunctival hemorrhage, circular ecchymosis, and nose bleeding. The purpose of this detailed examination was to note any ocular issues, including diplopia, decreased visual acuity, altered globe level, lowered pupil level, limited eye movements, and enophthalmos. A subjective assessment of the infraorbital nerve's sensory distribution was carried out. A high resolution helical 16-slice computed tomography (CT Scan) with a slice thickness of 0.6 mm, was performed to demonstrate orbital wall defects, orbital soft tissue herniation into the maxillary sinus, and for the preoperative assessment of the orbital volume in the normal unaffected orbit and the affected traumatized orbit (FIG 1).

Surgical phase

Treatment for each patient was nasotracheal intubation while they were in the supine posture and under general anesthesia. After scrubbing the surgical field using a povidone-iodine surgical scrub solution, the patient was covered with sterile towels so that only the surgical site was visible. Prior to releasing the tissue that was entrapped into the maxillary sinus, a forced duction test was performed. Depending on the related face injuries and fractures, the fracture line was exposed using a transconjunctival or transcutaneous method to access the orbital floor and infraorbital rim. The inferior rectus muscle and other contents that had herniated into the maxillary sinus were released by dissecting the orbital floor up to the posterior edge of the floor fracture, and then the bone was reduced into the correct anatomical position. To verify total release following the release of the entrapped tissue, a forced duction test was performed. The titanium mesh was adapted, inserted and fixed using mini screws. Surgical wound closure was done (FIG 2).

Early post-operative phase:

Following surgery, all patients received intravenous Cefotax 1 g/12 h for one day. Thereafter, they were given oral antibiotics (Amoxicillin + Clavulanic acid; Augmentin 1 gm; GlaxoSmithKline, UK) twice a day for five to seven days. Diclofenac potassium 50 mg tablets (Cataflam50 mg, Novartis, Switzerland) were administered as an analgesic and anti-inflammatory drug every eight hours for five days.

Clinical evaluation (14):

After 24 hours, a week, four weeks, and six weeks, a comprehensive follow-up was carried out to evaluate the subsequent clinical parameters.

An assessment of postoperative pain was conducted using a 10-point Visual Analogue Scale (VAS). (0–1) = None; 2-4 = Mild; 5-7 = Moderate; 8–10) = Severe. The sutured wounds were checked for pain, swelling, redness, hotness, pus discharge, and other infection-related symptoms. Subjective evaluation of the infraorbital nerve's sensory function by questioning the patient about any changes in cheek/midface sensation. objective evaluation with the nociceptive method (the pin prick test). The middle of the lower eyelid's dimensions, the middle of the nose's lateral half, the middle of the upper lip, and the middle of the zygoma were among the specific sites to be evaluated for sensory nerve function. Depending on whether the palpebral fissure was occluded or not, postoperative edema was identified. The "follow my finger" test was used to evaluate ocular mobility. There have been reports of postoperative ocular problems, including scleral show, corneal abrasion, entropion, ectropion, enophthalmos, limited eye movements, and diplopia.

Radiographic evaluation (14):

CT scan was performed immediately after surgery and after 6-months' postoperative to evaluate how well reduction and fixing went. In addition, to verify that the orbital soft tissue herniation into the maxillary sinus was fully released and that the implant had been placed anatomically appropriately.

Orbital Volume assessment (12):

The orbital volume as an objective assessment tool for the management of cases with orbital floor fracture was conducted from the High-resolution DICOM files of the preoperative and the immediate postoperative records. The DICOM data were introduced into 3D segmentation and image processing software (MIMICS 10.01, Materialism, Leuven, Belgium) for the orbital volume assessment. The following boundaries were used to automatically trace the CT scans: In the axial cross-section, the orbital anterior boundary was located at the posterior lacrimal crest, The optical nerve's orbital entry served as the posterior limit's location, And the bony structures of the orbit determined the superior, inferior, medial, and lateral boundaries. To create a three-dimensional model, manual segmentation had been started in each CT scan coronal plane slice and continued until the orbital limitations were achieved. The orbital volume for the following was automatically determined using these 3D models: the normal, unaffected orbit; the affected traumatized orbit; the post-surgery affected orbit. The normal contralateral side and the preoperative value will be compared to the postoperative volume on the fracture side (FIG 3,4).

Statistical Analysis

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp). The Shapiro-Wilk test was used to verify the normality of distribution. Significance of the obtained results was judged at the 5% level. For abnormally distributed quantitative variables, Friedman test was utilized to compare between more than two periods or stages and Post Hoc Test (Dunn's) for pairwise comparisons. While for non-parametric variables, Cochran's test was utilized for binary response variable and Post Hoc Test (Dunn's) for pairwise comparisons

RESULTS

The current study involved ten patients who were presented with orbital floor fracture. The mean age of the patients was 31.30 ± 8.72 years, the gender distribution showed a male-to-female ratio of 9:1. Road traffic accidents (RTAs) were identified as the primary etiological factor, accounting for 80% of cases. This was followed by falls and interpersonal violence (IPV), each contributing 10%.

All the enrolled patients suffered from OZC fractures with 60% of the enrolled patients suffered from fractures on the right side, whereas 40% had fractures on the left side. The infraorbital rim in one case was accessed via a transconjunctival approach. In contrast, the other cases were managed using transcutaneous incisions.

Regarding the clinical assessment of the patients, throughout the follow-up intervals, a statistically significant reduction in the preserved postoperative pain levels was reported in all enrolled subjects ($p<0.001$).

During the first follow-up period in this study, nine patients subjectively described a paresthesia along the distribution of the infraorbital nerve. This was confirmed by an objective pin-prick nociceptive test throughout the specified points. By the sixth postoperative week, all patients had completely recovered their normal sensation. This significant improvement in infraorbital nerve function was statistically significant over the follow-up period ($p<0.001$).

During the initial follow-up session, all patients had fully occluded fissures in the affected orbit due to postoperative edema. By the end of the first week post-surgery, two patients had returned to normal fissure morphology. By the sixth postoperative week, all patients had restored the normal orbital fissure outline. In terms of the assessment of the incised wounds, none of the patients stated wound complications during the intervals of follow-up.

Regarding ocular complications, only one patient (10%) experienced diplopia in the first 24 hours. This diplopia did not persist beyond the initial observational period, and the patient reported normal vision in the second follow up session.

Orbital Volume Assessment

The normal side's orbital volume had a mean value of 22.08 ± 0.35cc. whether a preoperatively injured orbit revealed a mean value of 23.86 ± 0.67 cc, representing an average increase of 8.09% from the orbital volume of the unaffected side orbit. A statistical significance in the difference in orbital volume between the normal and preoperatively injured sides was reported ($P < 0.001$).

From the immediate postoperative records, the injured side's postoperative orbital volume revealed a mean value of 22.64 ± 0.84 cc, representing an average decrease of 5.09% from the orbital volume of the preoperative fractured side and an average increase of 2.56% from the orbital volume of the normal side. A statistically significant difference was reported between the orbital volumes of the preoperative and postoperative injured sides ($P = 0.003$), whether the difference in orbital volumes of the postoperative measurements when compared to the measurements of the normal side was statistically insignificant ($p = 0.211$). (Table 1,2)

Table (1): Analysis of the Orbital Volume in the preoperatively affected, postoperatively treated, and contralateral sides (n = 10).

		Affected Side		% of Change	P
		Preoperative	Postoperative	-5.09 ± 3.22	0.003*
Unaffected Contralateral Side	% of Change	8.09 ± 2.68	2.56 ± 3.87		
	P	<0.001*	0.211		

SD: **Standard deviation**.
Test: ANOVA with repeated measures with adjusted Bonferroni Post Hoc Test.
p: p value for comparing between the studied periods
*: Statistically significant at p ≤ 0.05

Table (2): A comparative analysis of the percentage change in volume between the preoperative and postoperative measurements of the injured side and the corresponding normal side. (n = 10).

Orbital Volume / CC	Unaffected Contralateral Side	Affected Side		Test	p
		Preoperative	Postoperative		
Mean ± SD.	22.08 ± 0.35	23.86 ± 0.67	22.64 ± 0.84	28.705*	<0.001*
Min.-Max.	21.70 – 22.63	23.0 – 25.20	21.50 – 24.65		

SD: **Standard deviation**.
Test: ANOVA with repeated measures with adjusted Bonferroni Post Hoc Test.
p: p value for comparing between the studied periods
*: Statistically significant at p ≤ 0.05

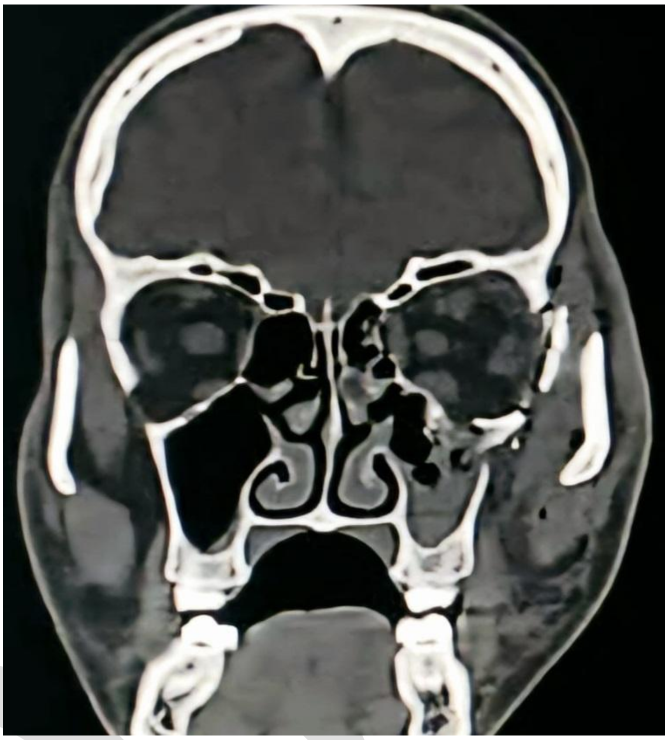

Figure (1): preoperative CT scan.

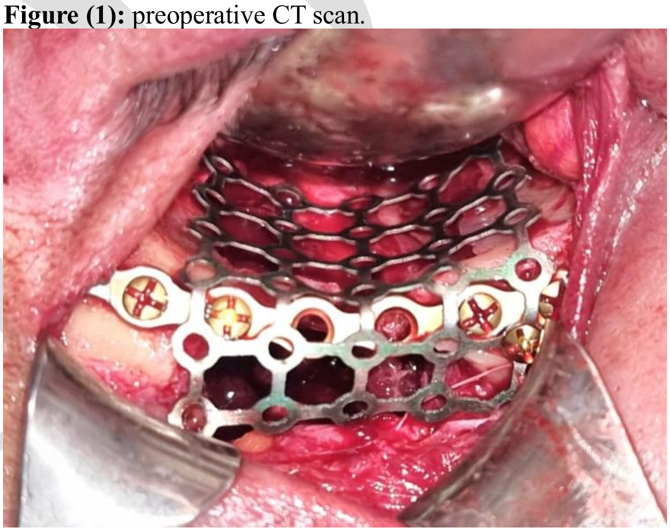

Figure (2): Reconstruction of orbital floor fracture with titanium mesh.

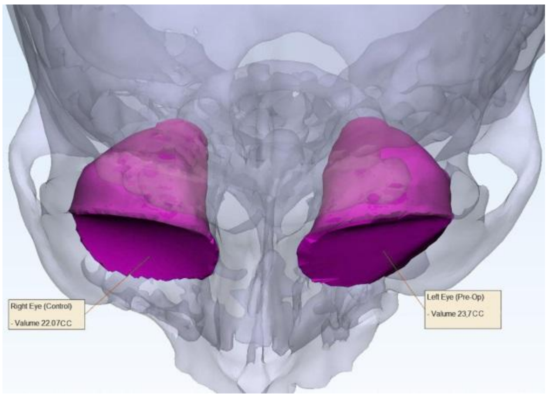

Figure (3): Assessment of Preoperative orbital volume.

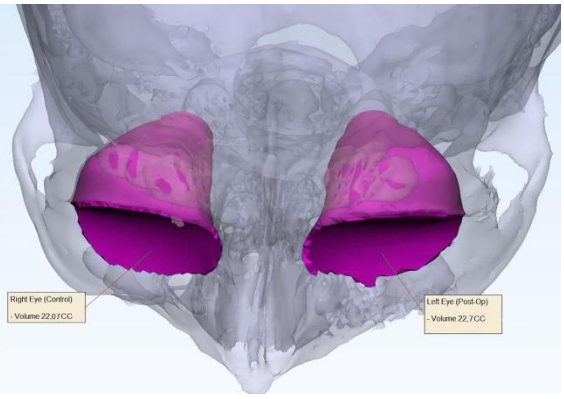

Figure (4): Post operative orbital volume analysis.

DISCUSSION

The orbit's intricate shape and three-dimensional geometric architecture present a significant difficulty for maxillofacial surgeons when treating OZC fractures, particularly when orbital wall/s defects are present (15). After trauma or surgical resection, reconstructing orbital floor defects is essential to restore both function and esthetics. Because of its biocompatibility, structural support, and simplicity of manipulation, titanium mesh has been widely used (11).

The safety profile of titanium mesh in orbital reconstruction is well-documented, with low incidences of complications. Gear et al. (2002) conducted a study over a 5-year period and found minimal risk for infection and no requirement for removal of the mesh due to complications (16). A study by Schubert et al. (2002) demonstrated rapid soft-tissue incorporation of titanium mesh, indicating its biocompatibility and suitability for orbital reconstruction (17). Long-term follow-ups indicate sustained positive outcomes with the use of titanium mesh. Patients reported high levels of satisfaction with their postoperative facial symmetry and functional outcomes. Motiee-Langroudi et al. (2015) noted that patients with titanium mesh reconstructions showed minimal complications and were generally satisfied with their aesthetic results (18).

The motivation behind this study was the dearth of information regarding an objective tool for the evaluation of the restoration of orbital floor traumatic defect using titanium mesh, since most previous research is anthropometrically and subjectively focused (19).

According to the study's assessment of the demographic data, the gender distribution showed a male-to-female ratio of 9:1, with an average of 31.30 ± 8.72 years regarding the age. These findings align with the demographic study by Ellis et al. (2004), which analyzed zygomaticomaxillary complex fractures (20). Likewise, the demographic findings are comparable to those of Khojastepour et al. (2020) concerning orbital blow-out fracture prevalence (21).

A consensus in the literature indicates that facial trauma predominantly occurs in the age range of 25-35 years old. This age group may be more susceptible to traumatic experiences due to their increased rate of daily undertakings and laborious tasks (21).

In this study, All the enrolled patients suffered from OZC fractures with 60% of the enrolled patients suffered from fractures on the right side, whereas 40% had fractures on the left side 60%.This distribution aligns with other studies, such as Das et al. (2015), who reported a predominance of right-sided fractures (22). Overall, the distribution of OZC fractures between the right and left sides varies, with no significant predilection for either side, reflecting the symmetrical anatomy of the facial bones.

Although this study had a higher male population, it has been observed that the affected females were higher than males, according to choi k-e et al.2015 (23).The substantial number of affected female patients may be associated with the identified etiological factors, as most of the cases gave a history of interpersonal violence (IPV) or falling from heights as the traumatic causative factor. Research was conducted by Clark et al. (2014) to highlight a frequently overlooked etiological factor of orbital fractures in females, specifically domestic violence. he found that 20% of orbital trauma cases were attributed to (IPV) (24). Despite the expectation of higher facial trauma incidence in females due to their vulnerability, this study demonstrated a clear male predominance. This can be attributed to the greater involvement of males in high-risk occupations, road traffic accidents and violent activities within our eastern communities, resulting in a higher likelihood of physical injuries and facial fractures.

Road Traffic Accidents (RTA) were the main traumatic causative factor in this study with a percentage of 80% of the involved patients, this was followed by falls and interpersonal violence (IPV), each contributing 10%.The literature consistently reports a high prevalence of RTA, particularly in cases involving (OZC) fractures (23, 25). Despite the results of a study done by Sun et al. (2015), who stated that 85% of orbital floor fracture cases were the result of assault incidents (26), it had been reported that 76% of cases with ZMC fractures were subjected to RTA as the main traumatic etiologic factor in a study performed on 101 cases conducted by Yamsani et al. (2012) (25). The significant contribution of RTAs to facial trauma incidents can be attributed to several factors, including the increased number of vehicles, higher traffic density, inadequate road safety measures, irresponsible driving and High speed.

Numerous ocular complications result from zygomaticomaxillary complex (ZMC) fractures as a result of the orbital floor's anatomical proximity to

ZMC. These complications indicate an urgent surgical intervention to reduce the fracture and restore the orbital floor. Consequently, many authors refer to these injuries as orbito-zygomatic fractures (27).

It had been reported by Ellis that the restoration of an orbital floor defect is mandatory when the defect exceeds 1 cm (27). Ali (2020) further stated that out of 45% of patients with orbital floor fractures, only 20% were indicated for surgical restorative intervention (28).

Transient paresthesia was observed during the initial intervals of follow-up throughout the distribution of the infraorbital nerve on the affected side, but all patients had restored normal function of the infraorbital nerve at the end of the sixth week postoperatively. In cases of OZC fractures, the infraorbital nerve is particularly vulnerable to being injured or trapped within a collapsed infraorbital canal. According to Beigi et al. (2017), it is noticed that traumatic orbital defects usually result in infraorbital nerve neuralgia. Neglected surgical intervention can lead to bony canal and nerve adhesion, resulting in a permanent change in the function of the infraorbital nerve (29). Therefore, it is necessary during surgical treatment of OZC fractures and orbital restoration to properly release the entrapped orbital muscles and properly reduce the fractured bone to relieve nerve pressure.

It had been reported in this study that all of the enrolled patients represented normal function of the infraorbital nerve at the end of the intervals of follow-up, indicating a successful surgical bone reduction, release of orbital contents, proper orbital reconstruction, and the biocompatibility of the titanium mesh with the infra orbital nerve. Ozer et al. (2016) further support this, emphasizing that precise reduction is essential for the restoration infraorbital nerve function (29).

In this study, both the subtarsal and transconjunctival approaches were employed to access the fracture. Bronstein et al. (2020) found that both of these approaches are effective for orbital floor reconstruction, with no significant differences in complication rates between the two methods (30).

The extent of the occlusion of periorbital fissures was used to assess the Postoperative edema. Severe edema was reported in all patients during the first follow-up period, with complete occlusion of the palpebral fissure. Dickinson and Gausas (2006) noted that the convergence of primary superficial and deep lymphatic drainage channels at the canthus lymphatic vessels causes postoperative edema, which presents as palpebral fissure occlusion (31).

It had been observed that the intensity of immediate postoperative edema was significantly influenced by the surgical approach used. In this study, the only patient who underwent the transconjunctival approach experienced a higher degree of occluded palpebral fissures compared to the other cases during the first postoperative week. This severe edema gradually decreased throughout the postoperative observational period. Similar findings were observed by El-Anwar et al. (2017), who reported that the transconjunctival approach had a significant direct effect on postoperative edema, which resolved over the follow-up intervals (32). Lateral canthotomy, sometimes used in the transconjunctival approach for better access to the fracture, can disrupt lymphatic drainage, which can negatively impact postoperative edema. Additionally, the narrow surgical field requiring increased retraction further exacerbates this issue.

Regarding ocular complications in this study, only one patient (10%) experienced diplopia within the early post operative follow up period. This diplopia did not persist beyond the initial observation period, indicating a transient nature likely related to immediate postoperative conditions rather than long-term complications. An approximate report was declared by Motiee-Langroudi et al. (2015) who found that 2 out of 12 patients experienced mild diplopia early in the postoperative period, which resolved within a few months. This further indicates that early postoperative diplopia is often temporary and resolves without further intervention (18). This transient diplopia is likely due to temporary factors such as edema or minor misalignments during the immediate postoperative period, which resolve as healing progresses.

None of the patients experienced postoperative ocular complications such as ectropion, entropion, enophthalmos, or impairment in ocular motility throughout the follow-up period. This indicates effective surgical treatment, including bone reduction, release of trapped muscles and fats, and the compatibility and effectiveness of titanium mesh in orbital floor reconstruction. Zhang et al. (2015) reported similar findings (33).

Regarding the assessment of the incised wounds, no complications were observed throughout the six weeks of postoperative follow-up period. This positive outcome can be attributed to the maintenance of a clean surgical field, strict sterilization protocols, and comprehensive postoperative care, including effective wound management and prophylactic antibiotics.

It has been reported that titanium mesh offers little problematic orbital volume and globe position maintenance during orbital floor reconstruction. For example, Zhang et al. (2015) demonstrated that titanium mesh successfully preserved orbital volume and globe projection, showing no significant differences compared to the unaffected side (33).

The findings of this research indicated that the normal side's orbital volume had a mean value of 22.08 ± 0.35cc. This result was slightly higher than the 21.39 ± 1.93 cc reported by Oh et al. and comparable to the 22.47 ± 4.18 cc documented by

Gribova et al., both of whom utilized the same techniques to measure the orbital volume (34, 35).

The preoperatively injured orbit revealed a mean value of 23.86 ± 0.67 cc, significantly lower than the values reported by Sharma et al who reported a mean value of 25.5 ± 0.20 cc. However, it was equivalent to the 23.17 ± 2.0 cc reported by Oh et al (35, 36). Variations in sample size or demographic differences illustrate the discrepancies in these results. In the current study, A statistical significance in the difference in orbital volume between the normal and preoperatively injured sides was reported ($P < 0.001$), with the affected orbit showing an average increase of 8.09 ± 2.68 % compared to the normal orbit. This increase in orbital volume following the orbital trauma can be attributed to the opening, widening and displacement of bony sutures as a result of the fracture. This separation leads to a reduction in the overall structural integrity and volume of the orbital cavity. Consequently, the transposition of orbital contents, including fats and muscles, into the fracture area typically occurs.

The injured side's postoperative orbital volume revealed a mean value of 22.64 ± 0.84 cc representing an average increase of +2.56% from the orbital volume of the normal side, the difference in orbital volumes of the postoperative measurements when compared to the measurements of the normal side was statistically insignificant ($p = 0.211$). Sharma et al. also reported similar postoperative insignificant differences ($P > 0.05$) (36). However, Özyazgan et al. reported a significant difference between the volumes of postoperative and unaffected orbits.($P < 0.05$) (37). In this research, a statistically significant difference was reported between the orbital volumes of the preoperative and postoperative injured sides ($P = 0.003$), with a mean decline of 1.42 ± 1.38. The percentage change in postoperative orbital volume from preoperative values was 5.09 ± 3.22%. The significant reduction in the volume of the postoperative injured orbit indicated the proper reduction of the fracture and the effective restoration of the orbital floor defect using titanium mesh.

The average volume of the injured orbit postoperatively represented an average increase of 2.56% from the orbital volume of the normal, not-injured side, demonstrating the precision of the treatment. This observation aligns with the findings of multiple authors, who concluded that the volume of nearly all postoperatively injured orbits showed some degree of increase (36, 37). Polder et al. asserted that a clinical perception of enophthalmos requires an orbital volume increase of 3 cc (12, 38). None of the cases in this study showed an increase reaching the 3 cc threshold when compared to the normal contralateral eye, which explains the absence of subjective complaints from patients.

The advent of several 3D image analysis programs has significantly improved the accuracy and consistency of orbital volume analysis, minimizing errors and variability associated with outdated methods. The 3D tracing feature allows for the creation of virtual models of the orbit and simplifying the measurements of the orbital volume (34, 35).

Postoperative CT scans, clinical evaluations, and patient satisfaction provide surgeons with valuable feedback on the effectiveness of different treatment approaches. Evaluating orbital volume after managing OZC fractures introduces a new dimension for objectively assessing the treatment. This method could facilitate future comparisons between various treatment modalities, devices, and approaches.

In this study, all enrolled cases involved orbitozygomatic complex (OZC) fractures, with lack of cases of isolated orbital blowout fractures indicated for surgical intervention. This limitation could impact the results concerning orbital volume, as the presence of additional fractures in the orbit besides the orbital floor might alter the volume outcomes. The absence of isolated blowout fracture cases means that the study primarily reflects the outcomes of complex fractures, where multiple orbital structures are involved, potentially leading to different volumetric changes compared to isolated orbital floor fractures.

CONCLUSION

Orbital volume analysis can be utilized for the quantitative evaluation of the success in managing orbital zygomatic complex (OZC) fractures. Additionally, Titanium mesh is a highly effective and safe material for orbital floor defects reconstruction, offering superior outcomes in terms of structural support, restoration of orbital volume, minimal risk of postoperative complications and patient satisfaction.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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