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Evaluation of common procedures for assessing the accuracy of reduction and fixation of unilateral orbital fractures in Iranian patients

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Original Article

Abstract

BACKGROUND AND AIM: The purpose of this study was the quantitative assessment of accuracy of surgical approaches for reconstruction of unilateral orbital wall fractures by means of measuring orbital volume changes through analysis of pre- and post-operative computed tomography scan (CT scan).

METHODS: Twenty-two patients with unilateral orbital wall fractures were included in this study. CT scans were used to obtain computer-based measurement of orbital volume in uninjured and injured orbit before and after surgery. The Shapiro-Wilk test, t-test, and paired t-test were used to analyze the data by SPSS software, such that $P < 0.05$ was significant.

RESULTS: The orbital volume of fractured orbit was significantly increased compared with unfractured orbit before surgery ($P = 0.0001$). There was no significant difference between the two orbits after orbital reconstruction ($P = 0.42$), but there was a significant difference between orbital volume of fractured orbit before surgery and after reconstruction (adequate reduction of the fractured orbit, $P = 0.0001$).

CONCLUSION: This study showed that common surgical approaches to reconstruct unilateral orbital fractures were adequate methods to restore the orbital fractured volume.

KEYWORDS: Orbit; Computed Tomography Scan; Facial; Trauma

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Trauma is the second leading cause of mortality and morbidity in Iran[1,2] and the face comes across a higher preponderance of risk. Professionals who deal with facial injuries, in addition to restoring function, are responsible for repairing facial aesthetic defects, recovering appearance, and minimizing the period of incapacity.[3] Besides, fractures involving the orbital walls are among the fifth most common facial fractures (with a prevalence of 8.4%).[4] While in developed countries, orbit fractures have contributed more to all craniofacial fractures. In an epidemiological study in American treatment centers, the prevalence of fractures involving orbital walls has been noted up to 50% of all craniofacial fractures.[5]

Isolated orbital fractures or more commonly in combination with fractures of other parts of the face cause the soft tissue within the orbit to be herniated out the orbital cavity, followed by enophthalmos, diplopia, and eye movement limitation.[6-8]

A scientific controversy has been the subject of debate in the best treatment of

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orbital fractures for years; however, recent studies on orbital wall fractures mainly focus on restoring the original volume of the orbit and the precise reconstruction of the orbital walls.[9]

Quantitative measurement of the orbital volume provides valuable evidence in the treatment of pre- and post-surgery patients with maxillofacial trauma, and can be used as a contributing parameter to primary reconstruction of the orbital wall fractures and to the estimation of treatment success.[10]

The computed tomography scan (CT scan) is known as the best imaging technique for evaluating orbital fractures, and can be used for quantitative evaluation of orbital fracture reconstruction treatments. Charteris et al. assessed orbital volume using CT scan to compare the results of pure blowout fracture treated either surgically or conservatively. Their findings revealed that it was possible to use orbital volume discrepancy to decide on surgical intervention in patients with orbital fractures.[10]

In the study by Ye et al., to evaluate the efficacy of Medpor implants in the reconstruction of large unilateral orbital fractures, pre- and post-surgical orbital volume changes obtained by CT scan were used. The results of this study showed that assessing orbit volume was valuable and could be used to estimate delayed enophthalmos.[12]

The new method which is proposed recently for the treatment of unilateral orbital fractures is using computer-aided design/computer-aided manufacturing (CAD/CAM). In this method, three-dimensional information is used to design and construct facial prostheses[13] and patient specific implants (PSIs) are designed and produced based on the mirror image of an unfractured orbit. The significant advantage of the CAD/CAM is restoration of anatomical detail and reduction of surgical time.[14]

Despite the fact that PSIs allow for accurate reconstruction of the orbital walls and reduce the duration of surgery, there are limitations in their use. According to a study by Gander et al. in 2014 in Switzerland, designing and constructing patient-specific prostheses will require four to six days for restoration of the orbital walls.[15]

Although customized plates have their indications, they are not suitable for all cases, because they are time- and resource-consuming.[16]

Conceptually, management of these injuries has changed a little over the years. However, advances in maxillofacial/orbital imaging, introduction of intraoperative navigation systems, better evidence-based surgical indications and timing, and improved implant designs have led to a reappraisal of time-honored techniques and guidance. Although treatment considerations for orbital roof and medial wall fractures will be discussed, this review will primarily focus on challenges and solutions for orbital floor fractures. In addition, due to the limited studies on quantitative evaluation of common methods for treatment of orbital wall fractures, the high cost associated with PSIs in restoring orbital wall fractures, and prolonged time for designing and constructing these prostheses, this quantitative evaluation of the accuracy of the common methods for the reconstruction of unilateral orbital fractures pre- and post-surgery was performed to evaluate the efficacy of the common methods of reconstructing orbital fractures in restoring the orbital volume to actual size before the trauma.

Methods

We evaluated 22 patients (20 men and 2 women) with unilateral orbital fractures treated in Shahid Bahonar Hospital, Kerman, Iran, between 2013 and 2016 through a retrospective study.

Inclusion criteria included patients with unilateral orbital fractures treated by common surgical methods of treating and their CT scans pre- and post-surgery were available in the picture archiving and communication system (PACS) of the hospital. Moreover, none of the patients had orbital rim fractures.

Patients were excluded if they had bilateral orbital fractures, linear fracture without displacement of orbital walls, fracture history, or previous surgery of periorbital bones. Besides, due to the lack of cooperation of some patients, it was not possible to restore orbital anatomy and visual function. Therefore, some patients chose not to have surgical correction of the orbital fractures. These patients were eliminated from the study.

Demographic information was extracted from the archives and registered in a checklist for this purpose. Pre- and post-surgery CT scans with the same radiation condition (120 kV/100 mA/1 s/continuous 5 mm slice thickness) prepared by Toshiba (Model Number: Aquilion 16, Japan) were reviewed. This method was used in previous similar researches.

We manually marked the landmarks prior for calculating the orbital volume and two clinicians were calibrated before the time of this study.

In order to measure orbital volume, software package on Toshiba CT system was used and to carry out the measurements (by senior oral and maxillofacial surgeon), the orbital cavity was traced as the following landmarks:

1- Anterior limit of the orbit: A straight line that connects the lateral and the medial rims of the orbit (connecting line of zygomaticofrontal suture to the nasomaxillary suture).

2- Posterior limit of orbit: Orbital apex

3- Medial limit of orbit: Nasomaxillary suture

4- Lateral limit of the orbit: Zygomaticofrontal suture[17]

After tracing the orbital cavity in all axial slices, the software calculated the total volume of the orbit. The orbital volume of uninjured and injured sides before and after surgery was recorded in the patient's checklists. The volume of uninjured orbit and volume of injured orbit before and after reconstruction were entered into the SPSS software (version 19, SPSS Inc., Chicago, IL, USA).

Changes in the volumes of injured orbit in comparison to uninjured orbit following the trauma and changes in the volumes of the reconstructed orbit compared with injured orbit following surgery were calculated to measure the quantitative accuracy of the restoration. Shapiro-Wilk test of normality was performed to assess the normal distribution of the variables and the t-test and paired t-test were used to analyze the data, such that $P < 0.05$ was significant. In this study, the titanium mesh technique was used.

Our research was approved by Ethics Committee of Vice Deputy of Research at Kerman University of Medical Sciences and justified as IR.KMU.REC.1395.279 number.

Results

The study population included 20 men and 2 women with mean age of 23.5 ± 6.3 years (range: 16-35 years). The causes of the traumatic event in these subjects were road accidents with motorcycles (10/22), car road accidents (8/22), and assault (4/22).

All individuals suffered from multiple orbital fractures. The most common anatomical location was lateral and inferior wall (Table 1).

Table 1. Frequency distribution of anatomical location of orbital fractures

Anatomical location of orbital fractures	n (%)
Lateral, inferior	14 (63.6)
Lateral, medial, inferior	3 (13.6)
Lateral, medial, superior, inferior	2 (9.1)
Medial, superior, inferior	1 (4.5)
Lateral, superior, inferior	1 (4.5)
Lateral, superior	1 (4.5)
Total	22 (100)

The mean and standard deviation (SD) of fractured and unfractured orbital volume before and after reconstruction surgery and changes in orbital volume following reconstruction surgery are shown in table 2.

Based on statistical results at 95% confidence, we concluded that there was a significant difference between fractured and unfractured orbital volume preoperatively (P = 0.0001).

Table 2. Measures of central tendency and variability

Orbit volume (mm³)	Mean ± SD	Minimum	Maximum	P
Unfractured orbit	23034.07 ± 2575.41	19044.30	28591.40	0.0001
Fractured orbit before reconstruction	27994.25 ± 2402.07	20208.40	31636.40	0.0001
Fractured orbit after reconstruction	23645.73 ± 2503.05	19983.50	28883.80	0.4200
Volumetric changes following reconstructive surgery	4348.51 ± 1179.30	2246.80	7220.70	0.0001

SD: Standard deviation

There was no significant difference between fractured and unfractured orbital volume after reconstruction (P = 0.4200). Finally, it was revealed that there was a significant difference between the volume of orbit before and after operation (adequate reduction of the fractured orbit, P = 0.0001).

Discussion

In the present study, similar to other research works, we evaluated the efficacy of common methods for reconstructing orbital fractures in restoration of orbital volume before the trauma by titanium mesh technique. The patients who entered the study were treated by this system and the patients who needed for more complex planning were excluded.

The results of this study showed that the common methods of reconstruction of unilateral orbital fractures significantly improved orbital volume after surgery. However, in spite of the significant difference between the volume of unfractured and fractured orbital volume before surgery, there was no significant difference between unfractured and fractured orbital volume after reconstructive surgery.

The results of our study are comparable to the findings of other studies in which new methods of reconstruction of fractures involving orbital walls have been used.[17-19] Similar to our research in the study by Liu et al., comparing the volumes of unfractured and fractured orbits pre- and post-operatively in high-energy zygomatic maxillary complex injuries led to no statistically significant difference, postoperatively.[18]

In addition, Zhang et al. showed no significant difference between volume of normal orbit and those reconstructed when they used patient's specific titanium mesh and intraoperative navigation for orbital floor defects following maxillectomy.[17]

In the study by Tang et al. who examined the application of patient's specific titanium mesh in restoring orbital wall defects, their results showed that the accuracy of the reconstruction of the orbital volume was improved through the design of patient-specific prostheses.[19] Ye et al. used Medpor channel surgical implant in restoring orbital volume in the wide fractures of the orbital wall, and there was a significant difference in orbital volume between the injured and uninjured orbits before surgery. Finally, they reported no significant difference after reconstruction; demonstrating a positive effect of common surgical procedures on restoring orbital volume.[12]

The findings in the study by Charteris et al. confirm the effect of the common surgical procedure on the reconstruction of orbital fractures. They analyzed the CT scan of patients with pure blowout fracture treated with or without surgery and reported significant volumetric differences between the injured orbits between the two groups.[10]

Finally, it should be noted that surgical input for fractures of the orbitozygomatic complex varies significantly between simple and comminuted fractures.

This study has some limitations**.** It does not grade the severity of the injury or assess the need for more complex planning. In this study, the relationship between the restoration of orbital anatomy correlated with restoration of visual function was not evaluated.

Conclusion

It was revealed in the present work that the common methods of reconstruction of the fractures involving orbital walls were sufficiently precise. Although the use of new methods of reconstruction such as olecranon bone graft, autogenous iliac crest bone, heterologous cortical bone, and etc. is preferable to previous common methods, due to the limitation in the provision of reconstruction facilities in modern methods, common methods of reconstructing orbits can also be used with assurance.

Conflict of Interests

Authors have no conflict of interest.

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References

1. Forouzanfar MH, Sepanlou SG, Shahraz S, Dicker D, Naghavi P, Pourmalek F, et al. Evaluating causes of death and morbidity in Iran, global burden of diseases, injuries, and risk factors study 2010. Arch Iran Med 2014; 17(5): 304-20.
2. Saadat S, Yousefifard M, Asady H, Moghadas JA, Fayaz M, Hosseini M. The most important causes of death in iranian population; a retrospective cohort study. Emerg (Tehran) 2015; 3(1): 16-21.
3. Rezaei EA, Farahvash MR, Fathi M. Epidemiologic evaluation and management of patients with orbital fractures admitted to plastic and reconstructive surgery ward in Imam Khomeini Hospital, Tehran, Iran. Iran J Otorhinolaryngol 2009; 20(4): 201-8.
4. Motamedi MH, Dadgar E, Ebrahimi A, Shirani G, Haghighat A, Jamalpour MR. Pattern of maxillofacial fractures: A 5-year analysis of 8,818 patients. J Trauma Acute Care Surg 2014; 77(4): 630-4.
5. Bell RB, Markiewicz MR. Computer-assisted planning, stereolithographic modeling, and intraoperative navigation for complex orbital reconstruction: A descriptive study in a preliminary cohort. J Oral Maxillofac Surg 2009; 67(12): 2559-70.
6. Lim LH, Lam LK, Moore MH, Trott JA, David DJ. Associated injuries in facial fractures: Review of 839 patients. Br J Plast Surg 1993; 46(8): 635-8.
7. Converse JM, Smith B, Obear MF, Wood-Smith D. Orbital blowout fractures: A ten-year survey. Plast Reconstr Surg 1967; 39(1): 20-36.
8. Chang EL, Bernardino CR. Update on orbital trauma. Curr Opin Ophthalmol 2004; 15(5): 411-5.
9. Alinasab B, Ryott M, Stjarne P. Still no reliable consensus in management of blow-out fracture. Injury 2014; 45(1): 197-202.
10. Charteris DG, Chan CH, Whitehouse RW, Noble JL. Orbital volume measurement in the management of pure blowout fractures of the orbital floor. Br J Ophthalmol 1993; 77(2): 100-2.
11. Lukats O, Vizkelety T, Markella Z, Maka E, Kiss M, Dobai A, et al. Measurement of orbital volume after enucleation and orbital implantation. PLoS One 2012; 7(12): e50333.
12. Ye J, Kook KH, Lee SY. Evaluation of computer-based volume measurement and porous polyethylene channel implants in reconstruction of large orbital wall fractures. Invest Ophthalmol Vis Sci 2006; 47(2): 509-13.
13. Feng Z, Dong Y, Zhao Y, Bai S, Zhou B, Bi Y, et al. Computer-assisted technique for the design and manufacture of realistic facial prostheses. Br J Oral Maxillofac Surg 2010; 48(2): 105-9.
14. Alghazzawi TF. Advancements in CAD/CAM technology: Options for practical implementation. J Prosthodont Res 2016; 60(2): 72-84.
15. Gander T, Essig H, Metzler P, Lindhorst D, Dubois L, Rucker M, et al. Patient specific implants (PSI) in reconstruction of orbital floor and wall fractures. J Craniomaxillofac Surg 2015; 43(1): 126-30.
16. Khatib B, Gelesko S, Amundson M, Cheng A, Patel A, Bui T, et al. Updates in management of craniomaxillofacial gunshot wounds and reconstruction of the mandible. Facial Plast Surg Clin North Am 2017; 25(4): 563-76.
17. Zhang WB, Mao C, Liu XJ, Guo CB, Yu GY, Peng X. Outcomes of orbital floor reconstruction after extensive maxillectomy using the computer-assisted fabricated individual titanium mesh technique. J Oral Maxillofac Surg 2015; 73(10): 2065-15.
18. Liu XZ, Shu DL, Ran W, Guo B, Liao X. Digital surgical templates for managing high-energy zygomaticomaxillary complex injuries associated with orbital volume change: A quantitative assessment. J Oral Maxillofac Surg 2013; 71(10): 1712-23.
19. Tang W, Guo L, Long J, Wang H, Lin Y, Liu L, et al. Individual design and rapid prototyping in reconstruction of orbital wall defects. J Oral Maxillofac Surg 2010; 68(3): 562-70.