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Original Research

Efficacy of Polyproplyene mesh (Prolene) in Traumatic Midfacial Defects

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Abstract:

Background: A number of alloplastic materials have been proposed suitable for grafts in reconstruction of the midface such as methyl methacrylate, hydroxyapatite, teflon, titanium, and polyethylene. Undyed polypropylene surgical mesh (prolene mesh) appears to be another option for traumatic midfacial defects.

The main objective of this study was to post-operatively assess the "usefulness and effectiveness of prolene mesh used for reconstruction of the traumatic midfacial defects."

Materials and Methods: A 10 patients with age ranging from 22 to 40 years with traumatic midfacial defects were included in the study. An undyed monofilament polypropylene non-absorbable surgical mesh was contoured using surgical scissors. The surgical access to the midface was achieved via standard approaches, the mesh was placed on the defect and was stabilized with 1.5 mm titanium screws. All the patients were post-operatively assessed for the biocompatibility and versatility of prolene mesh.

Results: Average follow-up period ranged from 3 to 4 years. Factors evaluated both clinically and radiographically were infection and extrusion of the graft. No complications were recorded in patients that underwent reconstruction of the floor of the orbit. Out of 10 cases of anterior sinus wall defects reconstructed with prolene mesh, three cases had signs of infection after 1st and 3rd months, respectively. They were managed with oral antibiotics for a period of 1-week. One patient did not respond to antibiotic regime, and the graft was removed under local anesthesia.

Conclusion: We conclude that prolene mesh can be effectively used after proper case selection and surgical technique for reconstruction of the traumatic midfacial defects.

Key Words: Anterior wall of maxillary sinus, orbital floor, polypropylene mesh

Introduction

The midface is composed of the nasal, zygoma, maxilla, ethmoid and concha, palatine, inferior concha and vomer which is collectively referred to as the middle third of the facial skeleton.[1] Fractures of the facial skeleton result from assaults, motor vehicle crashes, and industrial accidents. Maxillary sinuses are the most frequent injured anatomic region of the facial skeleton in midfacial fractures. The most midface fracture involves the anterior maxillary sinus; the anterior sinus wall consists of thin bone because of low loading during normal function as load transmission occurs through the perinasal and zygomatic buttress. Therefore, the anterior maxillary wall is the most frequent involved in fractures. In fractures, the infraorbital nerve is affected in many cases, which may lead to hypo-sensibility or, even worse, anesthesia and allodynia of innervated skin areas.[2]

The blood supply to the maxillary sinus is provided by three branches of the maxillary artery: The greater palatine artery, the infraorbital artery (IOA) and the posterior superior alveolar artery (PSSA). Usually, the PSSA, and the IOA from anastomosis inside and outside the bony lateral antral wall the supply the epiperiosteal vestibular tissues. According to literature, an intraosseous anastomosis is constantly present in about 44% of the cases. Of particular importance is the intraosseous anastomosis, which is also called the alveolar antral artery (AAA). It was first described in 1934, and its course was found to be completely intraosseous in 100% of the cases, partially intraosseous in the second premolar to second molar area in 100% of cases and, in such an area, the AAA was strictly close to the Schneiderian membrane and partially encased in the lateral sinus wall in all specimens. Severing of the AAA, although not life-threatening, can dramatically complicate the procedure by causing intense bleeding and obscuring the vision. In a patient with an artery with a diameter of more than 0.5 mm (1-2 mm), the probability of a high risk of hemorrhage is about 57%.[3]

The most frequent disorders of the maxillary sinus after trauma are sinusitis, pressure sensibility, eventually purulent secretion and rhinitis. Another important reason to reconstruct the anterior sinus wall after trauma is the prevention of the facial asymmetry through soft tissue and prevention of ventilation disorders which may arise from a narrowing of the sinus volume and may cause infection and rhinitis.[2]

The orbital skeleton represents an important anatomic crossroads, because of the intimate relationship to the central nervous system, the nose, the paranasal sinuses, the face and the structures related to the support and function of the eye.[3,4] Fractures of the internal orbit can range in size from a small crack in the floor to extensive multiple wall defects. It is documented that disturbances of visual acuity and enophthalmos are the most common complaints following orbital trauma.[5,6] Diplopia and hypoglobus with or without enophthalmos seem to be the most common clinical signs for surgical intervention.[7]

Depending on the size and location of defects; reconstructive options may vary considerably, which includes primary closure, local or regional flap, grafts, free vascularized grafts or flap with diverse options as each has its inherent advantages and disadvantages.[8]

Surgical techniques have become more aggressive, and the purpose of defect repair is to support orbital contents, free entrapped tissue, reposition herniated orbital tissue, and especially restore the original orbital volume. If the volume is not restored, enophthalmos will inevitably occur. Failure to restore continuity to the walls of the orbital cavity inevitably leads to atrophy and cicatricial contraction of herniated or incarcerated intraorbital contents.

Numerous biomaterials are available for reconstructing the original bony contours and restoration of proper orbital volume. Biomaterials include both naturally occurring and synthetic substances. They can be classified as alloplasts, allograft, autografts, and xenografts. The ideal material being that whose physical properties most closely replicate those of the tissue it replace.[9]

Selection of the source of material has been and remains an ongoing debate. Autogenous materials remain the standard to which the other materials are compared. Alloplasts have been gaining popularity for reconstruction of the internal orbit because of their ease of use and elimination of donor-site morbidity.

The purpose of this study is to evaluate the efficacy of monofilament non-resorbable prolene mesh in the reconstruction of traumatic midfacial defects.

Materials and Methods

The study was carried out at the Department of Oral and Maxillofacial Surgery, PMNM Dental College and Hospital, Bagalkot, Karnataka, India. The study group included 10 patients with midface fracture. All the patients were males with age ranging from 22 to 40 years. The procedure to be performed was explained, followed by informed written consent.

Patient with traumatic midface defects [Figure 1a] with its imaging CT and radiograph [Figure 1b] and clinical diagnosis of orbital floor defects [Figure 2a] with its imaging CT and radiograph [Figure 2b] showing maxillary anterior wall and orbital floor defects respectively were included in the study. All patients were evaluated for restriction of ocular mobility, alteration in ocular level, forced duction, palpabale step deformity and egg shell crackling over anterior wall of the maxilla. Routine heamatological and biochemical investigations were done

Clinical and radiographic investigations with three-dimensional reformatted axial and coronal sections of paranasal sinus view along with 30° occipitomental view showed orbital fat herniation (Figure 2b) and collapse of the anterior maxillary wall with disruption of the sinus lining (Figure 1b). Hence, open reduction and internal fixation and reconstruction with undyed monofilament polypropylene surgical mesh (prolene

Figure 1a: Pre-operative.

Figure 1b: Computed tomography-paranasal sinuses of face with three-dimensional reconstruction.

mesh) for orbital floor and anterior wall of maxillary sinus defects was performed (Figures 2d and 1d).

Surgical technique

- The main surgical objectives were reduction of the fracture, preservation of orbital volumes, periorbital fat and buccal pad of fat and stabilization of fragments.
- The vestibular incision was placed approximately 3-5 mm superior to the mucogingival junction, leaving unattached mucosa on the alveolus. The incision extended as far posteriorly as necessary to provide adequate exposure, usually of the first molar tooth (Figure 1c).
- Periosteal elevators were used to elevate the tissues in the subperiosteal plane. Dissection should be orderly, first elevating tissues superiorly, then along the piriform aperture, then posteriorly behind the zygomaticomaxillary buttress. The neurovascular bundle was encountered, and the periosteum was dissected completely around the foramen. Dissection proceeded superiorly to the infraorbital rim and posteriorly to the pterygomaxillary fissure (Figure 1c).

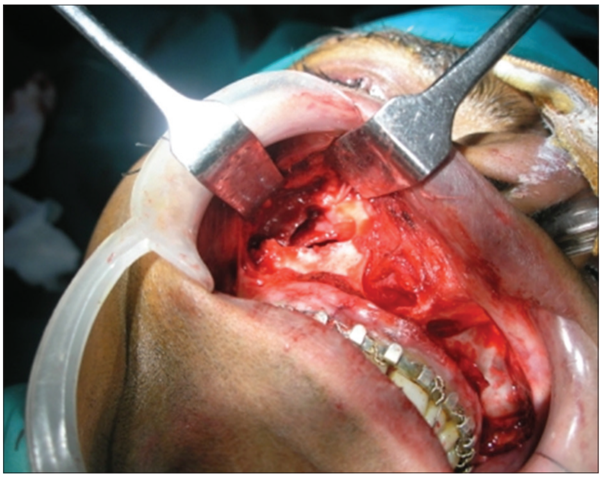

Figure 1c: Reflectionn of mucoperiosteal flap to expose the anteror wall of maxillary sinus via vestibular incision.

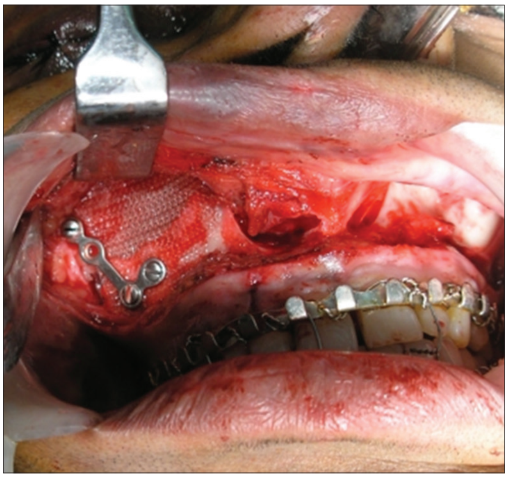

Figure 1d: Defect closed with polypropylene mesh and fixation with miniplates.

- A mucoperiosteal flap was elevated to expose the zygomaticomaxillary complex fracture site and soft tissue prolapsed within the sinus. The sinus walls were repositioned into their anatomic position, and the herniated contents were retrieved (Figure 1c).
- Prolene mesh was trimmed, depending on the extent and site of the defect. The mesh was then inserted in the subperiosteal plane ensuring that the margins rested on the firm bone. Fixation was done with titanium screws of size 1.5 mm × 4 mm and mesh was stabilized. Closure was done with absorbable sutures (Figure 1d).
- For the orbital floor fractures, surgical access was obtained through infraorbital approach-placing the skin incision along one of the natural skin creases' and palpating the bony rim. Subcutaneous dissection toward the rim proceeds for a few millimeters followed by an incision through the muscle at a lower level, producing a step-incision, and then following the orbital septum to the rim. Blunt dissection was done to reach the periosteum. The following that subperiosteal dissection was done to expose the fracture site (Figure 2c).
- The entrapped fragments of bone and herniated soft tissue were retrieved. Prolene mesh was trimmed, depending on the extent and site of the defect. The mesh was then inserted in the subperiosteal plane ensuring that the margins rested on firm bone. The prolene mesh was later stabilized with titanium screws of size 1.5 mm × 4 mm (Figure 2d).
- After checking for adequate globe mobility, the orbital periosteum was closed with interrupted absorbable sutures. The skin was closed with running subcuticular non-absorbable suture.

Post-operative follow-up

- Intravenous antibiotics were administered for 5 days followed by oral antibiotics. Thorough irrigation with povidone iodine 5%, saline and chlorhexidine gluconate 0.2% w/v was done twice a day for the post-operative period of about 5-day.
- Patients were evaluated for infection and extrusion of the graft at 7 days, 1 month, 3 months, 6 months post-operatively for the 1st year, followed by bi-annual follow-up for the 3-4 years.

Results

Out of 10 patients with maxillofacial injuries, 4 patients had concomitant orbital floor fracture, and 6 patients had anterior maxillary sinus wall fracture. The etiologies of the maxillofacial injuries were found to be road traffic accidents (80%) and fall (20%).

All patients were followed up for 3-4 years for infection and extrusion of graft both clinically and radiographically. No complications were recorded in patients that underwent

Figure 1e: Post-operative.

Figure 2a: Pre-operative

Figure 2b: CT-PNS of Face with 3D reconstruction

reconstruction of the maxillary sinus [Figure 1e] and floor of the orbit [Figure 2e]. Out of 10 cases of anterior sinus wall defects reconstructed with prolene mesh, three cases had signs of infection namely tenderness at the surgical site and radiographically haziness in the maxillary sinus as seen in paranasal sinuses (PNS) after 1st and 3rd month respectively.

Figure 2c: Exposure of the orbital floor defect via infraorbital incision

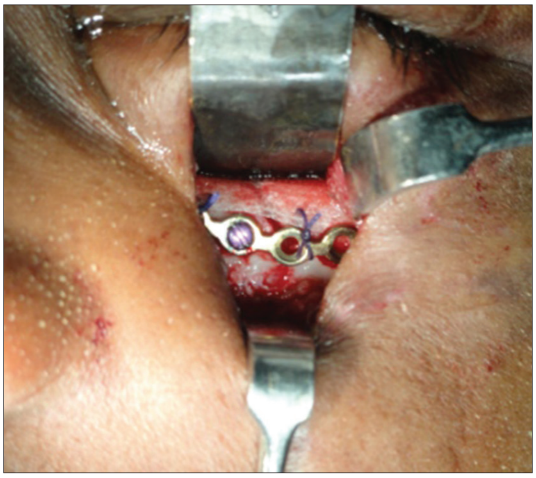

Figure 2d: Restorig the Orbital floor defect with prolene mesh via miniplates

Figure 2e: Post-operative

All three patients were managed by oral antibiotics for 1-week, one patient did not respond to oral antibiotics, and the graft was removed under local anesthesia.

Discussion

Fractures of the facial skeleton are a common component of the multiple trauma complexes resulting from assaults, motor vehicle crashes, and an industrial accident.[1,9,10] Treatment of maxillofacial fractures has long been a formidable challenge to the maxillofacial surgeon.[8] The orbit and the midfacial skeleton form the most common site of fracture being the most prominent part of face and if improperly diagnosed or treated these fractures may lead to serious complications like diplopia, enophthalmos and reduced globe motility and facial asymmetry.[11]

Most facial fractures as a result of road traffic accidents and fall as in our study impart transverse blow resulting in comminution. Compounded by these factors, the presence of maxillary sinus forms a hollow space in the skeleton which in incapable of resisting the forces. Maxillary sinuses are the most frequently injured anatomic region of the facial skeleton in midfacial fractures. The complications that are seen after maxillary sinus wall fracture are disruption of the sinus lining and prolapse of the facial structures into the sinus resulting in cosmetic defect, maxillary sinusitis, wall defects, and foreign bodies in the sinus cavities.[12-16]

Ballon *et al.*[2] evaluated the importance of the primary reconstruction of the traumatized anterior maxillary sinus wall. In the case of comminuted fractures of the midface special attention should be given to the reconstruction of the anterior maxillary sinus wall to lower the risk of long standing post-operative discomfort. The main goals of reconstructive procedures are the prevention of a cheek soft tissue prolapse into the sinus, the intrusion of bone fragments, and sequestration or irritations of the mucosa. The basic treatment should always be the exact repositioning of the fractured anterior sinus wall, followed by osteosynthetic fixation.[2]

If the defect cannot be closed with the primary available bone, autografts or allografts can be used to replace the same. Goals of orbital floor fracture repair are to free incarcerated or prolapsed orbital tissue from the fracture defect and to span the defect with an implant to restore the correct anatomy of the orbital floor and the pre-trauma orbital volume.[13] These goals may be achieved by interposing an autologous graft or a biomaterial between the residual orbital floor and the soft tissues prolapsed into the maxillary sinus, suitably repositioned inside the orbit.[2]

Numerous biomaterials are available for reconstructing the original bony contour and restoration of proper orbital volume which include both naturally occurring and synthetic substances. They can be classified as alloplasts, allografts, autografts, and xenografts. The ideal material is that whose physical properties most closely replicate those of the tissue it replaces.[5,9]

Ever since the 1889 report by Lang, a myriad of techniques and materials have been proposed for the surgical reconstruction of the internal orbit. The use of virtually every imaginable alloplast has at one time or another been reported. With the introduction of resorbable systems for reconstruction in the 1990s, the possibility of resorbable alternatives for internal orbital reconstruction has arisen.[9]

Numerous graft materials are available but all suffer from certain limitations. To overcome the same, there is a search for more appropriate graft material.

However, none of them match with ideal properties and hence the search for newer materials. Methylmethacrylate generates a significant amount of heat intra-operatively when molded *in vivo* and it is also highly reactive with surrounding tissues. For these reasons we do not recommend its use in orbital reconstruction.[13]

Hydroxyapatite is a naturally occurring, porous material. As opposed to porous polyethylene, hydroxyapatite is more fragile, more expensive, and not as easily shaped intraoperatively. In addition, hydroxyapatite confers a greater incidence of post-operative enophthalmos.[14]

Late inflammatory reactions, dacrocystitis are seen in Silastic and Silicone implants. Gelfilm has been shown to work well in small defects. However, Gelfilm strength and stability in larger defects is uncertain.[13]

On the other hand, undyed polypropylene mesh is easy to handle and can be fabricated to appropriate dimensions without frayed or sharp edges. Its tissue reactivity is low, and from our observation in the few cases of late exploration, polypropylene mesh is intimately incorporated into the periosteal tissue. The prolene mesh implant is useful for small to moderate sized defects. With appropriate applications, prolene mesh can correct or prevent the adverse sequelae of enophthalmos and diplopia.[13]

None of the patients reconstructed with prolene mesh in the floor of orbit had any complications. Out of 10 cases of prolene mesh in anterior sinus wall defects, three cases had signs of infection namely tenderness at the surgical site and radiographically haziness in the maxillary sinus as seen in PNS view after 1st and 3rd month respectively. They were managed by amoxicillin with clavulanic acid 625 mg orally for a period of 1-week. The infection in one case did not subside despite the antibiotic regimen, and the graft removal was done under local anesthesia.

Our study indicates that prolene mesh can be effectively used in the reconstruction of traumatic midface defects. There are no serious complications or resorption of the graft when followed for 3-4 years. The graft undergoes fibrous encapsulation and can be safely used in reconstruction of maxillofacial defects. The success of prolene mesh implant also depends on case selection and surgical technique. The study also shows the versatility and biocompatibility of undyed polypropylene mesh in the reconstruction of sinus wall, floor of orbit. Prolene mesh gives an excellent opportunity for the use of prolene mesh implant in the reconstruction of traumatic midfacial defects.

Summary and Conclusion

10 patients who presented with traumatic midfacial defects underwent open reduction and fixation of fracture with reconstruction using monofilament undyed non-absorbable surgical mesh at our department.

The results reveal that prolene mesh implant can be successfully used for small to moderate sized defects. Prolene mesh implant is biocompatible and also gives an excellent opportunity in the reconstruction of traumatic midfacial defects.

Although our series comprises of limited number of cases and with a good follow-up period, initial results were satisfactory, permitting us to logically conclude that undyed polypropylene surgical mesh is a reliable option in the reconstruction of traumatic midfacial defects.

Thus, we conclude that monofilament undyed non-absorbable surgical mesh (prolene mesh) can be effectively used after proper case selection and surgical technique for reconstruction of the traumatic midfacial defects.

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