INTRODUCTION

The surgeon encounters orbital fractures in the acute, subacute and chronic settings. In each situation, the treatment goals are similar—restoration of orbital integrity and volume. However, the nuances of treatment can vary widely according to the specific setting and injury. In this chapter, we will attempt to provide an overview of how we approach orbital fractures in a variety of settings, and provide enough reference materials to satisfy the need for additional study.

ANATOMY

The adult human orbit has a volume of approximately 30 ml, of which the globe accounts for approximately 7 ml, or about 25%. It traditionally is said to be formed of 7 bones: maxillary, zygomatic, frontal, lacrimal, ethmoid (lamina papyracea), palatine, and the sphenoid, although the greater and lesser wings of the sphenoid develop independently during embryogenesis [the alisphenoid (greater wing) and orbitosphenoid (lesser wing) bones]. The optic canal is part of the lesser wing of the sphenoid.

Orbital bony strength is dependent on a series of dense bony buttresses that provide structural integrity and create a protective frame around the eye. Anteriorly are the frontomaxillary and frontozygomatic buttresses. Posteriorly is the ptérygomaxillary buttress (Figure 17.1). Orbital fractures can be classified as blow-out fractures (no rim involvement), and fractures that involve the rim as part of La Forte II or III fractures. Fractures involving the buttresses typically present with larger displacements. Alternatively, when the buttresses are intact, trapdoor-type fractures are more common.

The anatomic landmarks of most fractures correlate with the bony anatomy (Figure 17.2). Floor
fractures often extend up to the infraorbital groove and/or canal, since the thin bone of the floor abuts the stronger bone of the canal. Posteriorly, floor fractures nearly always leave the most posterior portion intact since it is part of the large and strong palatine bone. Medially, floor fractures often leave intact the inferomedial strut, a part of the frontomaxillary buttress.10, 11 Medial wall fractures often end at the frontoethmoidal suture line: the lamina papyracea is very thin, whereas the frontal bone is thick and supported by the cribriform plate. Lateral wall fractures often occur as part of a complex fracture involving the zygomatic arch and the maxillary bone.

 Orbital nerves and vascular bundles can often be involved in orbital fractures, and serve as important landmarks (Figure 17.2). Since the infraorbital nerve often abuts the floor fracture edge, it is commonly contused by the trauma but rarely severed. Hence, hypesthesia in the V2 distribution of the trigeminal nerve is very common following orbital trauma, but such numbness typically resolves, at least partially, several weeks to months after injury unless surgical repair causes further damage. Just posterior to where the infraorbital groove and canal meet, a perforating branch of the infraorbital artery is often encountered, which can cause significant bleeding if not isolated and cauterized in the course of surgical repair.12

 The zygomatic bone contains foramina for both the zygomaticofacial and the zygomaticotemporal nerves, branches of the V1 division of the trigeminal nerve. Overall, the area innervated by these nerves is small, and patients often tolerate hypesthesia associated with injury to these nerves, which may occur from surgery as well as from the initial injury.

 Injury to the infraorbital, posterior ethmoidal and/or anterior ethmoidal neurovascular bundles are uncommon, but can be associated with significant bleeding. Superomedial orbital injury may also be associated with damage to the trochlea, causing torsional diplopia.

 Orbital fractures can often cause ocular dysmotility. There are several general etiologies in the acute setting: direct muscle damage and/or edema, nerve damage, or muscle entrapment. The restriction caused by muscle entrapment often involves the orbital fibrous connective tissue complex, of which the extraocular muscle pulleys and septa are a part.13,14 Hence, herniation and entrapment of orbital connective tissue that is associated with an extraocular muscle can often cause a clinical picture of entrapment even though the muscle itself is not incarcerated in the fracture. Such findings can often

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Figure 17.2: An anterior-posterior view into the right bony orbit
be subtle. So a high index of suspicion is important (Figures 17.3A and B, and 17.4A to D).

Finally, the optic nerve enters the optic canal near the apex of the orbit. Blunt trauma can result in optic nerve injury through several mechanisms: collapse of the optic canal with crush injury to the nerve, injury of perforating vessels to the optic nerve, hemorrhage with compressive optic neuropathy, severing through avulsion of the nerve, and direct injury to the globe with transmission of the impact posteriorly (Figures 17.5 and 17.6).

EXAMINATION

A patient with orbital trauma requires a complete history and ophthalmic examination, including a dilated fundus examination. Any loss of consciousness should be documented, and the possibility of an intraocular or intraorbital foreign body must be addressed. The possibility of an open globe should be considered in every patient with orbital trauma, and an open globe must be ruled out prior to any orbital evaluation and management. Loss of vision, dysmotility, hyphema, and 360° subconjunctival hemorrhage are often associated with a ruptured globe.

When the examination occurs in an intensive care setting, as is often the case, exact history and a full examination cannot be obtained. In such a setting, early evaluation of the pupils, prior to sedation/analgesia-related miosis, is critical to identifying optic nerve trauma and a relative afferent pupillary defect (RAPD). Intraocular pressure should be measured with a handheld device, such as a Tonopen (Medtronic Ophthalmics, Minneapolis, MN, USA), and high intraocular pressure treated aggressively. In an alert patient with loss of vision and elevated intraocular pressure, the possibility of a retrobulbar hemorrhage must be assessed, and when appropriate, a lateral canthotomy with cantholysis performed acutely. Particular attention must be given to patients who are on blood-thinning medications, such as warfarin, which can make an orbital hemorrhage both more likely and more severe. Canthotomy incision is a simple and fairly benign technique for rapidly reducing vision-threatening orbital pressure, and the addition of a cantholysis can further improve the decompression.15 It is not rare for patients with an orbital compartment syndrome to report improvement in vision within minutes of a canthotomy and cantholysis. Evacuation of an orbital hematoma in the acute setting has been described, including a minimally invasive technique.16

While extraocular motility cannot be evaluated in the sedated patient, radiologic suggestion of entrapment should be further investigated with forced duction testing at the bedside, which the sedation facilitates (Figures 17.7A to E). It should be

**Figures 17.3A and B:** Mild muscle entrapment. Patient is a 45 years old man who suffered a left blow-out fracture and experienced diplopia in upgaze. He presented several weeks after his initial trauma with a CT scan taken shortly after the injury. Examination found mild restriction of the left eye in upgaze. The CT scan showed left inferior rectus rounding, consistent with muscle entrapment. He was only minimally symptomatic in upgaze with no diplopia in primary or downgaze, and did not require surgical repair.
Figures 17.4A to D: Severe entrapment with muscle pinching. Patient is a 19-year-old college student involved in a nightclub alteration, who attributed his pain to swelling and bruising. One week later, when the swelling subsided, he continued to have pain and nausea with eye movement, with significant diplopia. Examination revealed right inferior rectus restriction (A and B). CT showed pinching of an entrapped muscle in a small minimally-displaced floor fracture (C). Urgent exploratory surgery found a dusky IR. After muscle release and fracture repair, he was instructed to patch his uninjured left eye and use his right eye to read and do homework. Over the next few weeks, motility recovered to better than 80% of normal, with only minimal diplopia in extreme down and up-gaze (D).
Figures 17.5: Optic canal injury. Patient was a 12 years old involved in an unhelmeted accident while riding an all terrain vehicle (ATV). She developed a left relative afferent pupillary defect. Maxiface CT scan revealed evidence of fractures (arrowhead) through the sphenoid sinus extending into the left optic canal, with a small air bubble located at the intracranial opening of the optic canal (arrow).

Figures 17.6: Axial section of CT scan showing small air bubble (arrow) at the intracranial opening of optic canal. These subtle fracture findings are a common occurrence in pediatric patients in whom the bones are malleable.

Figures 17.7A to E: Forced ductions – before (A) and after (B) repair. (A) Forced ductions before repair demonstrating vertical restriction, (A to C) Forced ductions after floor fracture repair with release of entrapped inferior rectus muscle, demonstrating normal ductions (D and E)
remembered that ductions may also be limited by orbital edema, so the ductions should be compared with one another. Often, the pupils cannot be dilated because of the tenuous neurological state of these patients in the immediate postinjury period. In these cases a direct ophthalmoscope may be used to view the vitreous and disc. A vitreous hemorrhage should be noted and further investigated for a possible rhegmatogenous retinal detachment using B-scan ultrasound. Likewise, the presence of a corneal abrasion or a hyphema should be assessed and treated.

The evaluation of facial fractures is often performed by a multi-disciplinary team, and it is important to communicate effectively with other members of that team. The orbital evaluation should include palpation of the rim for any step-offs, and of the periorbital region for crepitus (Figures 17.8A and B). If the patient is alert, sensation in the trigeminal distribution can be assessed. Hypoesthesia in the distribution of the V2 branch of the trigeminal suggests an orbital floor fracture, but can also be associated with nerve contusion and orbital edema. Hertel exophthalmometry is a useful indicator of the risk of enophthalmos, and in our experience, the presence of 1.5 mm or more of enophthalmos in the acute posttrauma period suggests that further enophthalmos may develop once swelling is reduced.

Additional structural and functional consequences of orbital fractures should be carefully assessed. Attention should be given to integrity and symmetry of the medial and lateral commissures. Zygomatic fractures can often cause lateral canthal dystopia (Figures 17.9A to D), whereas nasoethmoid

**Figures 17.8A and B:** Lateral canthal dystopia post-ZMC fracture repair. Note the right lateral canthal dystopia. Patient had suffered a motor vehicle accident with right orbital fractures. His zygoma was reduced to achieve alignment in 2 dimensions (rather than 3 dimensions), with resultant enlargement of the orbital cavity. He presented to our clinic with enophthalmos and diplopia. Subsequent surgical repair resolved his enophthalmos and diplopia.

**Figures 17.9A to D:** Traumatic telecanthus (A). Patient suffered significant facial trauma following a fall, with severe comminuted nasoethmoid fractures along with maxillary and zygomatic fractures (B and C). Initial repair did not fully restore the anatomy of the medial canthus and she was referred for a consultation. Intraoperatively, scar tissue was debulked and miniplate fixation was used to anchor the medial canthal tendon. Postoperatively, she has medial scleral show, and only 1mm of telecanthus (D).
fractures can often cause telecanthus (Figures 17.10A and B). Nasoethmoid fractures are also associated with damage to the nasolacrimal duct, leading to an increased risk of posttraumatic epiphora.

Often, surgical repair of orbital fractures can be delayed until a better examination can be performed and an informed consent can be obtained. In this setting, useful adjuncts in the evaluation of diplopia and ocular dysmotility are ocular alignment measurements of heterotropia, and the binocular visual field (also known as diplopia field) which uses the Goldmann perimeter to delineate the area of fusion.

**IMAGING**

Computed tomography (CT) scan without contrast continues to be the workhorse of orbital fracture imaging. A study including axial, coronal and sagittal cuts through the orbit is preferred. Displacement should be noted using the bone-window, whereas the presence of soft-tissue herniation, including fat and muscle herniation, should be assessed using the soft-tissue window. A careful and systematic review of the orbital bones is necessary in order to avoid missing a small fracture that may be clinically relevant. Once a fracture has been identified, the imaging study is carefully reviewed for other facial fractures, especially nasal, frontal, zygomatic arch, and mandibular fractures, as well as any fractures of the orbital buttresses. The orbital rim, inferomedial strut, and the bony platforms at the edges of fracture are assessed. The repair of pan-facial fractures in most centers is coordinated with the rest of the trauma team in order to achieve the best possible outcome for the patient. Of great import is the overall size of the orbital fractures, as well as the extent of displacement. We typically recommend surgical repair for orbital wall fractures that total more than 50% of the size of the orbital floor, since such fractures, when not repaired, can lead to significant enophthalmos.18 (Figures 17.11A to C).

Next, the soft-tissue windows should be carefully examined for herniation of fat and/or extraocular muscle. However, it is important to emphasize that muscle entrapment is a clinical diagnosis, not a radiological diagnosis. The presence of retrobulbar hemorrhage should be noted, and its size approximated. The appearance of the extraocular muscles should be carefully noted for a rounding effect (which may signify entrapment) or for enlargement that can be associated with a hematoma (Figure 17.3). If muscle entrapment is noted clinically but not supported radiologically, we recommend that surgical exploration be carefully considered.

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**Figures 17.10A and B:** Naso-ethmoid comminuted fracture repair with miniplates, and fixation of the medial canthal ligament to the miniplates. A nasal splint with silastic bolsters can facilitate reconstruction of the medial canthal architecture

**Figures 17.11A to C:** Enophthalmos. Three examples of clinically-apparent enophthalmos resulting from orbital trauma
IMPLANT MATERIALS

The choice of material for orbital fracture repair is broad, and includes both autogenous tissues and alloplastic materials. Each has advantages and disadvantages.\(^{19}\)

Alloplastic implants are easily available, requiring no harvesting procedure with its associated morbidity. Several, such as titanium plates and porous polyethylene, have proven over time to be strong and effective.\(^{20-24}\) The disadvantage of alloplasts is that they do not completely integrate with the living orbital tissues, which can lead to early and late complications, including infection, exposure and/or extrusion. The bacterial load required to infect an alloplastic implant can be lower by a factor of 10,000 than for an autogenous graft.\(^{25}\) Implant exposure can particularly pose a risk for infection. In addition, because the integration of even the best alloplastic implants is incomplete, migration and exposure can occur, both in the early postoperative period and as a late complication. Finally, when a complication occurs with an alloplastic implant, management will often require removal of the implant, which can be challenging.

Alloplastic materials include porous polyethylene (e.g. Medpor, Porex Surgical, Newnan, GA, USA), hydroxyapatite (e.g. Biocoral, Wilmington, DE, USA), titanium mesh (such as from KLS Martin, Tuttlinger, Germany; Stryker Craniomaxillofacial, Portage, MI, USA; Synthes Inc., West Chester, PA, USA), and nylon (such as Supramid, S. Jackson, Alexandria, VA).

Titanium is a strong, inert metal. It does not integrate but can be easily fixated to the surrounding bones and can provide excellent support for orbital structures.\(^{23}\) If bone resorption occurs, it may infrequently require removal. Overall, titanium mesh can be an excellent choice for orbital fracture repair and has a significant track record of safety.\(^{24}\) However, in our experience, reoperations following implantation of titanium mesh are more difficult as fibrous scar tissue insinuates itself into the holes of the mesh (Figures 17.12A and B). Hence, titanium mesh is not our first choice in the repair of orbital floor fractures. In cases of severe obliteration of more than one of the orbital walls, titanium mesh may be an excellent choice, owing to its ability to be shaped and maintain the desired shape. The use of titanium mini-plates in the stabilization of orbital rim and buttress fractures is a mainstay of fracture fixation techniques.

Nylon sheets come in a variety of sizes and are easy to use.\(^{26}\) Fixation can be achieved with a fibrin sealant (e.g. Tissee1, Baxter, Deerfield, IL, USA) or a biological glue (Bioglue, CryoLife, Kennesaw, GA, USA). However, late complications with nylon sheets are not uncommon, and in particular, the capsule that forms around the nylon sheet can spontaneously hemorrhage.\(^{27}\)

Our preferred alloplastic implant material is porous polyethylene, which is strong, biocompatible and can integrate well.\(^{20,28-30}\) Medpor Barrier implants (Porex Surgical, Newnan, GA, USA), are porous polyethylene plates that are coated with a thin, non-porous, high density polyethylene barrier that is heat-bonded to the porous material on one side. This barrier is positioned toward the orbital tissues to reduce scarring and attachment of orbital tissues to the plate.\(^{31}\) The barrier also has the added benefit of strengthening the sheet. Porous polyethylene implants can also be easily secured to the rim with screws if necessary, either using a channel implant or directly through the porous polyethylene. They are malleable and can be cut into various sizes and shapes with a large Metzenbaum scissors. A newer version of the porous polyethylene implant is the TITAN implant (Porex surgical), which can hold curved shapes particularly well. This implant is well

**Figures 17.12A and B:** Titanium mesh with scarring. Patient is a young woman who was injured in a motor vehicle accident. She suffered severe ocular injuries that eventually resulted in an enucleation. In addition, she underwent floor fracture repair with titanium mesh. Her implant motility was severely limited and she developed significant enophthalmos with superior sulcus deformity. She was referred for an orbital consultation and underwent orbital volume augmentation. Intraoperatively, her inferior rectus and surrounding orbital tissues were found to be tightly adherent to the titanium mesh, with extensive scarring through the holes in the mesh. These were dissected off to free the orbital tissues from incarceration in the titanium mesh.
suited for repair of large floor fractures and reconstructions that involve both the floor and the medial wall (such as loss of the inferomedial strut) (Figures 17.13A to D). The titanium mesh embedded in the porous polyethylene contains holes through which screws can be placed for improved fixation if necessary.

Autogenous bone grafts have a proven track record of reliability, but require a harvesting procedure unless a cadaveric bone graft is used. Given recent concerns with infectious agents and prion diseases, cadaveric bone grafts may be seen as less desirable to many patients. Fresh bone contains living osteocytes and integrates well with the surrounding bones. When cranial bone is used, early integration is achieved and minimal resorption is observed.\textsuperscript{32-34} This is most likely the result of the neural crest origin of calvarial bone, which is shared with orbital bones. The neural crest-derived craniofacial bones form through intramembranous ossification, whereas the mesodermal bones of the ribs and pelvis form through endochondral ossification.\textsuperscript{35,36} Calvarial bone can be harvested without the need for surgical preparation of a different body site (Figures 17.14A to D). In addition, calvarial access can be hidden behind the hairline, and when a bicoronal approach is used for orbital fracture repair, the same exposure can be used for harvesting the graft. A major disadvantage of calvarial bone grafts is that despite the overall safety of the harvesting procedure, the

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{Figures_17.13A_to_D.png}
\caption{Figures 17.13A to D: Medpor TITAN in complex fractures and orbital reconstructions. A: Posterior large medial wall fracture and Medpor TITAN implant prior to placement. The implant was cut to size, incorporating a notch for the inferior oblique. It was then bent and placed into position. A=anterior, P=posterior, S=superior. B: Even a large Medpor TITAN implant can be bent and will hold its shape. This patient underwent orbital reconstruction following excision of sino-orbital squamous cell carcinoma that involved the inferomedial orbital bones. Fixation was achieved with glutaraldehyde-crosslinked albumin adhesive (BioGlue, Cryolife Inc).}
\end{figure}
Orbital Fractures

Figure 17.14A to D: Calvarial bone grafts. After exposure of the skull, a partial thickness calvarial graft is harvested. Next, it is used to repair an orbital floor fracture.

inner table can be penetrated, and bleeding and brain damage can occur. Particular care must be taken to avoid harvesting within 2 cm of midline in order to prevent injury to the sagittal sinus. Patients will often feel a depression at the donor site, which must be explained preoperatively. At our institution, we rarely use calvarial bone grafts, and when we do, it is in the context of extensive craniofacial reconstruction performed by a team that includes craniofacial and neurological surgeons.

Iliac crest and rib bone grafts are commonly by plastic surgeons. They offer a large supply of easily accessible cortical bone. Ribs are malleable, which can be both an advantage and a disadvantage. Iliac bone is hard and can be difficult to contour but can be used successfully. Donor site morbidity, in the form of bleeding, pain, and gait disturbance, can be significant. Both types of bone are of mesodermal origins, and ossify through an endochondral process. Their harvest into the neural crest-derived facial skeleton can result in delayed integration and significant resorption. We rarely use rib or iliac crest bone grafts, which are more commonly considered in facial reconstruction following craniofacial tumor resection, and is beyond the scope of this chapter. The interested reader is encouraged to refer to the excellent reviews and textbooks that focus on this subject (e.g. Holck and Ng, 2006).

GENERAL OPERATIVE CONSIDERATIONS

In evaluating orbital fractures, several issues should be addressed. These include any indications for fracture repair (such as fracture size and diplopia with entrapment), the timing of fracture repair, managing patient expectations, working with multiple surgical services, risk of infection and antibiotic
coverage, orbital edema and the use of steroids, concomitant management of soft tissue injuries, the use of blood thinning products, and elective versus urgent repair. Patients should be advised to avoid blowing their nose, and prescribed nasal saline spray 2-4 times daily. Patients are instructed to keep their head elevated, and to use ice-cold compresses for 2-3 days. Any blood thinning medications, especially aspirin, clopidogrel (Plavix, Bristol-Myers Squibb) or warfarin, should be discontinued in coordination with the prescribing internist. Other blood thinning products include non-steroidal anti-inflammatory drugs, vitamin E, garlic, ginseng, and ginkgo biloba. With patients on warfarin, the prothrombin time should be checked in the early preoperative period. Since an orbital hemorrhage can have catastrophic effects on vision, care must be taken in operating on anticoagulated patients.

**Antibiotics**

Orbital cellulitis is a serious but uncommon complication of orbital fractures. Practice patterns vary widely regarding the use of antibiotics in the context of orbital fractures. Multiple published studies have shown that postoperative antibiotics do not alter the rate of infection associated with orbital fractures, although good studies have not been performed. A randomized trial with 181 patients who underwent open reduction and fixation of mandibular fractures also showed no advantage to postoperative antibiotics. Risk factors for orbital infection in the context of orbital fractures include open fractures, sinusitis, and contaminated wounds. In these situations, we always give preoperative antibiotics, since preoperative administration of antibiotics has been shown to provide improved prophylaxis. In addition, in cases of frank wound contamination, we carefully treat the wounds with 5% Betadine solution and irrigate the wound intraoperatively with bacitracin solution. Our antibiotics of choice are Cefazolin, Ampicillin-Sulbactam (Unasyn, Pfizer, NY, USA) or Clindamycin, with the latter two providing improved coverage of anaerobic microorganisms.

The risk of antibiotic overuse cannot be overemphasized. The human body is continuously colonized by bacteria that exist in steady-state equilibrium in the context of the normal flora. Treatment with antibiotics alters the equilibrium, which can potentially lead to the proliferation of antimicrobial-resistant pathogenic organisms. Hence, overuse of antibiotics can cause an infection with resistant bacteria. We usually limit antibiotic usage to the preoperative setting, with administration prior to surgical incision in order to achieve significant tissue concentration at the surgical site intraoperatively. Postoperative antibiotics are given only if there are active signs of infection or if systemic steroids are prescribed in the context of a higher risk of infection (as discussed below).

**Steroids**

Glucocorticoids can be extremely useful in the perioperative management of orbital fractures. However, their use can lead to complications, especially an increased risk of infection. Hence, any steroid administration is done using a very rapid taper regimen.

The most useful contexts of steroid usage are in the preoperative assessment of extraocular muscle function and in the prophylaxis of postoperative emesis (which can cause implant movement and bacterial spread). In the preoperative setting, it is sometimes difficult to distinguish between extraocular muscle contusion or edema and frank muscle entrapment. This distinction is important to make since it can strongly influence the decision to recommend surgical exploration repair. Therefore, when there is significant dysmotility associated with moderate to severe orbital edema, a small orbital fracture and no obvious entrapment radiologically, we document the dysmotility with a binocular visual field (also known as a diplopia field, performed with both eyes open on a Goldmann Perimeter), and prescribe a rapid taper of Prednisone or Methylprednisolone over the course of 5-7 days. A typical Prednisone taper for an adult would be 40, 30, 20, 10, and 5 mg over the course of 5 days. We re-evaluate motility toward the end of the treatment course (in 5-7 days) and reassess the need for surgical intervention. In numerous cases, these exams will reveal significantly improved motility and near resolution of diplopia, avoiding the need for surgical exploration of a fracture that was otherwise too small to warrant surgical repair.

Another context for prescribing a steroid taper is in children, who tend to swell more and scar faster. We try to operate on children earlier (within 1 week
In cases of severe restriction, even sooner). A 5-day steroid taper can help control posttraumatic edema and facilitate early and safe surgery.

Intraoperative IV steroids can be very useful in two respects: control of nausea, and expedited resolution of postoperative edema and discomfort. In an adult, 8-10 mg of Dexamethasone are often given by the anesthesiologist toward the end of surgery. Intraoperative steroid irrigation of the orbit is performed rarely, and usually in the context of late repair of a scarred musculoseptal system.

Infrequently, a postoperative steroid taper is prescribed if severe edema is anticipated (e.g. late repair of severely scarred orbit), or if edema would interfere with the postoperative evaluation and patient management (e.g. with extraocular motility evaluation). However, there are no good studies to direct perioperative steroid use, and the potential side effects must be fully considered.

**Pediatric patients**

Special attention must be given to nondisplaced fractures and floor fractures in pediatric patients since muscle entrapment with frank muscle pinching may occur. Steroids will not only fail to resolve the dysmotility, but will also delay needed surgical intervention, which can lead to irreversible muscle injury. Such fractures have been termed "greenstick" fractures, and are the result of the fact that the facial bones of children have a higher cancellous composition and thinner cortices, resulting in increased bone flexibility.

At times, orbital floor fractures result in minimal soft tissue injury, no orbital edema and no enophthalmos but severe dysmotility with entrapment, pain, and nausea. CT scanning may only demonstrate minimal tissue herniation and fracture displacement. This presentation has been termed "white eye syndrome." Clinical signs of muscle pinching and entrapment include restriction in upgaze, severe pain worsened by upgaze, and oculocardiac reflex induced by upgaze, which can include nausea, vomiting, bradycardia and/or syncope. Timely management of fractures with muscle pinching is essential in order to reduce the risk of irreversible muscle damage and strabismus, both in the pediatric and adult population. In patients with White Eye Syndrome, surgical exploration and repair must be carried out urgently. The examination of a child who is in pain and distressed following orbital trauma can be quite challenging, and the surgeon must maintain a high level of suspicion, especially when the eye and orbit appear normal but there may be a motility disturbance.

**Timing of surgery**

The ideal timing of surgical exploration and repair depends on the clinical findings, the overall medical condition of the patient, the radiographic evidence and any concomitant injuries. Delayed repair has the advantages of reduced swelling, a more thorough preoperative evaluation, and an increased opportunity to establish a meaningful patient-doctor relationship prior to any surgery. Early repair has the advantage of reduced fibrosis and scarring. In general, we prefer to repair orbital fractures within 2 weeks of injury once the majority of post-traumatic edema has resolved.

There are several exceptions to this “2 week” guideline whereby early or late intervention would be preferred. First, if the patient’s overall medical condition is unstable, then medical stabilization must take precedence. Second, if entrapment with muscle pinching is encountered (often in children as part of a White Eye Syndrome), urgent repair is advisable in order to reduce the risk of irreversible muscle damage. Third, when the optic nerve may be compromised, the status of the optic nerve should be properly investigated prior to any orbital surgery. Otherwise, surgery may further compromise the already-traumatized nerve, or the patient may perceive the surgery as the cause of any optic nerve damage. The status of the globe and the possibility of a retinal detachment must also be fully addressed prior to any orbital fracture surgery. Finally, if other surgical interventions are planned, coordinating care can be an overall advantage to the patient by minimizing multiple inductions of anesthesia.

Another softer exception to the 2-week rule is the pediatric population. Children swell more, but their edema resolves faster. They heal and scar faster, and are more prone to greenstick fractures and muscle pinching. Hence, expedited repair is often recommended for children.
Decision: repair or not repair?

Surgical repair of orbital fractures is a very safe procedure when done appropriately. Nevertheless, surgery can cause complication. The decision of whether to repair an orbital fracture is complex, and must rely on the individual circumstances as well as on the experience of the surgeon. However, several guidelines have been published that can be of great help in making a recommendation regarding surgical repair. These guidelines address the risk of post-traumatic enophthalmos, ocular dysmotility, diplopia, and facial deformity.

Fracture size correlates well with the risk of post-traumatic enophthalmos. Hence, radiographic assessment of fracture size can be a critical part of the decision tree. There are several methods that have been advocated in the evaluation of post-traumatic enlargement of orbital volume. When the zygoma is not involved, it is simplest to address whether the sum of orbital floor and medial wall fractures constitutes half of the floor or more. This algorithm is simple to execute but does not take into account any lateral wall/ZMC fractures. Another method requires measurement of the added volume caused by the fracture. This is determined by comparing the fractured orbit with the non-traumatized orbit. For example, using one algorithm, measurements that reveal greater than 13% orbital volume enhancement would lead to a recommendation for surgical repair.

The weakness of this algorithm is that many patients sustain injury to both orbits, which precludes useful comparison.

Zygoma fractures can seriously complicate any volumetric assessment, since floor fractures are often present but get reduced once the ZMC fracture is reduced. Nevertheless, the rotation and/or displacement of a fractured zygoma can lead to severe orbital volume changes, and incomplete reduction of ZMC fractures can be a common cause for postoperative enophthalmos. ZMC reduction requires special care since without three point fixation, reduction may be incomplete although the fracture may appear well aligned along the orbital rim. Rotation and orbital volume expansion can still occur and can often be hard to detect. Hence, three-point reduction of ZMC fractures with proper fixation should be the goal of these surgical repairs.

Ocular dysmotility and diplopia are debilitating consequences of orbital trauma. Ocular dysmotility can occur for several reasons, and it is the task of the surgeon to distinguish between the etiologies in order to make the appropriate recommendation. Posttraumatic extraocular muscle dysfunction can occur as a result of muscle contusion, hematoma, fibrosis or avulsion, muscle entrapment with or without pinching, cranial nerve injury and muscle paresis, generalized orbital swelling, or contracture of the antagonist muscle. Muscle fibrosis or contractures are later complications that must be prevented by proper management. However, at times it can be very challenging to distinguish between ocular dysmotility with or without entrapment. Limitation in up-gaze with associated pain and nausea can be telltale signs of muscle entrapment. In addition, CT scans can be particularly helpful in this task. Rounding of an extraocular muscle is often associated with entrapment. The radiologist and surgeon must be particularly cognizant of orbital tissue herniation without frank muscle herniation: the herniated tissues may cause entrapment by virtue of their numerous fibrous attachments to a muscle. Such a fracture should be repaired.

Some surgeons advocate exploration and repair of orbital floor fractures for non-resolving infra-orbital hypoesthesia. However, a meta-analysis of the literature found little evidence to support such a recommendation since the reported surgical outcomes were poor. However, if infra-orbital pain is worsening, exploration is probably warranted.

The decision to operate is complex and must be individualized. Our preference is to operate within 2 weeks of injury except in children, in which case surgical repair would preferably take place within a week. In cases with pinched muscles, urgent repair within 1-3 days of injury would be advocated. When orbital edema makes the evaluation difficult, a steroid taper can be very helpful. When the examination is inconclusive, a re-examination is warranted and can be critical to making the proper diagnosis and surgical plan.

Irrespective of the type and location of the fractures, the goals of surgery are fundamentally similar: repositioning of herniated orbital tissues,
Orbital Fractures

FLOOR FRACTURES

Orbital floor fractures are common, and result from blunt orbital trauma in which force is delivered to the thin bones of the orbital floor, typically along the infraorbital canal. Often, an orbital floor fracture will not involve the orbital rim, which is much thicker and stronger. In such an instance, the term "blow-out fracture" is often applied. The term was first used by Smith and Regan in 1956 to describe orbital fractures caused by striking the orbital rim with a hurling ball.74-76

The orbital floor is the shortest of the walls. It consists of the roof of the maxillary sinus with a small contribution posteriorly from the palatine bone, and contains the infraorbital groove and canal. The edge of the canal forms a weak spot in the floor structure. Hence, most floor fractures extend up to the canal, but the canal is often left mostly intact.

Concomitant displaced zygomatic fractures should be repaired first, since reduction and fixation of the ZMC fracture will often reduce the floor fracture as well.65 Floor fractures are often associated with medial wall fractures. When making the decision to proceed with or forgo surgery, the total wall area involved by the fracture, including the floor and medial wall, must be taken into account and addressed.

The evaluation of a suspected floor fracture often requires CT scanning with coronal sections, which facilitates the assessment of bone displacement and extraocular muscle findings. It must be emphasized again that muscle entrapment is a clinical diagnosis, which should be supported by the radiologic evidence but need not be.

Extraocular muscle entrapment in the context of orbital floor fractures is not uncommon.(Figure 17.4) However, the finding of muscle entrapment can be subtle, and a high level of suspicion must be maintained (Figure 17.3). Tissue herniation is very common in the context of orbital floor blow-out fractures. All orbital tissues must be retrieved and repositioned into the orbit at the time of repair; otherwise, tissue incarceration can lead to necrosis and permanent muscle dysfunction.

Our favored approach to the inferior orbit is through a transconjunctival approach.77-80 We usually avoid the lateral canthotomy and inferior cantholysis, but at times, when better exposure is required for a larger fracture, a tighter orbit, or more extensive herniation, the canthotomy and cantholysis can greatly aid in obtaining adequate exposure. Care must be taken to perform the exposure correctly to avoid postoperative complications.81 The inferior fornix and lateral canthus are infiltrated with 2-3 ml of local anesthetic containing 1% Lidocaine, 0.25% Bupivicaine, and 1:100,000 dilution of epinephrine. The patient's face and any wounds are carefully prepped with 5% Betadine solution, and sterile drapes are placed. We routinely place a lubricated plastic corneal protective shield on the globe.

First, forced ductions are performed to assess for muscle entrapment (Figure 17.7). Next, the assistant retracts the lower eyelid down with a Desmarres retractor. The surgeon uses a malleable retractor to sweep the orbital fat posteriorly and drape the conjunctiva and lower lid retractors over the inferior orbital rim (Figure 17.15A). The surgeon then uses a monopolar electrocautery device with a microdissection needle (such as the Colorado needle, Colorado biomedical, Evergreen, CO, USA) to cut through conjunctiva, lid retractors and orbital rim periosteum to reveal the bony rim. The incision is made inferiorly in the fornix (at least half way between the inferior edge of the tarsus and the deepest part of the fornix) to help minimize cicatricial changes (retraction or entropion) of the eyelid margin (Figure 17.15B). We then use a Freer elevator to lift the periorbita off of the orbital floor. Our dissection is guided by the CT findings: the initial sub-periosteal dissection is performed away from the fracture and then brought to the fracture site. The fracture edges are carefully defined and visualized. A malleable retractor is used to gently retract the globe superiorly while the herniated orbital contents are lifted back into the orbit using a Freer elevator. Often, the herniated tissues need to be bluntly separated from any early scars that form at the edge of the fracture and in the maxillary sinus; this must be done slowly and carefully, taking care to avoid injury to the infraorbital neurovascular bundle and the perforating artery. The maxillary sinus is typically well visualized through the fracture (Figure 17.15C).
When the sinus is full of blood, we typically evacuate the blood using suction, which also improves visibility.

Once the herniated tissue is released, a Teflon sizer (DuPont, Wilmington, DE, USA) is used to assess the size of the needed implant (Figures 17.15D and E). In the absence of a sizer, aluminum foil from a suture packing, sterilized X-ray film, or any other similar strong and sterile material can be used. Adequate overlap with the fracture edges must be confirmed. Particular attention must be given to avoidance of orbital tissue incarceration between the implant and the fracture's bony ledges.

The implant is soaked in an antibiotic solution (e.g. bacitracin solution), and cut to size with the appropriate scissors (Figure 17.15F). It is then molded into the proper curvature. It is slipped carefully into the orbit to cover the fracture (Figures 17.15G to I). If a porous polyethylene implant with high density "barrier" surface is used, the barrier side is oriented toward the orbital soft tissue and the porous surface turned toward the maxillary sinus. Care must be taken to avoid an implant that is too long which might cause damage to the orbital apex. The support of the implant by the bony ledges is confirmed, and any tissue incarceration is reduced. The end point should be a stable implant that can slide 1 mm with gentle force but is otherwise immobile. When implant stability is in question, the implant should be rigidly fixated to the bony rim with a titanium microscrew.
Figure 17.15E: A Teflon sizer is used to assess coverage of the fracture

Figure 17.15F: Once the correct sizer is identified, the Medpor implant is cut to size

Figures 17.15G to I: The implant is placed on top of the fracture. Care must be taken not to incarcerate any orbital tissues between the implant and the orbital floor.
Figure 17.15J: Once the implant is stable, the eyelid retractors are reapproximated using buried interrupted sutures.

A screw can be placed right through the Medpor Barrier implant or through the TITAN MTB implant. Some surgeons favor surgical glue for fixating the implant temporarily. The Desmarres retractor is then removed, and the eyelid retractors sutured with buried, interrupted 7-0 polyglactin (Vicryl) suture using 3-point fixation (Figure 17.15H). The conjunctiva is left unsutured.

When no bony ledge is present to support the fracture, cantilevering of the TITAN implant or a Medpor Channel plate over the rim can provide rigid fixation. Some surgeons favor titanium mesh in this situation.

Other methods of fixation include the use of fibrin sealant (such as Tisseel, Baxter, Deerfield, IL, USA) and biological glue. BioGlue (CryoLife, Kennesaw, GA, USA) is a two-component glue, containing engineered bovine albumin in one tube and a glutaraldehyde solution in the other. When the two substances mix, the glutaraldehyde cross-links albumin molecules to each other and to the surrounding proteins. Glutaraldehyde cross-linking resembles a peptide bond, and hence can easily form covalent bonds among proteins in contact with the chemical. When a porous implant is used, the albumin infiltrates through the pores as it gets cross-linked, resulting in strong biocompatible chemical bonding of the implant to the surrounding tissues. The use of biological glue and sealants is particularly useful when implant stability is in question, yet the surgical exposure is inadequate for complete rigid fixation (often because the globe should only be retracted gently and carefully).

MEDIAL WALL FRACTURES

Medial wall blowout fractures are common but historically were under-diagnosed because they can be asymptomatic in the acute post-traumatic phase. The nearly ubiquitous use of CT scanning in the United States in the evaluation of facial fractures has made the diagnosis of medial fractures much easier. However, when CT is unavailable, the evaluating physician must maintain a high level of suspicion. Epistaxis can be associated with medial wall fractures because of tears in the sinus mucosa. The epistaxis is typically self-limited. Vision-threatening orbital hemorrhage can occur if the anterior or posterior ethmoidal vessels are injured.

It is important to remind patients to avoid blowing their nose, since this can lead to orbital emphysema and a compartment syndrome (Figures 17.16A and B).

The thin lamina papyracea constitutes most of the medial wall of the orbit, behind the posterior lacrimal crest. The medial orbital wall is completed posteriorly by the lesser wing of the sphenoid, and anteriorly by the lacrimal bone. Both the sphenoid and the lacrimal bones are thicker. Hence, medial wall fractures occur because of the weakness of the thin lamina papyracea, and are typically localized at the boundary between the lamina papyracea and one of the thicker bones. Medial wall fractures commonly occur in the context of orbital floor blowout fractures, but can also occur in isolation.

They can also be associated with nasal fractures, which can lead to...
telecanthus and possible damage to the nasolacrimal drainage apparatus.\textsuperscript{84, 85}

Described approaches to the medial wall fracture include a Lynch incision in the medial canthus, a bicoronal incision, a medial upper lid crease incision, or a transconjunctival incision. However, our preferred approach is the transcaruncular incision.\textsuperscript{86-88} When the medial wall fracture is large, or associated with a floor fracture, multiple incisions may be necessary, such as a secondary lower lid fornix incision.\textsuperscript{26, 89}

The transcaruncular approach requires meticulous hemostasis in order to properly expose and visualize the fracture. Pinpoint cautery with a micro-dissection needle (e.g. Colorado needle, Colorado Biomedical, Evergreen, CO, USA) is very helpful, as is the use of thrombin solution, absorbable gelatin sponge (Gelfoam, Pfizer), FloSeal (a combination of gelatin foam and thrombin, Baxter) or 3\% hydrogen peroxide solution. Care must be taken with hydrogen peroxide, since it can inhibit tissue healing, and its use has been associated with air embolization.\textsuperscript{90-92} Good lighting is also important, and a head-mounted light source is nearly always used in our cases.

Prior to initiating surgical repair, forced ductions are performed to assess for muscle entrapment (Figure 17.7). The transcaruncular approach begins with infiltration of the medial fornix with local anesthetic containing 1:100,000 dilution of epinephrine. An incision is made through the caruncle anterior to the plica semilunaris using Westcott scissors.\textsuperscript{86, 87} The incision is extended superiorly and inferiorly along the conjunctival fornice in order to create sufficient exposure and prevent uncontrolled tearing of the conjunctiva intraoperatively. A sufficient distance away from the canaliculi is maintained. Curved Stevens tenotomy scissors are then used to bluntly dissect along Horner’s muscle, which inserts on the posterior lacrimal crest. Care must be taken not to iatrogenically fracture the lamina papyracea just posterior to the crest, since this will make subsequent elevation of the periorbita more challenging. Once the posterior crest is exposed, the periorbita is incised with a monopolar unit and a microdissection needle. Achieving excellent hemostasis is critical at this point. Next, a Freer elevator is used to lift the periorbita anteriorly in order to fully expose the posterior lacrimal crest. The periorbita is then lifted posteriorly to create a subperiosteal dissection plane along the lamina papyracea (Figures 17.17A and B). The anterior ethmoidal neurovascular bundle is typically found approximately 24 mm posterior to the posterior lacrimal crest, along the fronto-ethmoidal suture line. This neurovascular bundle is carefully and thoroughly cauterized with a bipolar cautery unit, and then divided with the monopolar unit. The subperiosteal dissection is then completed to fully expose the fracture.

![Figure 17.17A: Transcaruncular exposure of the left medial wall following disinsertion of the inferior oblique muscle](image1)

![Figure 17.17B: Inferior oblique isolation. The IO muscle may be tagged with 6-0 polyglactin sutures and the origin disinserted to provide good exposure](image2)
If the fracture is very posterior, the posterior ethmoidal bundle may be encountered. In such cases, the posterior ethmoidal bundle should be carefully cauterized with the bipolar cautery to avoid intra- or postoperative hemorrhaging. The posterior bundle is typically found approximately 12 mm from the anterior bundle, and on average only 6 mm from the optic canal.

After adequate hemostasis and exposure are achieved, herniated orbital tissues are retrieved and repositioned into the orbit. The fracture size is measured, and implant properly sized. We have found Teflon implant sizers to be very useful at this step. The implant is then placed over the fracture, ensuring that no orbital tissues are left incarcerated. When using a Medpor Barrier plate, the barrier side should be turned toward the orbit to reduce the risk of tissue scarring to the implant.

If the fracture extends inferiorly to involve the orbital floor, an inferior fornix transconjunctival incision can be made to increase exposure. At times, the inferior oblique muscle must be disinserted from its origin. At the end of the case, the oblique is then reapproximated to its origin with 6-0 polyglactin suture. The floor and medial wall fractures can be repaired with a single implant. For this, the Medpor TITAN Barrier implant is ideal, since it can be molded into the required semi-cylindrical shape and will maintain this shape. Such a large implant is better placed through the inferior fornix incision, and then the positioning adjusted through the caruncular incision. Some surgeons advocate multiple implants that can overlap, using very thin implants.

Closing the transcaruncular incision involves placing one to three buried interrupted 6-0 fast-absorbing plain gut sutures to close the caruncular conjunctiva.

Medial wall fractures are particularly challenging to repair when they are part of a comminuted naso-ethmoidal fracture. In these circumstances, post-traumatic telecanthus is common, and can be quite disfiguring (Figure 17.9). Repair of the fractured posterior lacrimal crest and stabilization of the medial canthal tendon should be attempted during primary repair. Good exposure is critical, and when the naso-ethmoidal fractures are part of panfacial trauma, a bicornal approach has many merits. Transnasal wiring has been described for the repair of post-traumatic telecanthus, and may be necessary in combination with miniplate fixation when repairing severely comminuted naso-ethmoid fractures. However, whenever possible, we favor miniplate fixation of the comminuted bones and the medial canthal tendon (Figures 17.10A and B).

**LATERAL WALL AND ZYGOMATICOMAXILLARY FRACTURES**

Fractures of the lateral wall of the orbit are common, and typically result from direct blunt trauma to the zygoma and lateral orbital rim. The zygoma articulates with the sphenoid, maxillary, frontal and temporal bones. Therefore, fractures of the zygoma can often disrupt the architecture of the entire region, and hence are often referred to as zygomaticomalar complex fractures (ZMC fractures). Importantly, the orbital floor is always fractured in the context of a displaced zygomatic fracture, but will typically reduce once the zygoma fracture is reduced.

Numerous surgical approaches to the ZMC fracture have been described for open reduction, including transconjunctival, intraoral, temporal (Gillies), brow incision and bicornoral flap. In addition, some surgeons advocate closed reduction or observation for non-comminuted and uncomplicated zygoma fractures. The approach to the ZMC fracture is greatly aided by careful evaluation of the CT scan, and different classification systems have been proposed in an effort to provide guidance to proper preoperative planning. Whichever approach is chosen, a reduction of the zygoma should attempt to replace the zygoma back into its normal anatomic location. Because the zygoma can rotate around an axis formed by the inferolateral orbital rim, reduction of just the fronto-zygomatic and zygomatico-maxillary sutures is not sufficient: a third point of alignment should be confirmed in order to ensure proper reduction and avoid late enophthalmos. Exploration of the lateral floor of the orbit can greatly assist in the fracture reduction, as well as help avoid orbital tissue incarceration between the zygoma and the sphenoid bones.

When non-comminuted fracture displacement is noted on examination and CT scans, we favor surgical exploration and repair through a subconjunctival
inferior fornix and lateral canthotomy approach. First, forced ductions are performed to assess for possible muscle entrapment. The lateral canthus and inferior fornix are infiltrated with local anesthetic containing 1:100,000 dilution of epinephrine, and a lubricated plastic corneal protective shield is placed on the eye. A lateral canthotomy and inferior cantholysis (and sometimes superior cantholysis, too), are performed to release the lateral canthal attachments and provide good exposure of the lateral rim. The lateral inferior fornix is then incised to reveal the inferolateral rim. The periosteum is incised along the entire exposed rim, and a freer elevator is used to lift the periosteum and expose the rim from above the fronto-zygomatic suture down to below the maxillo-zygomatic suture and medially to the infraorbital canal. When a depressed floor fracture is present, the inferior fornix incision can be carried out medially to provide full exposure of the floor.

Next, the zygoma must be properly reduced and aligned along three points: the fronto-zygomatic suture, the maxillo-zygomatic suture at the inferior rim, and a third point that can be the zygomaticosphenoid suture at the lateral orbital floor, the zygomatico-maxillary buttress, and/or the zygomatic arch. The first two points ensure anterior alignment, whereas a third point ensures posterior alignment. Failure to achieve posterior alignment can predispose to enophthalmos by enlarging the posterior orbital volume (Figure 17.8).

A useful tool in ZMC fracture alignment has been the T-bar screw, also known as the Carroll-Girard screw (Walter Lorenz Surgical, Jacksonville, FL, USA). This cork-screw-like instrument is screwed onto the thick bone at the malar eminence and used to manipulate the zygoma into proper position (Figure 17.18A and B). This tool is particularly useful in minimally-comminuted fractures, and allows for exceptional control of the zygoma through a small-incision approach. However, when severe comminution exists without solid bone for placement of the screw, multiple incisions would be required to achieve complete reduction and rigid fixation.

Following reduction of the fracture, fixation is accomplished using titanium miniplates. Forced ductions are performed again to ensure that no entrapment was caused by the fracture reduction. The lateral floor is explored to assess the zygomatico-sphenoid suture. Next, the periosteum is sutured and the lower lid retractors are reapproximated using buried interrupted 7-0 polyglactin suture. The lateral canthal tendon is resuspended to the periosteum at Whitnall’s tubercle. If lower lid laxity is present, horizontal tightening is performed to reduce the risk of postoperative lower lid retraction. Placement of a Frost suture can be done in the presence of concomitant lower lid trauma and when the risk of cicatricial ectropion is felt to be high.

LATE AND SECONDARY FRACTURE REPAIR

As far back as 1957, Smith and Regan made the point that “late cases are far more difficult to correct.” Nevertheless, thirty years ago, many surgeons advocated observation and delay of surgery for all but the most severe orbital fractures. However, with the advent of CT scanning, an evolution in implants and fixation devices, and greatly improved surgical techniques, primary repair has become the standard of care for symptomatic or large orbital fractures. Still, there are occasions when late repair of orbital fractures is still encountered. Some reasons include lack of access to medical care following trauma, misdiagnosis, multiple medical problems preventing timely repair, or a suboptimal repair that requires reoperation.

The goal of late fracture repair is the same as for early repair, namely to restore orbital anatomy and reduce or eliminate any symptoms. Late repair is nearly always complicated by significant fibrosis and abnormal anatomy that can distort the normal anatomic landmarks. When dysmotility is a significant symptom and its repair a main goal of the operation,
good motility measurements are critical, as is the assistance of an expert in adult strabismus. Dysmotility that results from entrapment can be corrected when the muscle entrapment is reduced. However, if the dysmotility is the result of irreversible muscle or nerve damage, further orbital surgery will not restore normal motility, and can cause a significant increase in orbital fibrosis in addition to the risk of an unnecessary orbital surgery. Instead, strabismus surgery would be a better option. Hence, careful diagnosis of the underlying cause of dysmotility is crucial. In our practice, we will obtain a CT scan to evaluate the bony anatomy, and occasionally a dynamic MRI scan to evaluate the cause of dysmotility. In addition, we request a consultation from an expert in strabismus, and employ a team-oriented approach to caring for these patients.

A common reason for late surgical repair is severe enophthalmos (Figure 17.11). In a paper by Koo et al. (2006), 64 clinically apparent enophthalmos was found when enophthalmos was measured at 3-4 mm or more. In such cases, patients must weigh their symptoms against the risks of surgical complications. It is important to emphasize that counseling and managing expectations are very important for achieving a result that is satisfactory to both the surgeon and the patient.

Our approach to enophthalmos repair stresses pre-operative counseling in order to clearly define what the patient desires and what we believe can be accomplished safely. Our surgical technique emphasizes good exposure, optimized illumination, and meticulous hemostasis. We employ the same incisions that we utilize for early fracture repair, namely the inferior fornix, lateral canthotomy/cantholysis, and transcaruncular incisions. Often, the main decision is whether to attempt reduction of a healed fracture or to focus on the enophthalmos and provide orbital volume augmentation through the use of porous polyethylene implants. Given the added risk of re-fracturing and reducing healed fractures, we usually opt for orbital volume enhancement and accept the mild deformities that may be associated with poorly positioned but healed ZMC fractures. For volume enhancement, we typically utilize porous polyethylene wedge implants that are shaped to reduce orbital volume or implants with titanium that can be fixated at the orbital rim (Figure 17.19).

CONCLUSION

Orbital fractures are commonly encountered by the ophthalmologist, otolaryngologist, and orbitofacial plastic surgeon. Proper treatment requires a complete ophthalmic evaluation, systematic review of the radiographic evidence, and thoughtful surgical planning with careful attention to anatomic principles. The use of smaller and hidden incisions (particularly conjunctival incisions) has made surgical treatment of orbital fractures more esthetically satisfying while reducing the risk of complications. The choice of implant materials has never been greater, providing the surgeon with options that can be tailored to the needs of the patients. While surgical repair of orbital fractures has advanced considerably over the past 50 years, there is no doubt that we will continue to see innovations and further improvements in surgical techniques, to the continued benefit of our patients.

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Orbital Fractures


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