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Break the Fall: Orbital Blowout Fracture

Christopher Bugajski OD, FAAO
Department of Veterans Affairs, VA Northern Indiana Health Care System, St. Joseph County VA Clinic, bugajski@gmail.com

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Break the Fall: Orbital Blowout Fracture

Abstract

Background: Head trauma can lead to multiple ocular complications, among the most concerning is an orbital blowout fracture. Common associations with an orbital fracture would include periorbital ecchymosis, subconjunctival hemorrhage, eyelid edema, and crepitus, among others. Concerning complications, such as retinal detachment, need to be ruled out at the time of presentation. Surgical intervention may be warranted in certain cases. An emergent head computed tomography scan must be performed to evaluate and determine management.

Case Report: This case features a 66-year-old Caucasian male with an orbital blowout fracture following a fall. In addition to discussing the details regarding this patient's case, this report highlights fracture types, pertinent imaging, determination of muscle entrapment, and other underlying complications.

Conclusion: Careful evaluation is critical in proper management of potential orbital fracture cases. Entrance testing such as visual acuity measurement, pupil assessment, and extraocular muscle motility evaluation provide useful information regarding suspected severity of an orbital fracture. A dilated fundus examination is necessary for assessing concerning posterior complications. Computed tomography imaging must be obtained in all instances of questionable orbital fracture. Surgical intervention may be needed in some instances. Regardless of the necessity for surgical intervention, careful monitoring of these cases for resolution is advisable.

Keywords

orbital blowout fracture, inferior wall, medial wall, ocular trauma, CT scan

INTRODUCTION

Orbital fractures are predominantly associated with recent trauma such as falls, assaults, and motor vehicle accidents among various other incidents.[1-4] Males tend to present more frequently than females with orbital fractures and, more generally, facial fractures.[3,5] Children are less apt to be affected by orbital fractures than adults.[3] In children, orbital roof fractures are more common than floor fractures until 7 years of age.[6] In adults, orbital floor fractures are the most common type of fracture, followed by a fracture of the medial wall. The most common findings in an orbital fracture are periorbital ecchymosis and subconjunctival hemorrhage. Eyelid edema, tenderness of adnexal tissue, diplopia, crepitus, and numbness ipsilateral to the trauma can also be observed.[7,8] Less commonly, a patient may develop orbital compartment syndrome, which can lead to an ophthalmic infarction. This poses the greatest risk to vision loss following an orbital fracture.[9] Other complications including optic nerve damage, retinal detachment, and extraocular muscle entrapment need to be ruled out at presentation.[3,7,8] Surgical intervention is indicated immediately in the instance of a white-eyed blowout fracture related to a "trapdoor fracture" of the orbital floor, which commonly presents with an oculocardiac reflex.[3,10,11,12] Surgical intervention is warranted in other instances such as a large fracture, complex fracture, enophthalmos, hypoglobus, or frontal sinus involvement.[6,7,10,13-15] Computed tomography (CT) imaging is critical for evaluating the extent, severity, and involvement of the fracture.[4,7,8] Given all of these considerations, the patient will need to be evaluated appropriately to determine urgency in treatment and management.

CASE DATA

A 66-year-old Caucasian male presented to the Department of Veterans Affairs eye clinic for an urgent care visit, with a chief complaint of ocular trauma to the left eye as a result of a fall (while inebriated) onto concrete one day prior. Upon initial presentation, he presented with periorbital ecchymosis and edema, 6/10 adnexal pain, and blur of the left eye. He denied any diplopia, loss of vision, or headaches. Personal ocular history was unremarkable. The patient's family ocular history was negative. Medical history included hyponatremia, dyslipidemia, and vitamin B-12 deficiency for which he was taking cyanocobalamin 100 mcg/mL injection, hydrochlorothiazide 25 mg/triamterene 37.5 mg, metoprolol tartrate 100 mg, aspirin 81 mg, and fish oil 1000 mg. He denied any drug allergies. He was oriented to person, place, and time.

Corrected visual acuity was 20/20 OD and 20/20 OS with a spectacle prescription of -1.50 OD and -1.50 -0.50 x 121 OS with a +2.50 add OU. Motilities were unrestricted, full, and smooth in all gazes OU, though mild discomfort OS was noted in all gazes. Cover test demonstrated orthophoria in all gazes at distance and near. Confrontation visual fields were full to finger count OU. Pupils were equally round and reactive to light with no relative afferent pupillary defect (RAPD).

An anterior segment evaluation revealed normal eyelid appearance in the right eye. In contrast, the left eye exhibited an abnormal appearance with edema of both superior and inferior lids, erythema, ecchymosis, and a laceration above the left eyebrow. The cornea was clear and intact without abrasion, keratitis, or scarring for each eye. The conjunctiva was white and quiet for each eye. The anterior chambers were deep and quiet in each eye. The iris was flat, without tears, recession, or transillumination in each eye. The patient's intraocular pressures were measured as 19 mm Hg OD, 20 mm Hg OS using an Icare™ tonometer. The patient was dilated using one drop of 1% tropicamide OU.

Posterior segment examination revealed trace nuclear sclerosis of the lens in each eye and an intact vitreous without cells or detachment OU. Normal pink, healthy, distinct rim tissue and an optic nerve head appearance of 0.35/0.35 cup-to-disc ratio with a slight tilt OU was observed with no optic nerve head edema or pallor. Normal, flat macula OU was observed; retinal blood vessels were in a normal ratio of 2/3 OU; the periphery revealed an intact retina with no holes, tears, or detachments 360° OU.

The differential diagnoses to consider for this case include:

Orbital contusion	Orbital contusion will generally appear with periorbital ecchymosis and edema, the discoloration/bruising and swelling of the skin surrounding the eye.
Orbital fracture with muscle entrapment	Orbital wall fracture with muscle entrapment will generally appear secondary to trauma with periorbital ecchymosis and edema, adnexal pain, and diplopia. Forced duction testing is positive.
Orbital fracture without muscle entrapment	Orbital wall fracture without muscle entrapment will generally appear secondary to trauma with periorbital ecchymosis and edema, and adnexal pain. Forced duction testing does not demonstrate restriction.
Orbital hemorrhage (retrobulbar)	Orbital hemorrhage (retrobulbar) will generally present with pain, decreased vision, very severe periorbital edema causing difficulty in opening the eyelids, and poor extraocular muscle movements

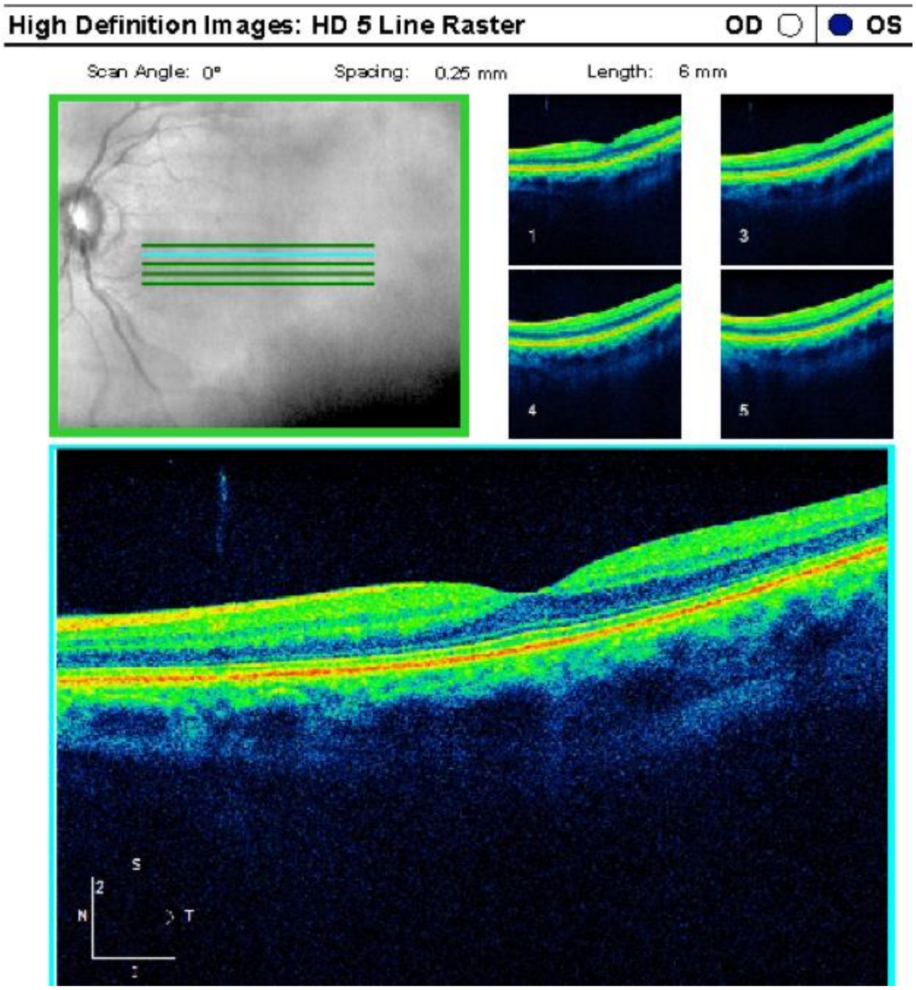

Figure 1 Figure 1 is a reliable quality OCT high-definition image of the macula OS. The image displays normal foveal contour and otherwise appears unremarkable. The image was obtained to establish normality and rule out Berlin's edema or other damage to the macula.

Optical coherence tomography (OCT, Figure 1) and computed tomography (CT, Figures 2 & 3) scans were ordered and performed the same day.

Figures 2 and 3 are CT scans without contrast. These scans were ordered to better visualize a suspected bone fracture insult from the resultant trauma due to the fall.

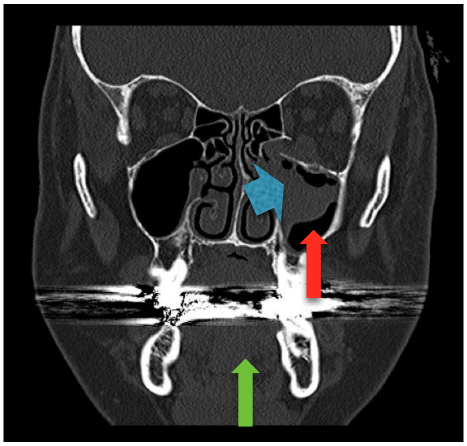

Figure 2
Figure 2 is a coronal section through the orbit. The left inferior and medial wall fractures (blue arrow) can clearly be observed. Blood in the maxillary sinus (red arrow) is also visible. No muscle entrapment exists. Due to previous dental work, there is a large artifact (green arrow) found near the bottom of the image.

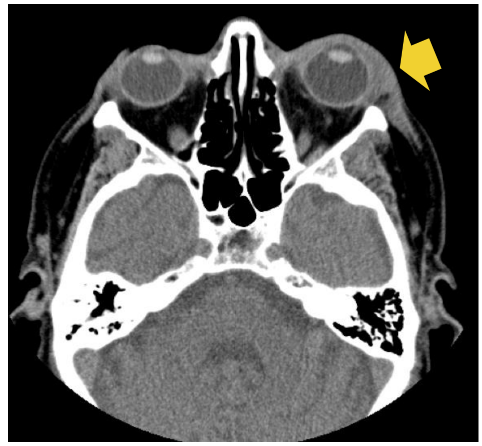

Figure 3
Figure 3 individually represents an axial cut through the orbit that clearly visualizes the significant periorbital swelling OS (yellow arrow). A lack of proptosis is appreciated as well. The fracture site itself is not as clearly visible in this image due to its location.

The CT scan results per radiology were noted as follows:

> There is [a] displaced fracture involving the inferior and medial wall of the left orbit. There is near complete opacification of the left maxillary sinus presumably with hemorrhagic material. No significant abnormality of the globe or optic nerve is appreciated on this exam. There is soft tissue density along the inferior orbital wall presumably post-traumatic hemorrhage. It is in proximity but not significantly displacing the inferior rectus muscle. There is significant swelling of the orbital anterior soft tissues, but no significant proptosis at this time.

There was no evidence of infection of the lids, and motilities were not limited. The CT scan clearly demonstrates a fracture of the orbit involving the medial and inferior walls. The patient was diagnosed with a left medial and inferior orbital wall fracture. No entrapment or retrobulbar hemorrhage was noted; post-traumatic hemorrhage along the inferior orbital wall into the maxillary sinus (as noted on CT) was observed. The lack of muscle entrapment was supported by the appearance of full and smooth extraocular muscle movements.

The patient was diagnosed with an orbital blowout fracture with associated periorbital ecchymosis and edema OS. The findings were discussed with the patient, including a review of the CT images. The patient was advised that surgical intervention would likely be unnecessary based upon initial presentation due to lack of muscle entrapment, lack of enophthalmos, small size of fracture site, and intact globe. He was instructed to return to clinic in one week for a dilated fundus examination. A CT scan was scheduled for a four week return visit. Amoxicillin 875 mg/clavulanic acid 125 mg twice daily by mouth for ten days was prescribed prophylactically. The patient was instructed to purchase over-the-counter nasal decongestant spray to reduce sinus congestion. He was given strict instruction not to blow his nose. The upper eyelid laceration was repair with three stitches by an urgent-care physician following the eye clinic visit. Ice packs were recommended to be applied every one to two hours for twenty minutes to the left eye for the next 24-48 hours.

FOLLOW-UP

The patient did not return for his one-week follow-up but showed up four weeks after the initial visit. At that time, a dilated fundus examination (which was within normal limits) was performed and CT imaging repeated. His visual acuity remained unchanged. He denied diplopia, eye pain, loss of vision, or headaches. He reported compliance with the prophylactic antibiotic course, which was completed about two weeks prior to the visit.

Slit lamp anterior segment evaluation showed small, residual bruising inferior to the lower lid OS. The patient's motilities were unrestricted, full, and smooth in all gazes OU. Cover test demonstrated orthophoria in all gazes at distance and near. Confrontation visual fields were full to finger count OU. Pupils were equally round and reactive to light with no RAPD noted OU. Non-contact tonometry measured intraocular pressures of 15 mm Hg OD, 16 mm Hg OS.

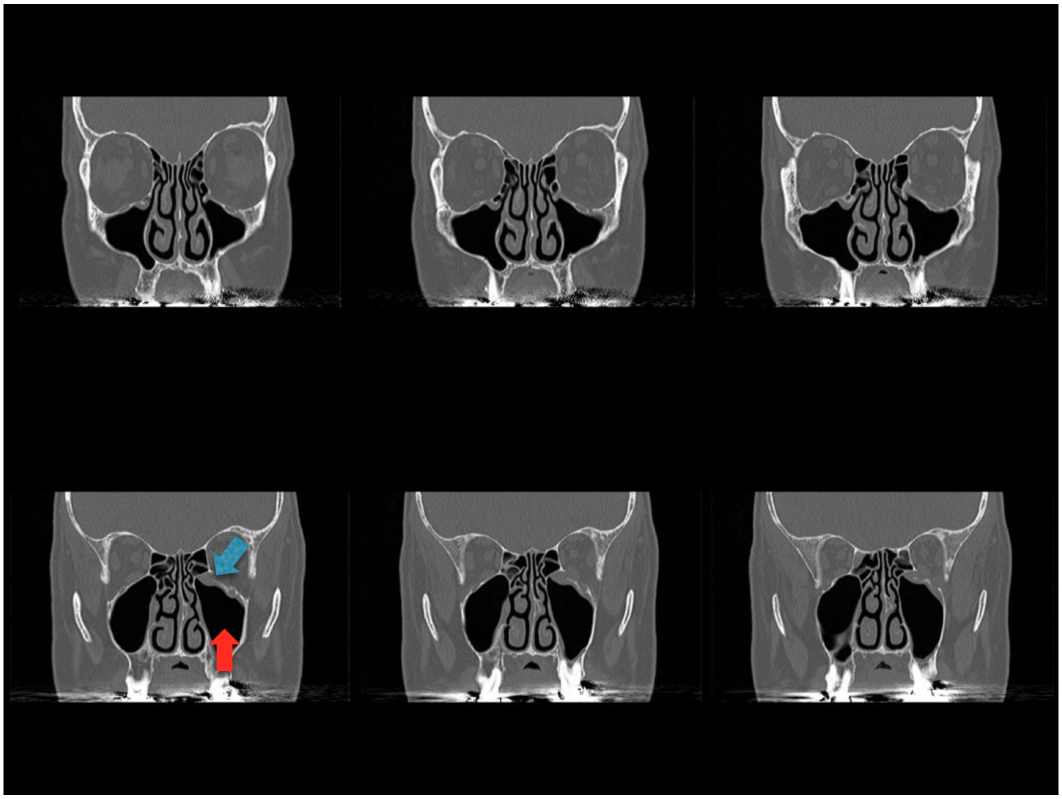

Figure 4
Figure 4 is a sequence of coronal CT scans without contrast. The left maxillary sinus shows significant reabsorption of blood (red arrow) compared to initial presentation. There is no visible muscle entrapment. The fracture site (blue arrow) inferiorly and medially is still observed.

The CT scan results (Figure 4) per radiology were noted as follows:

> "Again is noted discontinuity of the inferior medial posterior orbital wall consistent with minimally displaced fracture. There is near-complete resolution of previously seen opacification of the left maxillary sinus with now patent ostiomeatal complex. Minimal mucosal thickening of both paranasal sinuses is noted. Persistent soft tissue density at the fracture site consistent with localized hematoma is noted. There is no entrapment of the orbital muscle, inferior rectus muscle sclerosis in the very close proximity to the fracture site.
>
> The ventricles and sulci are normal in size for the patient's age. No abnormal intra-axial fluid collections are identified. The brain parenchyma appears intact, with normal gray-white differentiation. No evidence of large

territory vascular infarct, acute intracranial hemorrhage, mass, or mass-effect [observed].”

The findings from the follow-up examination were discussed with the patient, including a review of the new CT images. Surgical intervention was still considered unnecessary. The patient was instructed to return to clinic in 3 months for another follow-up examination.

DISCUSSION

Ten to 25% of facial fracture cases have orbital involvement.[4,7,10,16] Orbital fractures are predominantly associated with recent trauma (i.e., falls, assaults, motor vehicle accidents, etc.).[1-4] Males tend to present with facial fractures more commonly than females.[3,5] For example, in a retrospective orbital fracture study analysis involving 92 adults, 72% were male with a median age of thirty-two. There is a lower prevalence of orbital fractures in children than adults.[3] Although, Oppenheimer et al. suggests 5-25% of facial fractures in a pediatric population are orbital in nature, it is important to note that as high as 45-56% of facial fractures in children can be orbital in nature.[17] Neuman et al. and Oppenheimer et al. suggest the overall lower prevalence in children may be due to the following: small face when compared to overall head size, larger amount of cancellous bone than cortical bone allowing for more elasticity, buccal fat allowing for some protection near the orbit, and overall, less exposure to the above-mentioned risky events.

Frequent associated findings following orbital-involved trauma include: eyelid edema, tenderness of adnexal tissue, diplopia, crepitus, and numbness ipsilateral to the trauma. The most common findings are periorbital ecchymosis and subconjunctival hemorrhage.[7,8] Pain on eye movement may also be reported, though this is not always diagnostic as the resultant pain may be more associated with adnexal tissue swelling.

Optic nerve damage, retinal insult, and extraocular muscle injury need to be ruled out at initial examination with a dilated retinal examination and imaging. Some significant ocular complications associated with orbital fractures include: retinal tears or detachments, commotio retinae, orbital hematoma, traumatic optic neuropathy, hyphema, vitreous hemorrhage, ruptured globe, and angle recession.[3,7,8] If proptosis is observed, it may indicate an orbital hematoma, which would also present with diffuse pain and may require a lateral canthotomy and cantholysis to be performed allowing for decompression of the area by dis-inserting the lower eyelid. The presence of a RAPD would be indicative of traumatic optic neuropathy and has a poor prognosis.[1,10] Traumatic optic neuropathy is present in

2 to 5% of orbital fracture cases.[13] Of the 10 to 25% of facial fractures that present as orbital fractures, 11 to 15% are true ocular emergencies. Typically reduced visual acuity is associated with these scenarios.[7] Urgency is dictated by clinical observation.

The most significant and urgent complication related to orbital fracture is ophthalmic infarction due to orbital compartment syndrome (OCS), where there is a quick rise in orbital pressure. Ophthalmic infarction and subsequent vision loss can occur from central retinal artery occlusion, compressive optic neuropathy, or optic nerve vasculature compression.[9] Orbital compartment syndrome can result from hemorrhage of the infraorbital artery, anterior ethmoid artery, or posterior ethmoid artery, which can become severed as a result of the fracture. Other ways OSC can occur include: orbital edema, orbital implosion, and orbital emphysema. A significant amount of air can be pushed into the orbit from the surrounding sinuses generating an increase in orbital pressure.[7,9] This situation requires immediate surgical attention. A lateral canthotomy and cantholysis would likely be performed in this situation to allow for decompression of the area by dis-inserting the lower eyelid.[9]

The orbital floor is formed by the maxillary, palatine, and zygomatic bones. Anatomically, the inferior rectus muscle is in close proximity to the orbital floor and can be affected if damage to this boney area occurs. The maxillary bone contains the infraorbital canal, which houses the infraorbital nerve, artery, and vein. The infraorbital canal creates an anatomical weakness in the floor of the orbit, which causes this section to be the most commonly fractured wall. An isolated fracture in this area is referred to as "blowout fracture." [4,10] Oppenheimer et al. reported that orbital floor fractures become more frequent than roof fractures at 7 years of age due to the development of the skull and enclosed sinuses. Sensory innervation in the area of the lower eyelid to upper lip can be impacted on the ipsilateral side of the insult if the infraorbital nerve is damaged. If the inferior rectus muscle is entrapped, then there is corresponding limitation in vertical duction. Forced duction testing, as well as CT imaging, can determine muscle entrapment. The vasculature can be damaged as well, potentially causing a hemorrhage into the maxillary sinus. Orbital fat can also prolapse into the maxillary sinus. Essentially, herniation of the inferior rectus and/or other orbital contents can occur.[18] Following herniation of orbital contents, loss of muscle function due to ischemia can occur. This event is more common in adults; however, in children, function loss of the muscle is more commonly due to entrapment.[3] Palpation of the orbital rim may reveal crepitus and/or step-off irregularity of the bone.

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In an orbital floor fracture, surgical intervention is indicated when the fracture is greater than 50% of the floor, when the total area affected is greater than 1 cm^2, hypoglobus is present, enophthalmos of greater than 2 mm is present, posterior floor displacement greater than 1 cm is present, or muscle entrapment exists.[7,10,13-15] Immediate surgical intervention would also be deemed necessary if vision was threatened.[10]

Typically, in younger patients, a specific type of orbital floor fracture, a "trap door" fracture occurs. Compared with other orbital floor blowout fractures, there is not as much displacement of the fracture itself, and the fracture may occur in a linear pattern.[3] A type of injury associated with a "trap door" fracture is termed a "white-eyed blowout fracture." The globe appears normal,[4] though vertical diplopia is still present.[12] Common adnexal findings such as ecchymosis and edema are not frequently observed. These cases will typically present with oculocardiac reflex (Aschner phenomenon) which refers to nausea and vomiting due to vagus nerve irritation. This is an urgent event requiring immediate surgical intervention.[3,10-12] Once the muscle is released, the symptoms typically resolve.[3]

Another type of orbital fracture is that of the medial wall, which is formed by the maxillary, lacrimal, and ethmoid bones, and the body of the sphenoid. The medial wall is the second-most commonly fractured wall.[4] The thinnest portion of this wall is the lamina papyracea of the ethmoid, which separates orbital contents from the adjacent nasal sinuses. Damage or infection of the sinuses can occur. The lacrimal groove of the medial wall contains the lacrimal sac, which is part of the drainage route for tears. This can affect the proper outflow of tears. The medial canthal ligament can also be damaged. If this occurs, an increase in inter-canthal distance may be observed.[3] The medial rectus muscle is in close proximity to the medial wall of the orbit. Generally, if involved, a limitation in horizontal duction would result. A specific appearance truly indicative of muscle entrapment due to a fracture of the medial wall, termed pseudo-Duane's syndrome, is noticed on abduction: the eye may retract, and the palpebral fissure will constrict.[8] In a medial wall fracture, surgical intervention is indicated if muscle entrapment, enophthalmos, or a large fracture exists.[7] If the medical canthal ligament or lacrimal drainage system is damaged, surgical intervention is also indicated.[3]

The roof of the orbit is formed by the frontal bone and the lesser wing of the sphenoid. The superior rectus and superior oblique muscles lie in close proximity to the roof. Motor vehicle accidents account for almost half of orbital roof fractures in adults; however, this type of insult in adults is not seen as frequently as other orbital fractures.[7,19] In children, orbital roof fractures are more common than in adults as the frontal sinuses are developed last.[4,6] Furthermore, in children, the frontal bone and superior orbital rim will suffer the largest insult due to the prominence of those bones in children.[6] As occurs with the orbital wall fractures, muscle entrapment is a possibility. The supraorbital notch contains the supraorbital nerve, supraorbital artery, and supraorbital vein. Sensory innervation to the ipsilateral forehead can be affected if the supraorbital nerve is damaged. These structures can be impacted if an insult to the roof occurs. While the frontal bone forms the roof of the orbit, it also forms the floor of the frontal sinus.[3] If the frontal sinus becomes involved, cerebrospinal fluid leakage may occur, and the patient is at risk for an intracranial infection.[1,19] From Roth et al., dural tears and pneumocephalus can occur, which would warrant an immediate neurosurgical consultation. In children, a leptomeningeal cyst can form in the instance of a "growing skull fracture" as related to an orbital roof fracture. The cyst can disrupt the healing process, while causing pulsatile exophthalmos and potential orbital compartment syndrome.[6] Surgical intervention would also be indicated if any or all of the following occur: proptosis, hypoglobus, exophthalmos, diplopia, gaze restriction, and lagophthalmos.[7]

The lateral wall of the orbit is formed by the zygomatic bone and the greater wing of the sphenoid. It is the thickest wall of the orbit and has four zygomatic sutures: zygomaticofrontal, zygomaticomaxillary, zygomaticotemporal, and zygomaticosphenoid. Whitnall's tubercle is associated with the lateral wall and is also the insertion point for the lateral cantonal tendon, which is necessary for eyelid function.[7,8] A common type of fracture involving the lateral wall is called the tripod fracture, or zygomaticomaxillary complex (ZMC) fracture. A fracture of this type affects the sutures as well as four other areas: lateral orbital rim, inferior orbital rim, zygomaticomaxillary buttress, and zygomatic arch. If there is displacement of a ZMC fracture, then this becomes a type of orbital floor fracture as the zygomatic bone also forms part of the orbital floor.[20] Palpation may reveal crepitus and/or step-off irregularity of the bone as with a simple orbital floor fracture. The volume of the orbit can be affected with a fracture of this type; displaced fractures warrant surgical consultation so as to avoid any affects to the eye and vision.[1,4]

Le Fort fractures are complex fractures and may be observed in cases of severe facial trauma.[4] In children, this type of fracture occurs less than five percent of the time.[6] Le Fort I is a transverse horizontal fracture through the maxilla, inferior nasal aperture, and pterygoid plates. This type of fracture does not concern the orbits. Le Fort II is a fracture through the nasal root, the medial orbital floors, inferior orbital rim, anterior maxillary wall, and through the pterygoid plates. Le Fort III fractures pass through the nasal root, along the medial orbital walls, then posteriorly just inferior to the optic canal; this fracture then continues along the floor to the lateral orbital wall then through the frontozygomatic suture and zygomatic arch.[1] Complex fractures, such as the Le Fort II and III, are typically repaired in one to two weeks.[21]

If it is determined that surgical intervention is appropriate, multiple materials can be used. Titanium meshes, bone graft, porous polyethylene sheets, and resorbable materials are all common repair materials.[4] However, according to Totir et al., there does not appear be an agreement over the preferred material used.

Following surgical intervention, patients may still experience diplopia. According to Gunton and Brown, two percent of patients experienced diplopia after orbital fracture repair surgery. Strabismus surgery is an option; however, eight percent of patients were successfully treated with prism alone.[22]

Pertinent imaging that should be done in the case of orbital fracture would be a CT scan which should occur the same day as the initial presentation, especially if there is evidence of extraocular muscle motility deficits and/or visual acuity decrease.[3,15] There are numerous benefits to CT imaging, including: efficiency (time and cost), bone detail, fracture size evaluation, muscle entrapment identification, optic canal involvement, and hemorrhage assessment.[4,7,8] Betts, et al. suggests a mnemonic for CT evaluation, "BALPINE": Bones, Anterior chamber, Lens, Posterior globe structures, Intrazonal orbit, Neurovascular structures, and Extraocular muscles/extraconal orbit. Axial and coronal sections tend to be the most informative and helpful in determining extent, severity, and involvement of the damage. Typically, coronal sections would show orbital floor and roof fractures the best, while axial cuts will generally display medial fractures easily.[6,7] Appropriate image cuts are necessary: 2-3 mm in most cases, though thinner sections may be required.[7,8] In a pediatric population, 1.25 mm cuts would be more appropriate.[6] When considering other imaging, X-ray imaging does not allow for useful soft-tissue detail and should not be considered an appropriate test to perform.[18] MRI and ultrasonography have proven beneficial in management of orbital fractures; however, the mainstay is the CT image.[15]

CONCLUSION

This case demonstrates the role of case history, clinical observations, and proper imaging in the diagnosis and management of an orbital fracture. It is important for clinicians to remember that presenting visual acuity can provide an indication of associated globe severity following an orbital fracture, evaluation of pupil function proves useful in correlating optic nerve involvement, such as a traumatic optic neuropathy, extraocular muscle motility helps in determining the presence or absence of muscle entrapment, and a thorough dilated funds evaluation is critical to assess any posterior involvement that may require immediate attention. Furthermore, it is important for clinicians to remember computed tomography imaging is critical and should be obtained in all cases of a suspected orbital fracture. In most cases, 2-3 mm cuts are sufficient, however, if a white-eyed blowout fracture is suspected, thinner (1.25 mm) cuts would be more appropriate.[6-8] A white-eyed blowout fracture will typically appear in a younger patient with an accompanying oculocardiac reflex due to vagal nerve irritation. This presentation requires immediate surgical attention.[3,10-12] Orbital compartment syndrome is another instance, which requires immediate surgical attention with likely lateral canthotomy and cantholysis to allow for decompression of the orbit.[9] Overall, surgical intervention will be judged based on the presence of muscle entrapment, fracture size and complexity, appearance of exophthalmos or hypoglobus, and damage to surrounding orbital components.[3,7,10,13-15] Close monitoring for resolution should occur even if surgical intervention is not required.

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