Evaluation of Using Titanium Mesh in the Reconstruction of Traumatic Orbital Floor Fracture

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Abstract

Background: Among the nonresorbable implants, Titanium mesh is the most common graft used for orbital reconstruction. It is continuously improved to achieve accurate restoration of orbital volume. To evaluate the using of Titanium mesh for the reconstruction of traumatic orbital floor fractures.

Patients and Methods: A total of (32**)** patients were enrolled in this study where operated under general anesthesia to repair the orbital floor fractures by using titanium mesh, and they were (24) males and **(**8) females. (16) patients had Enophthalmos,(10) patients had Diplopia,(6) patients had both enophalmos with diplopia; all patients had ecchymosis, Subconjunctival hemorrhage, Parasthesia of infraorbital nerve.

Results: The results were well represented as the following: (29)patients(90.62%) had no both diplopia & enophthalmos. Postoperative complication had been found in only(3) patients (9.3%), Two patients(6.25%) had diplopia, one patient (3.1%) had Enophthalmos.

Conclusions: Titanium mesh has a long track record of reconstruction of large orbital floor defects and correction of globe malposition.

Keywords: *Titanium mesh; orbital reconstruction and fracture*

Introduction

Orbital floor fractures have specific clinical attention for many reasons. Failure to recognize and treat them early may result in severe sequelae. However, despite surgical intervention, orbital floor fractures are associated with the risk of persisting sensibility disorders, enophthalmos, and permanent diplopia. [1] The choice of the ideal material for reconstruction of orbital floor and walls remains highly controversial. Many materials, from different sources, have been described for that task. The ultimate goals are the reconstruction of the bony orbital defect with restoration of anatomy, volume, function, and esthetics. Each type of material has advantages and disadvantages, but the most important characteristic of a material is to allow those surgical objectives to be achieved. [2] Titanium mesh is the most common grafts used for orbital reconstruction because of its biocompatibility, availability, rigid fixation and no donor site needed. [3] There is still controversy existing about the ideal material for orbital reconstruction; autogenous and synthetic materials have been used for many years, and both of them have merits and demerits. The common sources of autogenous graft are the calvarium [4], rib, iliac crest, and auricular or nasal septal cartilage. Sakakibara et al. [5] used the iliac cancellous bone of only 1 mm thickness for the reconstruction of the orbital floor. Numerous synthetic materials have been developed with the advantages of availability, no donor site morbidity, and decreased operation time. The choice of material for reconstruction is largely determined by the experience of the surgeon and implant cost. Among the nonresorbable implants, titanium mesh and Medpor [6] are the most common grafts used for orbital reconstruction. Both materials are being

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continuously improved to achieve accurate restoration of orbital volume. During the past several decades, the standard of care for orbital reconstruction after trauma has been autogenous bone grafts, complications of bone grafts, including donor site morbidities such as scar alopecia and graft resorption with delayed enophthalmos, have inspired an interest in the use of alloplastic substitutes such as titanium, Titanium"s role in orbital reconstruction was limited originally to small orbital defects, and as an adjunct to bone grafts, more recently, clinical studies have documented the sole use of titanium mesh to reconstruct large orbital defects. [7] Orbits reconstructed with titanium mesh show better results than those reconstructed with bone grafts. [8-10]

Titanium is a chemical element with symbol Ti and atomic number 22. It is a lustrous transition metal with a silver colour, low density, and high strength. [11] Titanium can be alloyed with iron, aluminium, vanadium, and molybdenum, among other elements, to produce strong, lightweight alloys. [11] The two most useful properties of the metal are corrosion resistance and the highest strength-to-density ratio of any metallic element. [12] In its unalloyed condition, titanium is as strong as some steels, but less dense.[12] Titanium is used in steel as an alloying element (ferro-titanium) to reduce grain size and as a deoxidizer, and in stainless steel to reduce carbon content. [11] Titanium is often alloyed with aluminum (to refine grain size), vanadium, copper (to harden), iron, manganese, molybdenum, and other metals. [13]

Medical applications: Because it is biocompatible (it is non-toxic and is not rejected by the body), titanium has many medical uses, including surgical implements and implants, such as hip balls and sockets (joint replacement) that can stay in place for up to 20 years. [13] The titanium is often alloyed with about 4% aluminum or 6% Al and 4% vanadium. [14] Because titanium is non-ferromagnetic, patients with titanium implants can be safely examined with magnetic resonance imaging (convenient for long-term implants). The features of 3D Titanium mesh are:malleable,0.3mm thickness,1-1.3mm screws,available for right and left sides. [15] Advantages of titanium mesh plates :[15]

1. availability, biocompatibility
2. ease of intraoperative contouring
3. rigid fixation
4. .Radiopacity
5. No donor site needed
6. Tissue incorporation may occur

Disadvantages:

1. Irregular edges of the mesh may catch prolapsed orbital fat. [16]
2. .difficulties with ease of insertion
3. difficult to remove if required

Complications of titanium mesh:

1. While a nonresorbable material, titanium cannot be replaced by new soft tissue or bone tissue and remains in situ indefinitely. This may cause possible late side effects, including toxicity due to metal ion release. [17]
2. The fibrous reaction between the implant and the orbital contents caused the eye movement restriction and the lid retraction. [18]
3. To avoid adherence syndrome, titanium mesh plates should be placed 2 mm away from the orbital rim. [18]

Patients and Methods

A total of (32) patients were enrolled in this prospective study was conducted from 2014 to 2016. There were (24) males and (8)females. Patients' age ranged between (10- 50) years. The mean age was 30 years. **Inclusion criteria:** Patients were included in this study according to the following criteria: Patients with orbital floor fractures regardless of their age or gender and type of missile injury (Blast or Bullet), Orbital floor defect(small to very large defects) confirmed by C.T. scanning, Patients with Enophthalmos and Patients with Diplopia due to mechanical obstruction. **Exclusion criteria:** Patients with the following criteria were excluded from the study: Serious general disease and unfit for surgery, Refused to participate, All orbital fractures regardless of the fracture site and Patient with diplopia due to neural causes.

Measuring of Enophalmos:

The mean preoperative enophthalmos was about (4) mm measured by a ruler from the lateral orbital rim of the injured eye to the most anterior projection of the globe in comparison to the intact contra-lateral eye.

Results

Sex and age of the patients:

There were (24) males (75%) and (8) females (25%) with a male to female ratio of (3:1), (Figure 1 and 2). The age distribution of the patients revealed a mean age of(30 ± 2.1) years furthermore, {**2**} patients (6.25%) aged (10-19) years, {**10**} patients (31.25%) aged (20-29) years, **{8}** patients (25%) aged (30-36) years, **{7** } patients (21.875%)aged (37-45) years, {**5**} patients (15.625%)aged (46-50) years.

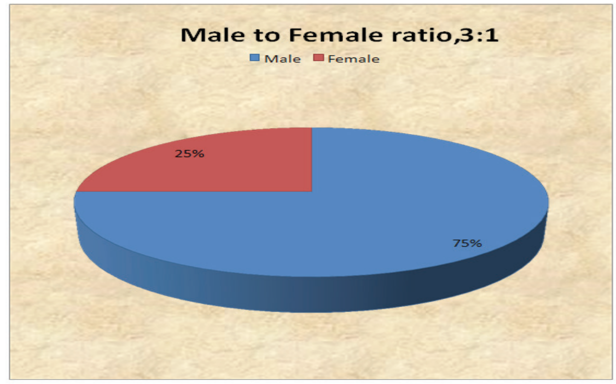

Figure 1. Gender distribution of the patients, (N=32, Male to female ratio; 3:1) Figure 2. Age distribution as percentages of the studied group, (N=32)

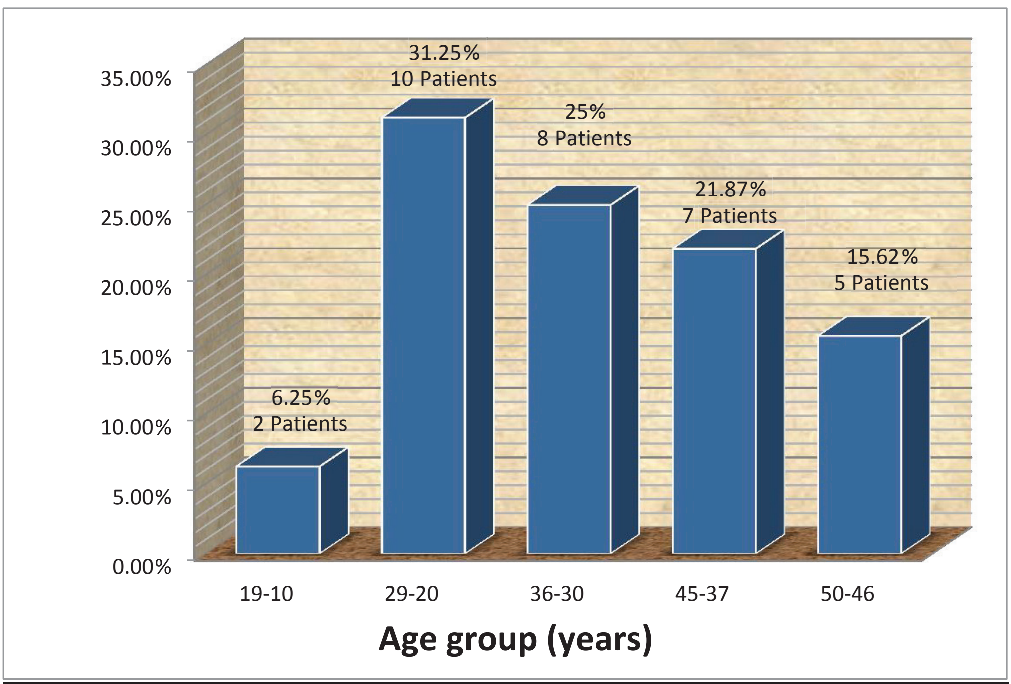

Figure 2. Age distribution as percentages of the studied group, (N=32)

Postoperative Complications

As shown in table 1, fortunately.

1. **(29) patients (90.625%) had no complications,**

2. **Post-operative complication had been found in only(3) patients (9.375%).**

3. **Two patients (6.25%) had diplopia, 3. one patient (3.125%) had Enophthalmos and**

4. **No patient (0%) had extrusion.**

Table 1. Post-operative complications of patients.

Complication	No. of patients	%
Diplopia	2	6.25
Enophthalmos	1	3.125
Extrusion of titanium mesh	0	0
No complications	29	90.625
Total	32	100

Discussion

Age Distribution

In the current study, the highest risk group weres the young patient (20-29 years) represented as(31.25%) and this was in agreement with Leibsohn et al., 1976 (19); Greenwald et al. 1979 (20); Crumley et al. 1977 (21); Andersen et al. 1985 (22). In fact that this age group represents the time of maximum activity in human life, especially males.

Sex Distribution:

Twenty four patients (75%) were males, while 8 patients (25%) were females. The predominant male to female ratio(3:1) can be explained by the fact that males spend most of their time outdoors, and due to occupational and recreational preferences. This result is consistent with the findings of the studies by: Thomas 2005 (23), Michael 2000 (24) ,David 2004 (25) ,Gordon 2004 (26), ,Joe 2005 (27)), Geoffrey 2005 (28) ,Petrus 2006 (29).

Reconstruction material:

The orbital wall is one of the most frequently damaged parts of the maxillofacial skeleton after midfacial trauma. Regardless of the fracture site, blow-out fractures can cause various functional and aesthetic sequelae. Preventing these complications from becoming long-term problems is very important, and it depends strongly on the materials used for bridging the orbital wall defects. The prerequisites of an ideal material are good biocompatibility, easy to manipulate and insertion, and it should allow fixation to the host bone by screws, wire, or sutures. It should be cheap, readily available, and strong mechanical strength to support the orbital structure. Titanium mesh has a long track record in the reconstruction of large orbital defects and correction of globe malposition. The advantages of titanium mesh plates are availability, easy intraoperative contouring, and rigid fixation. According to our work, we found it can be adapted to complex structures easily, and it can also be cut to shape as well. The orbits reconstructed with titanium mesh showed better overall reconstructions than those reconstructed with bone grafts, and according to our work, we agree with Ellis E 3rd[1], Tan Y 2003 (8).

Complications

Pre-operatively enophthalmos occur in (16) patients(50%), diplopia occur in (10) patients(31.25%), and (6) patients(18.75%) had both enophthalmos and diplopia. After reconstruction, we have only **one patient** who has persistent enophthalmos presented with extensive injury to surrounding bony structures with loss of bony architecture. We agree with the finding of { **Saikrishna Degala**, **2012** (30)}.

Postoperatively, diplopia occurs in two patients, mainly in the upward gaze. This consistent with that reported by Amrith S et al. 2000 (31).Where they reported that diplopia is not uncommon postoperatively, it is typically only disturbing when occurring in the primary or downward gaze. However, titanium plates are permanent foreign bodies. Several late-onset complications related to the titanium mesh plate have been reported, such as infection, extrusion, implant migration, residual diplopia, etc. (32). But we found in our study, the postoperative clinical and radiographical examination verified the anatomical reduction of the orbital floor. There was no displacement or resorption of the orbital floor or loosening or extrusion of the screws or mesh (6-9) months after the operation, and no modifications in the visual acuity compared with autologous materials have several disadvantages, including high risk of nerve and blood vessel injury, donor site morbidity, cosmetic disturbance, minimal controllability and an unpredictable degree of absorption (33,34).

Conclusions

1. Missile trauma was the most frequent cause of orbital injury followed by road traffic accidents, sports injury, and falls from height.

2. Titanium mesh has less complication postoperatively, such as infection and migration of mesh.

3. This study highlights the ability of the

alloplastic mesh to satisfactorily correct post-traumatic orbital sequelae, including enopthalmos and diplopia.

4. Titanium mesh can be considered to be the excellent orbital floor repair material.

5. No extrusion of Titanium mesh or rejection by the host was seen in the studied group.

Ethical Clearance: The Research Ethical Committee at scientific research by ethical approval of both environmental and health and higher education and scientific research ministries in Iraq

Conflict of Interest: The authors declare that they have no conflict of interest.

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References

1. Raghoebar GM, Brouwer TJ, Reintsema H, Van Oort RP: Augmentation of the maxillary sinus floor with autogenous bone for the placement of endosseous implants: a preliminary report. J Oral Maxillofac Surg 1993; 51(11): 1198-1203.
2. Ellis E III, Messo E. Use of nonresorbable alloplastic implants for internal orbital reconstruction. J Oral Maxillofac Surg 2004;62:873–881
3. Ochs M.W. (2004): Orbital and ocular trauma: In Michael Miloro editor: Peterson's principles of the oral and maxillofacial surgery second edition. BC Decker, Inc.
4. Burm, J. S., Chung, C. H., and Oh, S. J. Pure orbital blowout fracture: New concepts and importance of medial cubital blowout fracture. Plast. Reconstr. Surg. 1999; 103: 1839.
5. Patel PC, Sobota BT, Patel NM, et al. Comparison of transconjunctival versus subciliary approaches for orbital fractures: a review of 60 cases. J Craniomaxillofac Trauma 1998; 4:17–21.
6. Taban M, Nakra T, Mancini R, et al. Orbital wall fracture repair using seprafilm. Ophthal Plast Reconstr Surg 2009; 25:211–214.
7. Annals of Plastic Surgery: January 2002 - Volume 48 - Issue 1 - pp 1-9
8. Ellis III E, Tan Y – Assessment of Internal Orbital Reconstructions for Pure Blowout Fractures: Cranial Bone Grafts versus Titanium Mesh. *J Oral Maxillofac Surg* 2003;61:442-453
9. Kuttenberger JJ, Hardt N – Long-term Results Following Reconstruction of Craniofacial Defects with Titanium Micro-Mesh Systems. *J Craniomaxillofac Surg* 2001;29:75-81
10. Gear AJL, Lokeh A, Aldridge JH, et al. – Safety of Titanium Mesh for Orbital Reconstruction. *Ann Plast Surg*2002;48:901-910
11. *"Titanium". Encyclopædia Britannica. 2006. Retrieved 29 December2006.*
12. Donachie, Matthew J., Jr. (1988). *TITANIUM: A Technical Guide*. Metals Park, OH: ASM International. p. 11. ISBN 0-87170-309-2.
13. Hampel, Clifford A. (1968). *The Encyclopedia of the Chemical Elements*. Van Nostrand Reinhold. p. 738. ISBN 0-442-15598-0.
14. Orthopaedic Metal Alloys". Totaljoints.info. Retrieved 27 September 2010.
15. Ellis E 3rd, Tan YH. Assessment of internal orbital reconstructions for pure blowout fractures: cranial bone grafts versus titanium mesh J Oral Maxillofac Surg 2003;61:442Y453
16. Tuncer S, Yavuzer R, Kandal S, et al. Reconstruction of traumatic orbital floor fractures with resorbable mesh plate. J Craniofac Surg2007;18:598Y605.
17. Kozakiewicz M, Elgalal M, Loba P, et al. Clinical applications of 3D pre-bent titanium implants for orbital floor fractures. J Craniomaxillofac Surg 2009;37:229Y234.
18. Lee HB, Nunery WR. Orbital adherence syndrome secondary to titanium implant material. Ophthal Plast Reconstr Surg 2009;25:33Y36 .
19. Leibsohn J., Burton T. C. and Scott W. E. (1976): Orbital floor fractures: a retrospective study, Ann. Ophthalmol; 8:1057.
20. Greenwald H.S., Jr. Keeney, A. H., and Shannon, G.M. (1979): A review of 128 patients with orbital fractures, Am J. Ophthalmol; 78:655.
21. Crumley R. L., Leibsohn J., Krause C. J., et al. (1977): Fractures of the orbital floor; 87: 934.
22. Andersen M., Vibe P., Nielsen I.M., et al. (1985): unilateral orbital floor fractures, Scand J. Plast. Reconstr. Surg.; 19:193.
23. Thomas Widell, MD. Fractures, orbital, emedicine Journal, April, 2005. Available fromhttp://www.emedicine.com.
24. Michael E. Decherd, MD. Maxillary and Periorbital fractures. Grand Rounds Presentation, UTMB, Dept. of otolaryngology, January 26,2000 .

25. David K. Coats, MD, Evelyn A. Paysse MD, Jerane Kong MD. Unrecognized Microscopic Hyphema Masquerading as a closed Head Injury. PEDIATRICS, Official Journal of the American Academy of Pediatrics, Vol. 102, No. 3, September, 1998, PP. 652654.

26. Gordon Shields, MD. Maxillary and Periorbital Fractures. Grand Rounds Presentation UTMB, Dept. of Otolaryngology, January, 2004.

27. Joe Rabson, MD. Globe rupture. Emedicine Journal, July 13, 2005. Available from: http://www.emedicine.com.

28. Gecffrey M Kwitko, MD, FACS, FICS. Orbital fracture, floor. emedicine Journal, December9,2005.

29. Petrus Pereira Gomes DDS, MSc.,PhD., Luis August Passeri DDS, MSc, PhD and Jose Ricardo de Albergaria Barbosa DDS, MSc, PhD. A 5-year Retrospective Study of Zygomatico-orbital complex and Zygomatic Arch Fractures in Sao Paulo state, Brazil . Journal of oral and maxillofacial surgery, Vol. 64, Issue1, January 2006, P. 63-67.

30. Saikrishna Degala • Sujith Kumar Shetty • Lakshith Biddappa J. Maxillofac. Oral Surg. (Oct-Dec 2013) 12(4):418–423 DOI 10.1007/s12663-012-0444-9.

31. Amrith S, Seang MS, Thiam CL, Timothy KYL: Ophthalmic involvement in cranio-maxillofacial trauma. J. Cranio. Maxillofac. Surg. 2000; 28: 140-147.

32. Hwang K, Kim DH. Comparison of the supporting strength of a poly-L-lactic acid sheet and porous polyethylene (Medpor) for the reconstruction of orbital floor fractures. J Craniofac Surg 2010;21:847-53.

33. Ahlmann E, Patzakis M, Roidis N, et al. Comparison of anterior and posterior iliac crest bone grafts in terms of harvest-site morbidity and functional outcomes. J Bone Joint Surg Am 2002;84:716-20.

34. Takashima S, Tateishi J, Taguchi Y, et al. Creutzfeldt-Jakob disease with florid plaques after cadaveric dural graft in a Japanese woman. Lancet 1997;350:865-6.