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Shaping of comminuted maxilla fractures with titanium mesh

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***Abstract*---**Multiply comminuted fragmented fracturesof the maxillofacial area are difficult to fix with titanium plates because of the small size of fragments, complex 3D anatomy, thin bone which is unable to hold screws and multidirectional pull of muscles.This study

intend to present a case series of extremely comminuted maxilla fractures involving orbital floor both of which rereconstructed with Titanium mesh, cut to shape and used to mold the small fragmented segments in to the shape of the facial bones. Severe fragmentation of maxillary wall leads to facial hollowing, tissue prolapse and asymmetry even after major facial buttresses are reconstructed. Simple Titanium mesh can be used to reconstruct these severe fragmentations of thin bones of the maxillary wall as shown in the series and avoid late and unsightly complications.

***Keywords*---**maxillary fracture, titanium mesh, multiple communicated, fragmentation.

Introduction

In the early1960s, a rigid solid mesh was introduced for use in several facial traumas, and after that a malleableVitallium mesh was introduced[1]. The industrial production of Titanium mesh begun for the use of semi-rigid fixation of comminuted fractures [2]. Since then Titanium mesh has been used for several type of fractures of anterior wall of the frontal bone, orbital wall, anterior maxilla[3]. High-velocity road traffic accidents(RTA) is the most common aetiology and these variety of fracture is directly proportional to the impact of the injury[4]. Some of the high-speed RTA may present with comminution of thin maxillary wall and as well as orbital walls. Multiple Comminution of orbital rim, floor fractures as well anterior maxillary wall can also present with a similar situation where mini/microplates cannot be fixed because of the presence of multiple small fragments [6]. Comminution of orbital walls and anterior maxilla which forms the lateral nasal wall leads to soft tissue prolapse, chronic maxillary sinusitis and chronic nasal congestion in the long term[7,8]. The main purpose of this article is to present a series of various cases in which titanium mesh was used for reconstruction of the severely comminuted maxillary complex, orbital walls, orbital rim, and Naso-orbito-ethmoidal (NOE) fractures that were not managable by normal mini plate fixation techniques and present medium- term outcomes with the use of titanium mesh.

Case series

This case series was performed in the department of ENT at adesh institute of medical sciences and research , Bathinda from May 2020 to November 2021. In this study ; consecutive patients of all age group presenting with comminuted fractures of any facial bone were included (n = 12). All of the patients had undergone clinical investigations, CT scan with the acquisition of 3D reformatted images and were planned for surgical management under general anaesthesia. Inclusion criteria were fractures with fragmentation smaller than 2mm and multiple fragments, more than 4 in number, which was confirmed on the Computed Tomography scan measurement. Multiple fractured bone with larger fragments and fewer number of segments were excluded because they are better managed by micro/mini plateosteosynthesis. All of the patients completed their postoperative investigations and their immediate follow-up. All of the cases were

analysed retrospectively by retrieving their medical records from the central record system. We used a similar specific treatment protocol in all of them, where a stock of 0.6–1mm titanium mesh was cut and was shaped according to the part of the face that was being reconstructed, intraoperatively. All of the cases were operated within 48hours of admission as per the protocol of the unit. We obtained data on radiographic reduction from postoperative CT scan, the patient reported symmetry of the face, the patient reported diplopia or vision changes after surgery, impaired wound healing, incidence and cause of removal of the implant and any unanticipated problems with the titanium mesh. The study was approved by the ethical clearance committee of the institutional review board.

Technique

Case 1

A 15 -year female with gunshot, presented in emergency with severe comminution of right zygomatic-orbital complex with multiple facial lacerations. Enophthalmos and Hypoglobus were observed because of the comminuted orbital floor and widening of orbital volume due to lateral displacement of the lateral orbital wall(Fig.1AandB). The initial ophthalmic evaluation determined the loss of vision and patient was planned for enucleation if the she developed anysignsofsympathetic ophthalmitis of the contralateral eye. Osteosynthesis was performed though an existing exit wound and a 44 cm size, 0.6mm thickness continuous titanium mesh was meticulously cut according to shape of the defect in orbital floor and anterior maxillary wall. This single piece of Titanium mesh was used to mould and shape the comminuted fractures and fixed with 26mm titanium screws. Post-operative CT scan confirmed absolute mirror image reduction of fracture segments compared to the uninjured contralateral rim. The patient then regained light perception diminished vision in the right eye and signs of sympathetic ophthalmitis of the contralateral eye so enucleation was done. She was followed up and has no major defects.

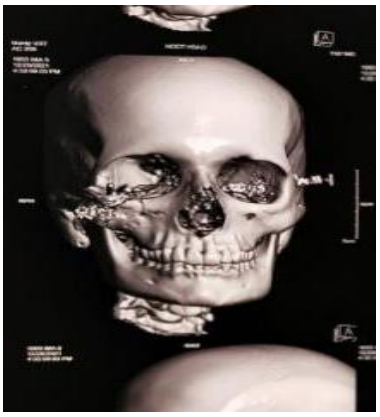

Figure 1 a (defect in orbital floor and anterior maxillary wall)

figure 1 b(single piece of Titanium mesh used)

Case 2
A17-year male presented to hospital with comminuted fracture of the right lateral orbital rim after RTA.The fracture was confined to the lateral orbital rim and was not extending into the orbit. The Fracture was exposed by a lateral eye brow incision and then comminuted fragments were moulded into shape with a 0.6mm Titanium mesh. Post-operative CT scan were done to confirm absolute mirror image reduction of fracture segments compared to the uninjured contralateral orbital rim . The patient was followed up and has no complications.

Case 3
A 36-year male suffered an isolated orbital floor fracture after an assualt. Ophthalmic examination revealed enophthalmos and diplopia in the inferior gaze. The isolated orbital floor fracture was extending posteriorly to the posteromedial ledge of the orbit. The fracture was approached by a trans conjunctival incision. The floor defect was spanned with a 0.6mm Titanium mesh that was cut in to defect size intraoperatvely based on CT scan measurements and fixed with 2×6 mm screws at anterior orbital rim. Post-operative Orbital CT scan revealed accurate reconstruction of the orbital floor defect. The patient was followed up and he has no ophthalmic and cosmetic complaints.

Case 5 and 9
A 49-year old male presented with comminution of left Nasomaxillary process and simple mandible symphysis fracture along with soft tissue lacerations after an assault. Fixation of mandibular fracture was done with 2mm mini plates and comminuted left Nasomaxillary fracture was repaired with a 0.6mmTitanium mesh which was cut and shaped to the lateral nasal wall and piriform aperture. The patient was very poor and he lived far from the city and was lost to follow up. A similar case of RTA presented with a continuous fracture of right NOE, Medial orbital wall and a fragmented lateral nasal wall along with right infraorbital rim. Reduction of the fragments and shaping was done with a continuous 0.6 mm titanium mesh cut to fit the shape of Frontonasal buttress, medial orbital wall and lateral nasal wall with a single mesh and fixed with 2×6 mm screws.

Case 8
A 38-year male was presented with a fracture of the anterior wall of frontal bone and Fragmentation of medial orbital rim (Fig.5AandB). The fracture was accessed

through the existing laceration and fragmented medial orbital rim was moulded into shape with a 0.6mm Titanium mesh cut to fit the fracture size and was fixed with 26 mm screws .The patient was followed up and has no complications.

Twelve cases of comminuted maxillofacial fractures were analysed. A slight of male predilection showed (9,75%and3 female25%) with mean age 34.16 years old. All the included cases were in the mid face and none of them in the mandible. According to the medical histories in 7 cases (77.14%), the cause of the fracture was RTA , 2 cases (17.14%) was attack, 1 case of assault (2.85%) and explosion in 1 case (2.85%). During initial clinical investigation asymmetry of the face was observed in 7 cases (17.14%), hypoglobus in 2 cases and loss of vision in one case. Radiological investigation revealed the majority of patients had extreme fragmentation (>10 fragments).

Discussion

We have presented a technical note with very few representative cases where draping and shaping of minute fragment comminution of facial fractures were achieved with Titanium mesh. Titanium is malleable and has good handling properties which are required for bending and shaping the mesh to the complex three-dimensional shape of the midface[9]. In our experience,we have found that the fragmentation of mid face bones can occur in conjunction with the typical pattern of fractures. We routinely used titanium mesh of a large size to cut out and customize a single spanning implant that can hold the multiple comminuted fragments in to the desired shape as shown in the reported cases . Conventional miniplates cannot be used to fix such fragmented bones. The additional advantage of titanium mesh is its ability to provide support or cupping of the fragments as it can be moulded to fit the exact curves and dimensions of the zygoma, orbit, maxilla and frontonasal region. In case of depressed orbital roof fractures along with frontal bone anterior wall fractures, a single piece of titanium mesh can be used to reduce and support the anterior wall of frontal bone as well as to adapt and mould the depressed supraorbital rim and orbital roof [10,11]. We achieved moulding of comminuted orbital rims with a small titanium mesh rolled into the shape of orbital rims. Appropriately trimmed and sized titanium mesh is a cheaper alternative as reconstructive material for orbital floor and medial wall fractures compared to orbit specific implants and custom implants[12].They are made of similar material and they have similar biocompatibility and mechanical properties as well as the mesh system allows fibrous ingrowth and acts as a scaffold for bone formation. We have been able to reconstruct orbital floor in nearly all of the cases with simple titanium mesh cut to the shape of the defect without requiring expensive custom orbital floor implants. It is imperative to have a sound idea of dimensions and curves of orbital walls and the importance of resting the posterior end of these implants on a stable bony ledge to ensure the end is not protruding in the maxillary sinus. The ease with which Simple rectangular titanium mesh can be cut and adapted to orbital wall defects is a boon for maxillofacial surgeons without access to the custom implants or expensive stock orbital implants [13]. One issue of importance is the management of sharp cut ends of mesh that can potentially injures of ttissue or even cause globe injury. These sharp ends need to be trimmed and rounded with a rotary trimmer or a filebe for application. Another trick is to insert the orbital floor mesh

in such a way that blunt edges of the mesh goes inside the orbit and cut end towards the rim[6]. The thin titanium mesh can also be folded upon themselves to provide thicker volume restoring implants in the cases of bone loss. The titanium mesh can be used to hold the small comminuted fragments with mini-screws if there are small-sized fragments that allow screw placement. In case of severe comminution where the minute fragments of bone are not amenable to screw fixation, titanium mesh can be adapted and moulded over the minute fragments to hold them in a place like bone grafts[14]. Although the mini plates and microplates have widespread usage for mid facial fractures, they have an innate problem of not being able to withstand three-dimensional movements and they cannot hold the fragments of bones in all three dimensions. These shortcomings led to the development of three-dimensional(3D) concept of stabilization and can be achieved with 3D miniplates, curved strut plates and mesh systems[15]. The biomechanical stability achieved by these systems helps in combating the torsional and bending forces along with the advantages of simplified adaptation to the bone without distortion or displacement. The semi-rigid nature of Titanium Mesh allows micromovements at the healing bone ends and prevents stress shielding along with acceptable postoperative aesthetic results. Titanium mesh combines the versatility of a mesh system with the multidimensional stability provided by a 3D system.

Conclusion

The Titanium mesh is versatile, very easy to use and inexpensive system that was used for semi-rigid fixation of extremely comminuted and minutely fragmented fractures of the frontal bone, NOE, Zygomaticomaxillary complex and the orbital walls in our case series, which could not be fixed with the miniplates.The titanium mesh has been available for a long period of time, and our case series shows that it can be used to shape extremely fragmented midface fractures. It has a good histocompatibility and allows the tissue ingrowth as well as it acts as a scaffold for osteogenesis. It is easily bendable, and can be cut into and shaped to the complex three-dimensional anatomy of the facial bones and used to mould and hold the comminuted facial bone fragments into shape.There are very few complications which have been observed with the use of Titanium mesh in our experience. A future direction of our research will be to provide a point of care 3D printed models of the fractures and defects for presurgical trimming and adaptation of themesh.

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