

Original article

Orbital reconstruction with a partially absorbable mesh (monofilament polypropylene fibre and monofilament poliglecaprone-25): Our experience with 34 patients



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Abstract

Purpose: To evaluate the effectiveness and complications related to the use of a partially absorbable mesh for the reconstruction of orbital floor fractures.

This is a retrospective review of 34 consecutive patients who suffered orbital trauma from August 2007 to March 2013 treated with a partially absorbable mesh for orbital reconstruction. Data collected included gender, age, nationality, cause of injury, date of admission, date of surgery, date of discharge, type of fracture, signs and symptoms such as diplopia, enophthalmos, and sensory disturbance related to the infraorbital nerve, complications before and after surgery, and follow-ups at 1 week, 1 month, 6 months, and after 1 year.

Results: Since January 2007, 34 patients were treated in our department with orbital fractures: 28 males (82.4%) and 6 females (17.6%). The mean age was 31 years (minimum 14, maximum 45). The main causes of trauma were road traffic accidents (20 patients, 58.8%), followed by work-related accidents (9 patients, 26.5%), aggressions (3 patients, 8.8%), and sports (2 patients, 6%). Posttraumatic Diplopia was present in 20 patients (58.8%), and enophthalmos was in 9 (26.5%). The incidence of postoperative diplopia was present in 8 patients (23.5%), which decreased to 1 (2.9%) after one year. Paresthesia due to trauma was first noticed in 8 patients (20.6%) and completely disappeared after 12 months. Post surgical enophthalmos was noticed in 3 patients (7.5%). There was one case of migration of the mesh and one case of adherence in the lower lid. Both required surgery and resolved completely. Time from trauma to surgery was on average 5.5 days (min 0, max 27, SD 5.15), and the number of days before discharge was 3.5 days (min 1, max 16, SD 2.61).

Conclusions: This study describes the results of the first series of orbital floor reconstructions with a partially absorbable mesh (Monofilament polypropylene fibre and monofilament poliglecaprone-25) to date. Although there are a wide variety of materials for treatment, we believe it is a suitable option with an acceptable rate of complications.

Keywords: Surgical mesh, Orbital fractures

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<http://dx.doi.org/10.1016/j.sjopt.2016.07.002>

Introduction

Fractures of the orbital cavity are common injuries. They can be classified as pure (isolated orbital floor fracture) or impure (associated with an orbital rim fracture) blowout frac-

tures.¹ Depending on the type of fracture, the herniated orbital tissue can be trapped in the fractured defect or prolapsed into the maxillary or ethmoidal sinus, causing eye movement restriction or enlargement of the orbital cavity with enophthalmos, a possible functional and aesthetic impairment.

Received 10 April 2015; received in revised form 17 May 2016; accepted 12 July 2016; available online 3 August 2016.

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Peer review under responsibility of Saudi Ophthalmological Society, King Saud University



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The orbital fracture comes very frequently associated with other midface fractures, such as the zygomatic process or naso-orbito-ethmoidal region, that make it even more challenging to give the patient the best outcome.

Adequate treatment is essential after proper diagnosis in order to prevent avoidable complications and morbidities to the patient such as diplopia, enophthalmos, paresthesia, and last but not least, aesthetical disturbances. Goals of orbital floor fracture repair are to free incarcerated or prolapsed orbital tissue from the fracture defect and to correct orbital volume.

Many materials have been used to repair orbital fractures. They can be classified as autologous, allogenic, alloplastic, and xenogenic implants. Under the *autologous* category, the more frequently used materials are bone (calvarial, mandibular, and iliac crest), temporalis fascia,² and cartilage (nasal septum, rib, and auricular conchal). They have low rates of infection, no rejection, and offer good support. On the downside, we have the morbidity of the donor site, a variable (and sometimes unpredictable) resorption rate,³ difficulty in modelling the appropriate shape, and extended surgical time.⁴ *Allogenic* materials such as lyophilized dura and cartilage have osteoconductive and osteoinductive properties that give adequate structural support. The main concern involves the risk of spreading infectious diseases such as spongiform encephalopathy which can occur years after the inset of the implant.⁵

Alloplastic materials can be classified into two main categories: permanent and absorbable. In the first category, the most common are silicone, Medpor (porex, Newnan, GA), and titanium mesh. Generally they are well tolerated, but the risk of foreign body reactions is present and increases proportionally to the size of the implant. The latter category includes poly (L-lactide), polydioxanone (PDS), polyglycolic acid, and Vicryl mesh or patch (polyglactin 910).

Polyglactin 910 (nondyed Vicryl) is a biodegradable, soft, pliable synthetic material composed of lactide and glycolide acids, made of the same suture material named Vicryl. This material is reported to be resorbed after 3 months and has later on been substituted by fibrous collagenous tissue, although the mesh might take longer.^{4,6}

Finally, we have a combination of absorbable and permanent materials like the mesh we used in this study: Monofilament polypropylene fibre and monofilament poliglecaprone-25 (Ultrapro™).

Partially absorbable meshes are commonly used in general surgery, mainly for abdominal hernias. They differ in the material, pore size, elasticity, absorption time and biocompatibility (8). The idea with a large-pore sized light-weighted structure is to provide good support with a minimal foreign body reaction and good integration to the surrounding tissue.

For the reconstruction of the orbits in this study we used Ultrapro™ mesh. It is made of two components in equal proportions: Monofilament polypropylene fibre (same as Prolene™ sutures) and monofilament poliglecaprone-25 fibre (same as Monocryl™ sutures).

Brief Anatomical Review: The orbital cavity is composed of 3 rings. The exterior one, formed by the frontal, maxillary, and zygomatic bone, is a strong and protective barrier to the globe that constitutes the first defence against any trauma. The inner ring also provides a rigid and safe surrounding to the optic nerve that is in the middle of the

Zinn annulus, where the majority of the extraocular muscles are inserted. The middle ring is the weakest area, particularly in the floor and medial wall, allowing a safe decompression of the globe in case of an aggression minimizing the possibility of a globe and optic nerve injury.

Through a retrospective study of the files of 34 patients in a 6-year period, our review intended to inquire about the postoperative outcomes of orbital reconstruction using a partially absorbable mesh like Ultrapro™.

Material and methods

We retrospectively reviewed the medical records of 34 consecutive patients between January 2007 and March 2013 at the Department of Oral and Cranio-Maxillofacial Surgery at Hamad Medical Corporation, Doha, Qatar. All of them underwent reconstruction of orbital floor fractures with a partially absorbable mesh (Monofilament polypropylene fibre and monofilament poliglecaprone-25 fibre).

Data collected included gender; age; nationality; cause of injury; date of admission, date of surgery, and date of discharge; type of fracture; signs and symptoms like enophthalmos, diplopia, and infraorbital paresthesia; complications before and after surgery; and follow-ups at 1 week, 1 month, 6 months, and 1 year.

The indications for surgery were determined by the presence of signs and symptoms such as diplopia, enophthalmos, which was assessed clinically before surgery after three to seven days of corticoids and NSAIDS when condition of the patient allowed, mainly consisting of thorough examination of the periorbital soft and bony tissue, such as symmetry of the eyes, length of the palpebral fissures and fullness of upper and lower eyelids, and sensory disturbances related to the infraorbital nerve. Other criteria were computed tomography (CT) scans showing significant displacement of the globe and the bone fragments of the fracture or soft tissue incarceration into the maxillary sinus. All patients were assessed upon admission by an ophthalmologist. A conservative treatment was followed if none of the previous situations were present. Reassessment was performed in that case 1 week after the accident and later on monthly follow-ups.

Two types of approaches were performed depending on the fractures that needed to be explored and reduced and the characteristics of the soft tissues: subciliary and transconjunctival, both followed by a preseptal dissection to the inferior orbital rim and subperiosteal freeing of the floor and/or medial walls with restoration of the prolapsed tissue. Ultrapro™ mesh of 6 × 11 cm was folded as many times as needed (between 2 and 8 times) until desired rigidity and height were obtained, trimmed to the adequate shape (Figs. 1–4) and then inserted after a clean subperiosteal dissection and exposure of stable bone (Fig. 5), bridging the defect over healthy borders, avoiding any injury to the infraorbital nerve, generally with no fixation but with meticulous suture of the periosteum (Figs. 6–8). If necessary, the Vicryl mesh was fixed on the sides with screws to the inferior orbital rim, creating a hammock-like support for the globe.

Forced duction tests were carefully done before and after wound closure.

As mentioned before all patients had preoperative ophthalmological evaluations. Postoperatively, controls were



Figure 1. Ultrapro™ mesh of 6 × 11 cm folded as many times as needed (between 2 and 8 times) until desired rigidity and height was obtained, trimmed to the adequate shape.

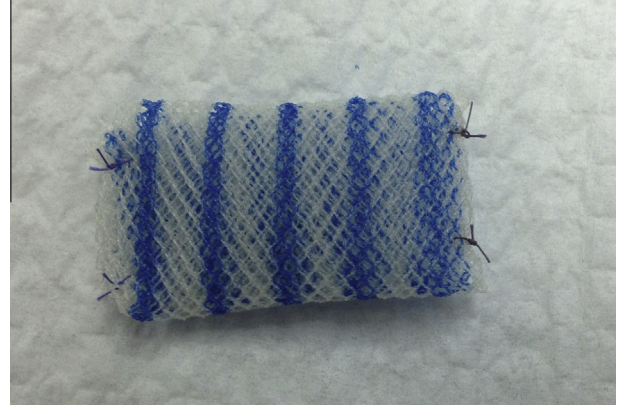


Figure 4. Clean subperiosteal dissection of the floor of the orbit and exposure of stable bone.

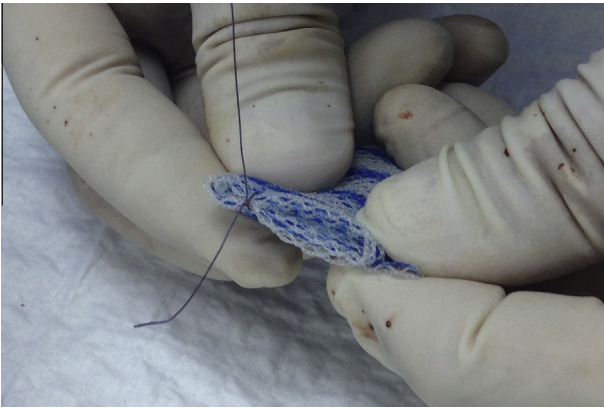


Figure 2. Ultrapro™ mesh fixed with a couple of sutures once it is folded to the right shape.

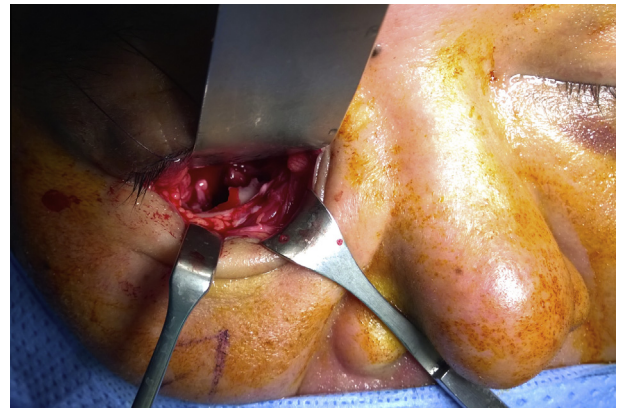


Figure 5. Placement of the mesh over the floor of the orbit making sure the borders of the fracture are covered and the anterior border is behind the inferior RIM so the periosteum can be sutured easily.



Figure 3. Final view of the mesh properly trimmed prior to the insertion in the floor of the orbit.



Figure 6. Bridging the defect over healthy borders, avoiding any injury to the infraorbital nerve, generally with no fixation but with meticulous suture of the periosteum.

done only when needed. Postop review was done at 1 week, as well as 1, 6, and 12 months subsequently after surgery. We reviewed the medical files for enophthalmos, diplopia, sensory disturbance related to the infraorbital nerve, and postoperative complications, such as clinical enophthalmos relative to the contralateral eye (if significant, we requested a control CT scan), diplopia, and infraorbital paresthesia.

Data analysis was made with software SPSS 22 (SPSS Inc., Chicago, Ill).

Our research was approved by Hamad Medical Corporation review board, which fully complies with the World Medical Association Declaration of Helsinki on medical research protocols and ethics.



Figure 7. Bridging the defect over healthy borders, avoiding any injury to the infraorbital nerve, generally with no fixation but with meticulous suture of the periosteum.



Figure 8. Bridging the defect over healthy borders, avoiding any injury to the infraorbital nerve, generally with no fixation but with meticulous suture of the periosteum.

Results

Since January 2007, 34 patients were treated in our department with orbital fractures: 29 (85.3%) isolated floor fractures and 5 involving the medial wall, lateral wall, and the roof (14.7%). Sixteen were associated with fractures of the zygoma complex (47%), 3 nasal bone fractures, and 3 frontal bone fractures (8.8%). They were 28 males (82.4%) and 6 females (17.6%). The mean age was 31 years (minimum 14, maximum 45). The patients were among 12 different nationalities: Indian (12 patients, 35.3%), Nepalese (6 patients, 17.6%), and Qatari (3 patients, 8.8%) were the most

common. The main causes of trauma were road traffic accidents (20 patients, 58.8%), followed by work-related accidents (9 patients, 26.5%), aggressions (3 patients, 8.8%), and sports (2 patients, 6%). Regarding signs and symptoms, diplopia was present in 20 patients (58.8%), and enophthalmos was in 9 (26.5%). All the fractures were assessed by CT scans, confirming significant bone displacement and increase in the orbital volume. Surgical approach was performed in 2 ways: subciliary in 27 patients (79.4%) and transconjunctival in 7 patients (20.6%). There were no immediate complications, and all of the patients were discharged by protocol and followed in the clinic at 1 week, 1 month, 6 months, and 1 year. See Table 1. The incidence of postoperative diplopia decreased from 8 patients (23.5%) the first week to 1 (2.9%) after 1 year. Paresthesia was first in 8 patients (20.6%) and completely disappeared after 12 months. Enophthalmos was noticed in 3 patients (7.5%). One patient underwent surgery using the mesh to restore the volume with satisfactory results. The other 2 patients (5.85) with minor enophthalmos were barely noticeable and did not need additional treatment. There was 1 case of partial mesh extrusion and 1 case of adherence in the lower lid. Both required surgery and resolved completely. The number of missing patients progressively increased from none in the first week up to 17 (50%) after 12 months.

Time from trauma to surgery was on average 5.5 days (min 0, max 27, SD 5.15), and the days before discharge was 3.5 (min 1, max 16, SD 2.61).

Discussion

Choosing the best biomaterial for orbital reconstruction remains a difficult task. With such a wide range of options, the final preference has to take into account the type of fracture, age and general state of the patient, type of the material (complications reported, expected time for resorption, price, hospital availability) and experience of the surgeon, among other things.

It has been repeatedly shown that when fractures are smaller than 2 cm², there is a good chance that most of the materials described before will work fine. Wider defects pose a greater challenge. In these cases, reconstruction with autogenous grafts like iliac crest could be the gold standard, giving good support to orbital contents, although proper moulding of the graft is not easy to achieve, the resorption is not predictable and there is the added morbidity of the donor site.¹⁰ Another option frequently used with a great rate of success is titanium mesh. It is thin, easy to mould, has minimum resorption, and is well tolerated with low distortion when using CT scans.¹¹ Orbital adherence syndrome resulting in extraocular

Table 1. Postoperative complications.

Complications	First week	First month	Sixth month	One year
None	14 (41.2%)	16 (47.1%)	23 (67.6%)	14 (41.2%)
Infraorbital Paresthesia	7 (20.6%)	5 (14.7%)	1 (2.5%)	
Enophthalmus	3 (8.8%)	3 (8.8%)	3 (8.8%)	2 (5.9%)
Diplopia	8 (23.5%)	6 (17.6%)	1 (2.9%)	1 (2.9%)
Migration		1 (2.9%)		
Adherence		1 (2.9%)		
Total	32 (94.1%)	32 (94.1%)	27 (79.4%)	17 (50%)
Missing	2 (5.9%)	2 (5.9%)	7 (20.6%)	17 (50%)

motility restriction and eyelid retraction has been described before when using titanium meshes, probably due to the fibrous ingrowth through the plate.¹² Though unlikely, there is also the risk of optic nerve and globe injury due to a secondary orbital trauma. Another objection we have when we use this material is the difficulty to provide a proper compensatory volume for the periorbital fatty tissue that frequently resorbs after treating these fractures.

Partially absorbable meshes are common alloplastic implants used for abdominal hernia repair for many years by general surgeons.^{6,8,13} Vicryl™, Monocryl™ and Prolene™ are the main materials used varying mainly in the proportions under each brand.

Jank et al.⁷ compared 435 patients with orbital fractures treated with polyglactin 910 patches, lyophilized dura-patches, and PDS foils for defects smaller than 2 cm². More than 15 months of follow-up showed similar results between them regarding diplopia, globe motility, exophthalmos, or enophthalmos. Buchel et al.¹ reviewed 87 patients with orbital floor defects reconstructed with polyglactin 910 patches with comparable results. Mauriello and colleagues⁶ reported the use of Vicryl mesh for repair of orbital floor fractures in 28 patients over a 5-year period with only one early complication in four patients related to transient palpebral oedema.

We have used several resorbable or partially resorbable meshes in our department for more than ten years with similar rates of success, but Ultrapro™ has been our standard mesh during the last 10 years. The easiness of handling, low complications rate, and a reasonable price make it an attractive option.

The size of the defect in our experience increases significantly when measured in the CT scan and then reassessing intraoperatively. When reviewing the files for the study unfortunately not all of the CT scans were available through the hospital imaging software for detailed measurements to be performed. Our first option was always the partially absorbable mesh. If the reconstruction of the fracture was not stable then the titanium mesh would be used.

As explained before the mesh was folded until the right orbital volume was acquired. Then the folds were fixed with a couple of absorbable sutures. Choosing the right number of folds might feel challenging in the beginning. Looking through a bird's eye view position should orient us after the insertion of the moulded mesh as well as symmetry upon palpation of the globes. We aim for a slight overcorrection of the volume of globe when placing the mesh to compensate the intraorbital fat atrophy that most of the time happens when reconstructing this area and the mild surgical oedema that will appear after surgery. Generally the mesh will not require fixation if the periosteum is sutured, but we have found it to be helpful to fix it anteriorly with a screw on each side in some cases when the size of the defect is bigger than 2 cm². It creates a sort of hammock that holds the orbital structures in the adequate position.

Twenty-nine patients (85.3%) presented isolated floor fractures. Another five (14.7%) were having affection of the lateral wall, medial wall, and the roof. Sixteen (47%) orbital fractures had associated displacement of the zygoma complex, which was reduced with either 1, 2, or 3 fixation points, depending on the stability the surgeon noticed after the reduction.

Due to the high rate of immigration in this country, we had a large scope of 12 nationalities within our patients, with

Indians and Nepalese being the majority, leaving the local ones, the Qataris, in a third position. The main cause of trauma was road traffic accidents (58%) and work related injuries (26.5%), coinciding with other studies in modern cities.¹⁴

The ideal timing for surgery varies considerably from early reconstruction in the first 2 weeks^{15,16} to over 6 months according to the symptoms.¹⁷ We waited for surgery a mean of 5.6 days (Min 0, Max 27, SD of 5.48 days). Delayed surgery is less preferred due to scarring and contracture of soft tissue occurring around the fracture sites, greater risk of haemorrhage, and difficulty in isolating the infraorbital nerve, which makes it technically more difficult to restore. Considering these facts, operative timing was settled on approximately 6 days after trauma, when periorbital swelling subsided, to follow the nature of the diplopia and clinical course of the enophthalmos. Surgery could be done earlier if the oedema was less, or later when the patient had other issues related to the trauma (polytrauma, brain injury, etc.).

The surgical approach was performed in 2 ways: subciliary in 27 patients (79.4%) and transconjunctival in 7 patients (20.6%). We did not have any significant lid retraction or ectropion in any group after the 12-month follow-up. The first postoperative lid massage was encouraged after the fifth postoperative day, when the stitches were removed, and continued for several weeks.

Diplopia is a controversial issue when it comes to orbital fractures. For Kunz et al.,¹⁸ if it resolves spontaneously within the first 14 days, it could be treated conservatively. Others recommend the patients should be observed for 6 months before a decision is made to intervene whether there is no muscle entrapment. In our series, 20 (58.8%) patients presented significant diplopia upon admission to the hospital. One week after surgery, only 8 (23.5%) had it, and a year later, we had 1 patient (2.9%) with diplopia to extreme upper gaze. This persisting symptom is accepted to be between 5% and 7% in some studies.^{14,19}

Out of 9 patients (26.5%) with enophthalmos before surgery, 2 patients (5.9%) had it 1 year postoperatively. The level of enophthalmos was barely noticeable, and they did not need any surgical correction.

Infraorbital paresthesia was noticed in 7 patients (20.6%) after surgery. Six months later, only 1 (2.9%) patient complained of numbness in the area, and it disappeared completely after 6 more months.

One patient had migration of the mesh that required removal of the implant, and another had a lower eyelid adhesion that was corrected with local anaesthesia.

Patients had antibiotics and nonsteroidal anti-inflammatory drugs from admission until they were discharged (roughly 1 week). We had no infections in any of the patients.

This study has certain limitations. The number of patients in the series could have been larger if we would have had access to the rest of the files before 2007, since we have been performing this procedure for more than 10 years with similar results. For a comparison of outcomes with different materials in our department, we had only a small group of orbital fractures reconstructed with titanium meshes (6 patients) that did not match appropriately.

We had a high number of missing patients by the end of the yearly follow-up (50%). We think this is mainly due to

the continuous mobility of expatriates in this country, particularly in the construction field.

To our knowledge, this is the only series of patients that had orbital reconstruction with a partially absorbable mesh (Ultrapro™). We experienced two minor complications (5.9%): one patient had migration of the mesh and another had lower eyelid adherence that was resolved under local anaesthesia: the portion of the mesh that was palpable was trimmed and secured beneath the periosteum with resorbable sutures. The lower eyelid adherence was also resolved under local anaesthesia followed by subcutaneous dissection with a supercut scissor.

Although some authors manifested the lack of rigidity with other similar types of materials for this area,⁹ the volume and rigidity generally can be achieved depending on the number of times the mesh is folded, getting enough stability to keep the globe at the right position. Another advantage is the low risk of globe injury in case of a secondary trauma such as when using a rigid and sharp material like titanium mesh. Also, in case of bleeding, the mesh provides a safe drain through the large pores to the maxillae and avoids any orbital pressure. We believe this partially absorbable mesh provides another handy tool for the orbital surgeon.

Disclosures

The authors have no commercial associations or financial disclosures that might pose or create a conflict of interest with information presented in this article. No funding was received for the work presented in this article.

Conflict of interest

The authors declared that there is no conflict of interest.

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