



Decision-Making in Treatment of Orbital Floor Fractures

Akshay Govind*, Nicholas Ray

Department of Oral and Maxillofacial Surgery, University of California San Francisco, Highland Hospital / Alameda Health System, 1411 E 31st St. - Oral Surgery - Wing E2, Oakland, CA 94602, USA

***Corresponding author:** Akshay Govind, Department of Oral and Maxillofacial Surgery, University of California San Francisco, Highland Hospital / Alameda Health System, 1411 E 31st St. - Oral Surgery - Wing E2, Oakland, CA 94602, USA

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Abstract

This is a review paper on management of orbital floor fractures. It includes tips regarding evaluation and diagnosis, treatment planning, intraoperative problem solving, and avoidance/management of complications.

Evaluation and Diagnosis: A young patient with a small fracture is most likely to have acute entrapment. Clinical signs concerning for orbital compartment syndrome include proptosis, a rock-hard globe, resistance to retropulsion, afferent pupillary defect, or loss of color vision. Surgeons should have a low threshold for an exam under anesthesia if the patient struggles to cooperate with an accurate exam in the emergency bay.

Treatment planning: Posterior and large fractures may be better accessed through a transantral approach, whereas smaller or more anterior fractures may be better accessed through transorbital approaches. Each transorbital approach has pros and cons, and choice depends on access needed and healing characteristics of the patient.

Intraoperative Problem Solving: Adding an additional approach to triangulate anatomy from multiple viewpoints, use of intraoperative imaging, and use of a high-quality headlight are all useful techniques.

Avoidance/Management of Complications: Always check for the presence of vision in the operated eye immediately following surgery. Steroids improve post-operative course. Antibiotics covering sinonasal flora should be used intraoperatively and for 24 hours following surgery. Combination orbital floor/medial wall fractures may have a higher risk of post-operative diplopia or gaze restriction. Prism corrective lenses and/or strabismus surgery may be indicated and appropriate referral to ophthalmology should be arranged.

Keywords: Entrapment; Headlight; Orbital compartment syndrome; Orbital floor fractures; Orbital trauma

Introduction

Orbital floor fractures are typically seen in patients who have sustained moderate intensity blunt trauma to the midface and may occur alone or in combination with other midface fractures. There has been considerable discussion over the past century about whether the pattern of the isolated orbital floor fracture is the result of linear force transmission known as the “buckling” theory or pressure transmission known as the “hydraulic” theory [1]. Nevertheless, the functional outcome is that the fracture of the orbital floor is thought to act as a pressure release valve, thus sparing the globe itself from injury after orbital impact.

The sequelae of orbital floor fractures themselves fall into two categories: functional and esthetic. Functional consequences

most frequently include binocular diplopia, gaze restriction, or an oculocardiac bradycardic response [2-4]. The esthetic changes of the fractures themselves are typically related to globe or orbit position- enophthalmos or vertical dystopia, respectively.

Similarly, there can be both functional and esthetic complications of orbital surgery, and thus the decision to perform surgery should be based on sound analysis of the patient’s goals and the risk-benefit profile of the proposed intervention. Rarely, there can be severe vision loss after orbital surgery, but this is typically seen in patients with facial polytrauma or with fractures involving the orbital apex [5]. The more frequently encountered functional risks include incomplete resolution of diplopia, gaze restriction, or enophthalmos [6-8]. Changes to the eyelid from orbital approaches can have a combination of functional and esthetic sequelae, which we will discuss in more detail below. Here we present a review paper based both on literature and the lead author’s experience in

managing orbital floor trauma. It includes tips regarding evaluation and diagnosis, treatment planning, intraoperative problem solving, and avoidance/management of complications.

Evaluation and Diagnosis

Clinical History

Consultants in orbital trauma may have backgrounds in oral and maxillofacial surgery, plastic and reconstructive surgery, otolaryngology, or ophthalmology. Most typically, calls will come from emergency departments or primary care physicians after an initial evaluation has been performed. It is rare in today that a patient with significant facial trauma does not have a CT scan prior to the consultant being called with a radiographic description of the injuries. The consultant should view the images him/herself, with particular attention to the coronal and sagittal slices of a thin-cut (<1 mm) CT scan without contrast. Patients who have had an orbital fracture diagnosed on a less detailed exam of the brain or cervical spine should have dedicated imaging of the facial bones.

In the acute setting, the critical question to answer is whether a patient with orbital trauma has entrapment, as relief of the entrapped muscle within 1 day reduces the risk of long-term diplopia [9,10]. While every patient should get a careful physical examination, some knowledge of the pre-test probability for entrapment is useful for the evaluating surgeon. The age of the patient and size of the fracture are to be considered. Muscular entrapment is more common in pediatric or adolescent patients than in older adults, and entrapment is more common in small fractures than in large ones [11]. The non-entrapped patient should be re-evaluated after resolution of acute edema. The history question I find most useful in the adult patient for isolating diplopia on up gaze is whether the patient notices double vision checking the rear-view mirror while driving.

Physical Examination

While a standard trauma assessment and complete head and neck exam should be performed on every patient, the goal of this section is to highlight a few key nuances of the physical exam specific to orbital fractures.

Evaluation for Orbital Compartment Syndrome (OCS)

Most facial trauma surgeons are taught to be concerned for orbital compartment syndrome in the setting of retrobulbar

hematoma. The absence of this radiographic finding should not lull the evaluating surgeon into a false sense of security, as edema alone can also cause OCS. Proptosis, a rock-hard globe, resistance to retropulsion, an Afferent Pupillary Defect (APD), or loss of color vision (loss of red vision is often the first sign) are all concerning physical exam findings for OCS.

Handheld tonometers are notoriously finicky. Clinicians should familiarize themselves with whatever device to which they have access, both with calibration and use of the instrument. Normal intraocular pressure is 10-21 mm Hg, and lateral canthotomy +/- inferior canthylisis if Intraocular Pressure (IOP) is greater than 40 mm Hg or greater than 30 mm Hg with other cardinal physical exam findings concerning for OCS [12]. The swinging flashlight test is the correct way to assess the pupils for an APD. It has been described elsewhere in detail, but in short, if there is an afferent pupillary defect, the pupils will be larger while the light is shining on the affected eye [13-16].

Entrapment

Entrapment is a clinical diagnosis, not a radiographic one. The extraocular movement exam is one where subtle findings may reveal a need for urgent intervention. Eye movements should be evaluated slowly with the clinician's finger equidistant between the examiner and the patient. The examiner should hold the extremes of gaze (characteristic H pattern as well as straight up and down) and watch for asymmetry and restriction. The inability of the affected eye to look in one or more directions (most commonly up) requires a trip to the operating room to release the entrapped muscle or periorbital tissue.

Periorbital edema can make the exam difficult. The swollen eyelid may prevent the patient from seeing in the extremes of gaze. Gentle retraction of the eyelid during extraocular movements can be helpful but is not successful in all cases, and the Desmarres lid retractor is the instrument of choice (shown in Figure 1). In cases with a very swollen eyelid but normal mental status, one can ask the patient to move the eyes behind the closed eyelid. The eye can be seen moving under the eyelid and restriction of movement can be reported by the patient sometimes more accurately than when the swollen eyelid is forced open. Diplopia without a clinically discernable gaze restriction does not necessarily mean the muscle is entrapped and should be evaluated in conjunction with the rest of the exam.



Figure 1: The Desmarres eyelid retractor is the instrument of choice for retracting the swollen eyelid to examine the globe.

If the patient is not able to cooperate with an extraocular movement exam or the exam is inconclusive, forced duction may be utilized. This is classically taught by grasping the conjunctiva/sclera with an Adson forceps and moving the eye to assess for any hang-ups [17]. The lead author typically uses topical anesthetic eye drops and two sterile cotton swabs to manipulate the eye.

In the patient who struggles to cooperate with an accurate exam in the emergency bay, have a low threshold for an exam under anesthesia if there is high enough clinical suspicion for entrapment.

Ophthalmology involvement

Different hospitals have different access to immediate ophthalmologic evaluation. Depending on the exact type of orbital injury, rates of concomitant ocular injury range from 2 to 17% [18]. All patients with abnormal visual acuity should be evaluated by an ophthalmologist. Different surgeons have different preferences on whether someone with a normal ocular exam needs an ophthalmologic evaluation prior to surgery. We believe all patients undergoing non-emergent orbital surgery should at least be given the option to see an ophthalmologist for documentation of a baseline eye exam.

Imaging

The surgeon should evaluate the CT scan him/herself, not

only to confirm or deny the findings stated by the radiologist, but also for planning the extent of surgical dissection. Comments on concern for entrapment in the radiology report can be distracting, and especially junior surgeons should be aware of the psychological challenge of “disagreeing” with the radiologist.

Radiographic signs concerning for OCS include guitar-pick shape at the posterior aspect of the globe or straightening of the optic nerve. Comparing the stretch angle between the affected and unaffected eyes and measuring the length from globe to orbital apex can help identify patients at risk for poor visual outcomes as well [19]. Cases of true entrapment with small greenstick trapdoor fractures may be entirely missed by the radiologist, especially if peri-orbital fat rather than a muscle is what is entrapped in the fracture. Bleeding into the maxillary sinus should heighten the reading physician’s awareness to look closely for orbital fractures.

Treatment Planning

Indications for surgery

Relief of an entrapped extraocular muscle or even periorbital fat should be done urgently, as involved tissue can undergo avascular necrosis. While persistent diplopia is an accepted indication for repair, we advocate letting acute edema resolve before deciding whether or not to operate. Often, enophthalmos may be more noticeable yet diplopia less so as swelling subsides. The lay public can identify as little as 2 mm of enophthalmos, but not all patients are bothered by this. Classically, we have used 50% of the orbital floor fractured as a predictor of who would develop noticeable enophthalmos, but outcomes are not worse in the non-entrapped patient if one waits a few weeks to re-evaluate [20,21]. Either way, a patient who is not sure, if he/she wants surgery and is not entrapped should not be “talked into” surgery. Accurate pre-operative photos, particularly from a submental vertex view and documentation of thorough discussion of risks and benefits are appropriate.

Surgical Approach

Approaches to the orbital floor can be broadly separated into transorbital and transantral approaches. Larger or more posterior orbital floor fractures are more easily treated through a transantral approach while smaller or more anterior fractures are better treated through transorbital approaches [22].

Transantral approaches are made through an intraoral maxillary vestibular incision and anterior maxillary osteotomy with or without the aid of an endoscope. We advocate for the use of a high-quality headlight no matter the approach. Whether using an endoscope or not, a large antrostomy window helps both for visualization and manipulation of the involved structures [23].

Placement of incision for transorbital approaches

Transorbital approaches may be transconjunctival or

transcutaneous. The transconjunctival approach may technically be done in a preseptal or retroseptal fashion, but for trauma surgery, the retroseptal variant is preferred due to its ease and low likelihood of disrupting the tarsal plate. Use of a lateral canthotomy widens the access but adds a visible scar. In addition, care must be taken to resuspend the lateral canthus accurately, which can be tricky and time consuming in some cases. Most straightforward reconstructions of orbital floors can be done through a transconjunctival incision alone. The incidence of entropion with this incision is 0.5-4% [24].

Transcutaneous approaches include subciliary and mid-lid/subtarsal variants. The subciliary incision carries with it a high risk of uncorrectable ectropion and should not be used for trauma surgery [25]. The subtarsal/mid-lid approach provides excellent access but carries with it some risk of hypertrophic scarring. When the inferior orbital rim must be plated, access is easier with the mid-lid incision than the transconjunctival, although this can often be done through a maxillary vestibular incision as well. Lastly, patients with darker skin are more likely to have poor cosmetic outcomes with transcutaneous incisions than their lighter skinned counterparts [26]. Figure 2 shows an obvious mid-lid scar on a young man with Fitzpatrick Type 4 skin over four months after surgery. Figure 3 shows a nearly imperceptible lower eyelid scar on a woman with Fitzpatrick Type 1 skin just four weeks after surgery. Notably, her supraorbital/eyebrow scar from a traumatic laceration is quite obvious.



Figure 2: Four months after surgery, this patient with Fitzpatrick Type 4 skin still has an obvious scar from a subtarsal approach.



Figure 3: Four weeks after surgery, this patient with Fitzpatrick Type 1 skin has an almost imperceptible lower eyelid scar. Notably, her supraorbital/eyebrow scar from a traumatic laceration is quite obvious.

Intraoperative Problem Solving

Consider adding an additional approach

Adherence to the principles described above in the treatment planning section decreases the chance for intraoperative difficulty. Like most surgeries, improving access and visualization are often useful when struggling. If struggling with a transorbital approach, one can consider adding a transantral approach with introduction of an endoscope to help guide the reduction, or vice versa.

From a transorbital approach, it can be difficult to find the posterior ledge. One technique is to let the periosteal elevator fall into the sinus and find the posterior-superior corner of the sinus, then bring the instrument along the roof of the sinus until the fracture is encountered. Then slide onto the superior aspect of the bone, and the instrument should be on the posterior ledge of the fracture.

Choice of reconstructive material and style

Orbital floors are typically described as being reconstructed with titanium, porous polyethylene, combination of the two, or bone grafts typically from the calvarium. Routine use of calvarium should be abandoned, as the morbidity of a second surgical site and the inability to customize the contour of the material make it inferior to an alloplastic reconstruction. Most plating companies have anatomic pre-formed orbital plates. The surgeon should select the plate that requires the least amount of modification to cover the defect and minimizes the amount of further dissection needed to place the implant.

Although many surgeons have success with simply a guitar-pick style sheet of porous polyethylene, we prefer a plate that can be fixated in some way, typically made from either titanium or titanium coated with porous polyethylene. Although rare, migration of an orbital floor plate can cause blindness, and there is minimal morbidity of adding screws to fixate the plate.

Use of Intraoperative Imaging

Intraoperative CT and/or navigation may be used, if available. These modalities can aid in intraoperative problem solving. More often, the image avoids the need for wondering overnight if the patient needs to return to the OR, and there is some evidence especially for novice orbital surgeons that image guidance can improve outcomes [27].

Closure

If using a transconjunctival approach, the wound will typically heal within a week whether it is closed with sutures or fibrin sealant, but there is some evidence the latter causes less post-operative discomfort [28]. Transcutaneous incisions should be closed in three layers: the periosteum with a 4-0 vicryl, the orbicularis oculi with a buried 5-0 monocryl, and a gentle skin

suture with 6-0 fast absorbing gut. The skin should already be approximated after the muscle closure, and the skin stitches should minimize pull on the eyelid.

There is no evidence to support the routine use of a Frost suspensory stitch, especially given that the subciliary incision should not be used for trauma [29]. However, a suspensory stitch may be useful if some of the lower eyelid has been avulsed in the injury. In the latter case, the Frost stitch may oppose the pull of the primary closure over the avulsed tissue [30]. Alternatively, well color matched skin grafts can be utilized to cover the defect.

Avoidance and management of complications

Immediately after surgery, all patients should have an immediate post-op check in the recovery room to check that there is vision in the eye that has been operated on. Absence of vision should be followed by immediate take-back to the operating room for removal of the reconstructive material, as it may have been impinging upon the optic nerve or providing unacceptable pressure on the globe. This should be done in conjunction with a consultation to the ophthalmology service.

There is strong evidence that steroids should be given at the time of orbital surgery, as they lessen perioperative edema and pain and improve function [31,32]. Intraoperative broad spectrum antibiotics covering sinonasal flora (ampicillin-sulbactam or similar scope) should be used. Twenty-four hours of post-operative antibiotics are given by most surgeons. A randomized controlled trial found that a 1-day course is as effective in preventing infective complications as a 5-day regimen [33].

Patients with significant diplopia after orbital surgery may need additional strabismus surgery and/or corrective lenses with prisms. This possibility should be discussed with patients ahead of time, particularly in patients with combined orbital floor/medial wall fractures [6]. Referral to an ophthalmologist for management is indicated for persistent diplopia beyond a few weeks.

Conclusions

The goal of treatment of orbital floor fractures is to support the eye to look and move naturally. Subtleties of the position and size of the fracture as well as the age and goals of the patient help the treating surgeon recognize absolute indications and decide on relative indications for surgery. There are myriad choices in terms of approach, reconstructive material, and assistive instruments, each with its pros and cons. The one constant is that a high-quality headlight should always be used, as there is no other way for light and the surgeon's eyes to focus on the same spot deep within the orbit. This paper guides the surgeon treating orbital floor fractures through some of the key decisions to consider in managing this pattern of injury.

Declarations

Authors' contributions

Govind A: Made substantial contributions to the composition of this manuscript.

Ray N: Conducted literature review as well as reviewed and edited this manuscript.

Conflicts of interest

All authors declared that there are no conflicts of interest.

References

1. Gart MS, Gosain AK (2014) Evidence-based medicine: Orbital floor fractures. *Plast Reconstr Surg* 134:1345-1355.
2. Mehmood N, Hasan A (2019) Oculocardiac Reflex: An Underrecognized but Important Association with Orbital Trap Door Fractures. *Pediatr Emerg Care*.
3. Worthington JP (2010) Isolated posterior orbital floor fractures, diplopia and oculocardiac reflexes: a 10-year review. *Br J Oral Maxillofac Surg* 48: 127-130.
4. Lee SC, Park SH, Han SK, Yoon ES, Dhong ES, et al. (2017) Prognostic Factors of Orbital Fractures with Muscle Incarceration. *Arch Plast Surg* 44: 407-412.
5. Jacobs SM, McInnis CP, Kapeles M, Chang SH (2018) Incidence, Risk Factors, and Management of Blindness after Orbital Surgery. *Ophthalmology* 125:1100-1108.
6. Biesman BS, Hornblass A, Lisman R, Kazlas M (1996) Diplopia after surgical repair of orbital floor fractures. *Ophthalmic Plast Reconstr Surg* 12: 9-16.
7. Sobol EK, Rosenberg JB (2017) Strabismus After Ocular Surgery. *J Pediatr Ophthalmol Strabismus* 54: 272-281.
8. Shah HA, Shipchandler T, Vernon D, Baumanis M, Chan D, et al. (2018) Extra-ocular movement restriction and diplopia following orbital fracture repair. *Am J Otolaryngol* 39: 34-36.
9. Kushner BJ (1982) Paresis and restriction of the inferior rectus muscle after orbital floor fracture. *Am J Ophthalmol* 94: 81-86.
10. Grant JH 3rd, Patrinely JR, Weiss AH, Kierney PC, Gruss JS (2002) Trapdoor fracture of the orbit in a pediatric population. *Plast Reconstr Surg* 109: 482-489; discussion 490-485.
11. Cruz AA, Eichenberger GC (2004) Epidemiology and management of orbital fractures. *Curr Opin Ophthalmol* 15: 416-421.
12. Amer E, El-Rahman Abbas A (2019) Ocular Compartment Syndrome and Lateral Canthotomy Procedure. *J Emerg Med* 56: 294-297.
13. Sun MT, Chan WO, Selva D (2014) Traumatic orbital compartment syndrome: importance of the lateral canthomy and cantholysis. *Emerg Med Australas* 26: 274-278.
14. Volpe NJ, Davdand L, Kim SK, Maguire MG, Ying GS, et al. (2009) Computerized binocular pupillography of the swinging flashlight test detects afferent pupillary defects. *Curr Eye Res* 34: 606-613.
15. Volpe NJ, Plotkin ES, Maguire MG, Hariprasad R, Galetta SL (2000) Portable pupillography of the swinging flashlight test to detect afferent pupillary defects. *Ophthalmology* 107:1913-1921; discussion 1922.

16. Bell RA, Waggoner PM, Boyd WM, Akers RE, Yee CE (1993) Clinical grading of relative afferent pupillary defects. *Arch Ophthalmol* 111: 938-942.
17. Li Y, Song X, Li L, Fan X, Lin M (2016) Forced duction training: A potential key point for recovery in pediatric patients with trapdoor fracture. *Medicine (Baltimore)* 95: e5121.
18. Brown MS, Ky W, Lisman RD (1999) Concomitant ocular injuries with orbital fractures. *J Craniomaxillofac Trauma* 5:41-46.
19. Oester AE Jr, Sahu P, Fowler B, Fleming JC (2012) Radiographic predictors of visual outcome in orbital compartment syndrome. *Ophthalmic Plast Reconstr Surg* 28: 7-10.
20. Dubois L, Steenen SA, Gooris PJ, Mourits MP, Becking AG (2015) Controversies in orbital reconstruction--II. Timing of post-traumatic orbital reconstruction: a systematic review. *Int J Oral Maxillofac Surg* 44: 433-440.
21. Ugradar S, Lo C, Manoukian N, Putthirangsiwong B, Rootman D (2019) The Degree of Posttraumatic Enophthalmos Detectable by Lay Observers. *Facial Plast Surg* 35:306-310.
22. Kwon JH, Kim JG, Moon JH, Cho JH (2008) Clinical analysis of surgical approaches for orbital floor fractures. *Arch Facial Plast Surg* 10: 21-24.
23. Govind A, Dierks E, Bell RB, Amundson M (2019) Four Practical Reconstructive Techniques Using the Transantral Approach to the Orbital Floor Without the Need for an Endoscope. *J Oral Maxillofac Surg* 77: 2074-2082.
24. Ridgway EB, Chen C, Lee BT (2009) Acquired entropion associated with the transconjunctival incision for facial fracture management. *J Craniofac Surg* 20: 1412-1415.
25. Ridgway EB, Chen C, Colakoglu S, Gautam S, Lee BT (2009) The incidence of lower eyelid malposition after facial fracture repair: a retrospective study and meta-analysis comparing subtarsal, subciliary, and transconjunctival incisions. *Plast Reconstr Surg* 124:1578-1586.
26. Floyd EM, Perkins SW (2018) Managing the Lower Eyelid Complex in the Thick-Skinned Patient. *Facial Plast Surg* 34:50-58.
27. Davis KS, Vosler PS, Yu J, Wang EW (2016) Intraoperative Image Guidance Improves Outcomes in Complex Orbital Reconstruction by Novice Surgeons. *J Oral Maxillofac Surg* 74:1410-1415.
28. You HJ, Son ST, Kim DY, Han SK (2016) A prospective randomized study comparing fibrin sealant versus suture for conjunctival wound closure in orbital wall fracture surgery. *Int J Oral Maxillofac Surg* 45:1418-1423.
29. Bartsich S, Yao CA (2015) Is frosting effective? The role of retention sutures in posttraumatic orbital reconstruction surgery. *J Plast Reconstr Aesthet Surg* 68:1683-1686.
30. Connolly KL, Albertini JG, Miller CJ, Ozog DM (2015) The suspension (Frost) suture: experience and applications. *Dermatol Surg* 41: 406-410.
31. Kormi E, Snall J, Koivusalo AM, Suominen AL, Thoren H, et al. (2017) Analgesic Effect of Perioperative Systemic Dexamethasone on Blowout Fracture Surgery. *J Oral Maxillofac Surg* 75:1232-1237.
32. Flood TR, McManners J, el-Attar A, Moos KF (1999) Randomized prospective study of the influence of steroids on postoperative eye-opening after exploration of the orbital floor. *Br J Oral Maxillofac Surg* 37:312-315.
33. Zix J, Schaller B, Iizuka T, Lieger O (2013) The role of postoperative prophylactic antibiotics in the treatment of facial fractures: a randomised, double-blind, placebo-controlled pilot clinical study. Part 1: orbital fractures in 62 patients. *Br J Oral Maxillofac Surg* 51: 332-336.