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Original Research Article

THE OUTCOMES AND COMPLICATIONS OF AUTOGENOUS BONE GRAFT VS TITANIUM MESH IN THE RECONSTRUCTION OF ORBITAL FLOOR FRACTURE

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ABSTRACT

Background: The aim of this study was to evaluate the clinical outcomes and complications of autogenous bone graft and titanium mesh in the reconstruction of orbital floor fracture.

Materials and Methods: A retrospective study was conducted involving 60 patients who have either isolated orbital floor fracture or associated with zygomaticomaxillary fracture were divided into two groups: 30 patients reconstructed with autogenous iliac crest bone grafts and 30 with titanium mesh. Parameters evaluated were diplopia, enophthalmos, recovery of infra-orbital nerve sensation, radiological restoration of orbital anatomy, complications and patient reported esthetic and functional satisfaction over a period of 12 months follow up. Data was analyzed using student t test, Chi-square test and Multivariate regression with level significance at <0.05.

Results: Titanium mesh reconstruction resulted in significantly reduced operative time (86 ± 11 minutes' vs mean 108 ± 14 minutes' $p < 0.05$) and no donor site morbidity. Complications rates were comparable between groups. Bone graft showed incidence of graft resorption and postoperative volume loss in one case. Both groups demonstrated satisfactory esthetic and functional outcomes but titanium mesh group showed slightly better patient reported satisfaction.

Conclusion: Both groups have comparable outcomes but titanium mesh offer reduced morbidity, reliable, efficient and suitable alternative to iliac crest bone graft.

Keywords: Orbital floor fracture, titanium mesh, iliac crest bone graft, maxillofacial trauma, orbital floor reconstruction.

INTRODUCTION

The orbit of human is a pyramidal cavity which housing the eyeball and its associated structures which include muscles, nerves and fat. The orbit is composed of seven bones which form the four walls of the orbital cavity, the roof, floor, medial and lateral walls.[1] Orbital floor is the anatomically the weakest and most susceptible to traumatic injuries amongst all four walls due to its thin structure and proximity to the maxillary sinus followed by medial wall.[2] Orbital floor is primarily formed by orbital plate of maxilla and to lesser extent by zygomatic and palatine bones. The thinness of the orbital floor, especially the area known as the "posterior ledge" makes it highly vulnerable to fractures, particularly in blunt trauma.[3]

Orbital floor fracture is a frequent component of midface fracture and most commonly associated with zygomaticmaxillary fracture, naso-orbital ethmoid

(NOE) fracture or may occur in isolation. In case of orbital floor fracture one should considered the degree of comminution, presence or absence of herniation, percentage of orbital involvement and involvement of inferior rectus and infra-orbital nerve.[4] The pathophysiology of the orbital floor is well documented through buckling and hydraulic theories: the force from the orbital rim is directly transmitted to the floor or intraorbital pressure during trauma causing the floor to fracture outward.[5]

The typical clinical features of orbital floor fracture include periorbital ecchymosis, edema, enophthalmos, diplopia, restricted extraocular muscle movements especially the inferior rectus, infraorbital nerve hypoesthesia and occasionally orbital emphysema or globe injury.[6] To prevent long-term sequelae such aspersiistent diplopia or cosmetic deformity timely and precise diagnosis is crucial.[7] Advanced imaging particularly high resolution CT scan of axial and coronal views are absolutely necessary in evaluating the extent of orbital bone fracture, hernioation of orbital contents and determining surgical intervention.[1,8]

The aim of orbital floor reconstruction is the alignment of bony contours, restoration of orbital volume, decompression of herniated soft tissue and re-establishment of ocular esthetics and function. Untreated or improperly treated orbital floor may lead to esthetic deformities such as enophthalmos and hypoglobus or functional problems such as diplopia. Therefore it is imperative to select an appropriate reconstruction technique as well as material to achieve favorable outcome.[3,8,9] Surgical timing also plays an important role. When there is no emergency, repair is usually takes place within 7-14 days after trauma allowing resolution of edema and providing a clearer anatomical view. The surgical approaches of orbital floor fracture depends on injury site, surgeon experience and equipment availability. The most commonly used surgical approaches for orbital floor reconstruction is transconjunctival and subciliary approaches to explore orbital floor, each have their own advantages and complications.[1,8,10]

Reconstruction of orbital floor required a detailed and precise preoperative planning, surgical technique, careful dissection and a thorough and in depth analysis of implant selection, sizing and contour. Although variety of materials have been applied for the orbital reconstruction but there is controversy exist about selection of implant material.[11,12] Among autogenous materials, bone grafts harvested from the iliac crest, calvaria, mandibular symphysis, and anterior maxillary wall have been widely used. These grafts offer excellent biocompatibility and the potential for osteointegration. Alloplastic materials, on the other hand, include titanium mesh, porous polyethylene, resorbable polymers, and silicone. Titanium mesh has emerged as a frontrunner due to its structural integrity, malleability, and radiopacity.[12,13] Autogenous bone grafting has been considered the gold standard in craniofacial reconstruction owing to its immunological compatibility and osteoconductive properties. The iliac crest is a common donor site due to its rich cancellous bone and ease of harvest. Calvarial bone provides a cortical graft with a natural curvature, making it suitable for orbital floor reconstruction. The mandibular symphysis, though limited in volume, offers ease of access within the same surgical field in oral and maxillofacial surgery.[6,12] However, the use of autogenous grafts is not without limitations. Donor site morbidity, increased operative time, risk of infection, graft resorption, difficulty in contouring, and prolonged hospital stays are significant concerns. Moreover, the long-term stability of bone grafts, particularly in large defects, is variable and subject to resorptive processes.[14] Titanium mesh has gained widespread acceptance as a reconstructive material due to its favorable properties. It is strong, lightweight and easy to contour to the complex curvature of the orbital floor.[12] Despite these advantages, titanium mesh has some drawbacks. The potential for implant exposure, extrusion, infection, and late-onset complications such as chronic inflammation or migration are notable. Additionally, titanium may cause imaging artifacts in MRI, limiting follow-up imaging in some cases. There is also the theoretical risk of thermal conductivity in extreme environmental conditions.[15]

The literature often suffers from heterogeneity of existing literature there is a passing need for a comprehensive and comparative analysis of autogenous bone graft and titanium mesh in the reconstruction of orbital floor.

The aim of this study was to evaluate not only the outcomes but also the complications associated with each technique.

MATERIALS AND METHODS

This was a retrospective study carried out for 36 months from January 2022 to December, 2024 in the Department of Oral and Maxillofacial Surgery, Sardar Begum Dental College and Hospital, Peshawar. Ethical committee approval was sought. A written informed consent was taken from the patients. A total of 60 patients were enrolled who have either isolated orbital floor fracture or fracture associated with zygomaticmaxillary complex (ZMC) fracture. Patients were divided into two groups based on reconstructive material used:

Group A: Patients undergoing orbital floor reconstruction using autogenous bone graft (Anterior Iliac crest).

Group B: Patients undergoing reconstruction using pre-contoured titanium mesh.

Patients aged 18-60 years, radiologically confirmed orbital floor fracture with >2cm2 defect or with herniation of orbital contents, diplopia or enophthalmos >2mm requiring surgical intervention and willingness to undergo follow-up for a minimum period of 12 months were selected. Those patients who have comminuted fracture involving more than two walls of the orbit, pre-existing ocular pathology (globe rupture or optic neuropathy), systemic diseases (uncontrolled diabetes, immunosuppression), previous orbital surgery and who refuse consent and inability to follow up were excluded from this study.

All surgeries were performed under general anesthesia by the same surgical team in order to reduce inter-operator variability. The choice of surgical approach was based on the location and size of the defect but remained consistent within each group. The surgical approaches used were transconjunctival and subciliary approach. Subciliary approach was used when required wider exposure or additional ZMC reduction. All patients received antibiotics and steroids preoperatively.

Autogenous bone graft was harvested from anterior iliac crest. The grafts were shaped and contoured according to the defect using carbide burrs and fitted over the defect site. Rigid fixation was done using titanium microplates and screws when required. Donor sites were closed with layered sutures, and pressure dressing was applied.

Pre-contoured titanium meshes were selected based on intraoperative templates and CT measurements. The mesh was trimmed, contoured to match the orbital floor curvature and fixed using 1.3mm titanium screw. Care was taken to avoid impingement on the infraorbital nerve and to prevent overcorrection.

Intraoperative forced duction test was performed before and after implant placement. Hemostasis was achieved to reduce postoperative hematoma.

Patients were observed postoperatively for 24-48 hours for orbital compartment syndrome signs or infection. Postoperatively the patient head was elevated, cold compression, intravenous antibiotics for 3 days followed by 5 days' oral antibiotic, oral corticosteroid for 5-7 days to reduce edema, analgesics and vitamin B complex was given. Follow up was scheduled at 01 weeks, 01 months, 03 months, 06 months and 12 months. At each follow up visit the following assessments were performed:

Clinical examination for diplopia, ocular motility and infraorbital nerve sensation, enophthalmos (using Hertel exophthalmometer), assessment of graft position and orbital volume using post-operative CT scan at 03 months, patient's satisfaction score using 10 points likert scale and esthetic outcomes.

The primary outcomes were resolution of diplopia, enophthalmos correction <2mm, recovery of infra-orbital nerve sensation and radiological restoration of orbital anatomy. The secondary outcomes were incidence of postoperative complications (infection, graft resorption, mesh exposure, persistent enophthalmos >2mm and donor side morbidity) and patient reported satisfaction (functional and esthetic).

The data was analyzed using SPSS version 23.0. Continuous variables were expressed as mean and standard deviation. Chi-square was used for categorical variables. Student t test was used for continuous variables. Multivariate regression analysis was conducted to identify predictors of poor outcome or complications. A p-value of <0.05 was considered statistically significant.

RESULTS

The mean age was 34.6 ± 9.2 years in Group A and 35.2 ± 8.7 years in Group B. Most patients were male (73.3% in Group A and 70% in Group B). The predominant cause of injury was road traffic accidents. Surgical duration was longer in Group A (mean 108 ± 14 minutes) due to the additional time for graft harvesting from the iliac crest. In contrast, Group B had a mean operative time of 86 ± 11 minutes ($p < 0.05$). Mean hospital stay was 4.2 ± 1.3 days for Group A and 3.5 ± 1.1 days for Group B. Functional outcomes were comparable between groups. Resolution of diplopia at 3 months was seen in 93.3% of Group A and 96.7% of Group B. Enophthalmos correction (<2 mm residual difference) was achieved in 86.7% in Group A and 93.3% in Group B. Infraorbital nerve hypoesthesia resolved in 80% of Group A and 83.3% of Group B by 6 months. CT scans at 3 months showed satisfactory orbital floor continuity and positioning of the graft or mesh. Restoration of orbital volume was 94.8% in Group A and 96.9% in Group B. Aesthetic outcomes rated by independent surgeons showed a mean score of 8.4 ± 0.8 in Group A and 8.9 ± 0.7 in Group B ($p = 0.11$). Patient satisfaction was slightly higher in Group B. The summary of clinical and radiographic outcomes was given in [Table 1]. Complications were slightly more common in Group A, primarily due to donor site morbidity. Two cases of donor site infection and one case of graft resorption were noted. In Group B, one case of mesh exposure and one transient nerve irritation were reported. The postoperative complications are given in [Table 2 and Figure 1]. Multivariate regression did not identify a statistically significant predictor of poor outcome, though delays in surgery and defect sizes >3 cm² were linked with prolonged recovery.

Table 1: Clinical and radiographic outcomes

Outcome	Group A (Bone Graft)	Group B (Titanium Mesh)	p-value	Unit
Surgery duration	108 ± 14	86 ± 11	<0.05	minutes
Diplopia resolution	93.3%	96.7%	0.55	%
Enophthalmos correction	86.7%	93.3%	0.38	%
Infraorbital nerve recovery	80%	83.3%	0.77	%
Orbital volume restoration	94.8%	96.9%	0.12	%
Aesthetic score	8.4 ± 0.8	8.9 ± 0.7	0.11	/10
Patient satisfaction	8.2 ± 1.0	8.7 ± 0.9	0.18	/10

Table 2: Postoperative complications.

Complication	Group A (n=30)	Group B (n=30)
Graft resorption	1	0
Donor site infection	2	0
Mesh exposure	0	1
Nerve irritation	0	1
Total complications	3 (10%)	2 (6.7%)

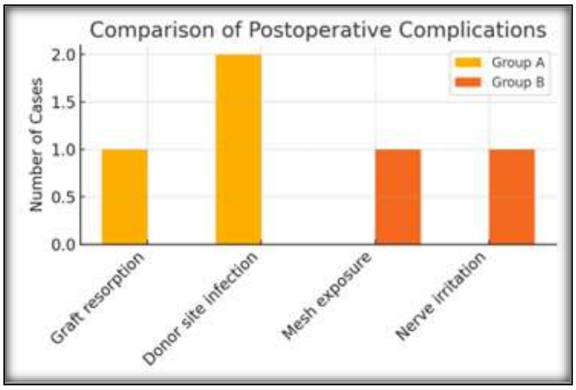

Figure 1: Comparison of postoperative complications.

DISCUSSION

The reconstruction of orbital floor fractures remains a critical aspect of maxillofacial trauma management due to the functional and aesthetic implications it poses. The choice between autogenous bone grafts and alloplastic materials such as titanium mesh has long been a subject of clinical investigation. This study provides an in-depth comparative analysis of the outcomes, complications, and surgical considerations related to these two widely used reconstructive techniques.

The autogenous bone graft especially from anterior iliac crest have been the choice of the surgeon and a corner stone in orbital reconstruction for several decades. The iliac crest provides abundant quantity of corticocancellous bone biologically support osteconduction and osteoinduction. These properties help in promoting healing and integration that are particularly important in young patients or in those cases that require extensive bony regeneration but the clinical benefits of autogenous bone graft must be weighed against the morbidity associated with graft harvesting including pain, hematoma, infection and potential gait disturbance.

The findings of this study showed a statistically significant increase in surgical time for autogenous graft group and could be due to the harvesting procedure from iliac crest. All patients recover without major complications. Moreover, one patient in this group experienced graft resorption resulting in residual enophthalmos which is a known limitation of non-vascularized grafts. This finding is consistent with other studies that highlight the unpredictable resorption rate of autogenous bone over time.[16] In contrast, titanium mesh offers a stable, easily contourable alternative that significantly reduces operative time and eliminates donor site complications. Our results demonstrated that patients in the titanium mesh group had shorter operative durations and fewer complications overall. One patient did experience mesh exposure, which is a known risk, particularly in cases of inadequate soft tissue coverage. Yu Y et al,[15] in their also revealed mesh exposure and may be due to inadequate soft tissue coverage. However, conservative management was successful, and no implant removal was required. Titanium's biocompatibility and structural integrity provide sustained orbital support and also with a low risk of late degradation.[17]

Functionally both groups achieved satisfactory outcomes in terms of diplopia resolution, enophthalmos correction and infraorbital nerve recovery but titanium showed little better outcomes than iliac crest. These results are in consistent with the results showed by Alasraj et al.[18] These findings demonstrate that both titanium and iliac crest effectively restored orbital anatomy when they are used with appropriate planning and surgical technique.

From the patient centered prespective, esthetic satisfaction and quality of life are important. While both group showed high satisfaction score but titanium group reported a slightly higher mean score than iliac crest group, although not statistically significant which is in consistent with study done by Ahmad et al.[19] The reason could be that titanium group showed faster recovery and absence of donor site pain.

This study's limitations include a modest sample size and limited follow-up duration. While early results are encouraging, longer-term follow-up is necessary to assess implant longevity, late complications such as graft resorption, mesh exposure, and functional recurrence. Furthermore, cost analysis and resource considerations, particularly in resource-constrained settings, must be addressed in future research.

Future studies should incorporate patient-reported outcome measures (PROMs) and long-term imaging follow-up to assess both clinical success and subjective quality of life. Multicenter trials with larger cohorts would provide more robust data to guide clinical decision-making.

The clinical implications of the study could be that titanium mesh is advantageous in high risk patients where donor site morbidity must be avoided. Those in elderly patients, systemic diseases or those going multiple simultaneous procedures, titanium mesh are the choice for orbial floor reconstruction. Whenever a composite bone defect is present iliac crest should be the choice of material in orbital floor reconstruction due to biologic integration. Preoperative scanning is required for accurate planning and intraoperative navigation to enhance accuracy. The decision of ewhether to use titanium mesh or iliac crest graft must be individualized based on defect size, patient's comorbidities, surgeon experience and resources vailibility.

CONCLUSION

The findings of this concluded that bothe autogenous iliac crest bone graft and titanium mesh more reliable for orbital floor reconstruction with acceptable outcomes and complication rates. Titanium mesh is advantageous over iliac crest in terms of reduced surgical time, absence of donor site morbidity and consistent functional and esthetic outcomes making it a preferable choice in many cases. However, autogenous bone graft have specific clinical scenarios where biologic regeneration is manadatory.

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