

This podcast can be accessed at www.pedscases.com, Apple Podcasting, Spotify, or your favourite podcasting app.

APPROACH TO BLUNT OCULAR TRAUMA

Developed by Cody Lo and Dr. Jane Gardiner for PedsCases.com.
April 24, 2021

Introduction

Hi everyone, my name is Cody Lo and I am a 4th year medical student at the University of British Columbia in Vancouver, Canada. This podcast will provide you an overview and organized approach to blunt ocular trauma with a focus on pediatrics. I would like to thank Dr. Jane Gardiner, head of pediatric ophthalmology at the University of British Columbia and BC Children's Hospital in Vancouver, Canada, for her help in developing this podcast.

After listening to this podcast, the learner should be able to:

1. Obtain a focused history and understand the relevant physical exam techniques for a presentation of blunt ocular trauma
2. Demonstrate a systematic approach to rule in or rule out injury to various ocular and extra-ocular structures based on history and examination findings
3. Discuss an appropriate management plan for blunt ocular trauma including ophthalmic follow up
4. Identify the red flag signs and symptoms that would warrant urgent referral to ophthalmology

Clinical Case

First, we'd like to present a case. Jack is a 11-year-old boy who presents to the pediatric emergency department after being struck in the left eye by a badminton birdie in gym class approximately 2 hours ago. He complains of decreased vision in his left eye, only being able to perceive lights and vague shapes. It is mildly painful and there is already significant bruising around the eye. He did not lose consciousness or hit his head.

Epidemiology

Ocular trauma is a common complaint in the pediatric primary care and emergency department settings and encompasses injuries to the ocular and extra-ocular structures. Eye injuries are the leading cause of visual disability and non-congenital unilateral blindness in children. Males account for nearly 70% of all ocular injuries with boys aged 11-15 years old being most susceptible. Blunt trauma is defined as impact with a non-sharp object, commonly a ball or fist. The majority of cases in pediatrics happen at

Developed by Cody Lo and Dr. Jane Gardiner for PedsCases.com
April 24, 2021.

school or during play.¹ However, non-accidental/inflicted trauma should always be considered on the differential for potential mechanisms.

Pathophysiology

First, let's quickly review some relevant anatomy for this topic. The eye sits inside of the orbit which is made up of multiple facial bones. The bones which are seen from the front are able to protect the eye from most large objects that hit the orbit, hence the bones, are most likely to be injured in trauma. Bones of the orbit include the frontal bone superiorly, ethmoid nasally, maxilla inferonasally, and zygomatic bone inferotemporally. Your eyelids protect the eye from small particulate matter but do little to reduce the force of blunt impact. The eyelid margin is the edge of your eyelid where it transitions from skin into mucosa – it is important that any lacerations involving the margin are repaired properly. The nasolacrimal system is responsible for drainage of tears into the nose. Entry into the nasolacrimal system is through the puncta which are on the nasal aspect of the upper and lower lids. Tears then drain into the canaliculi followed by the nasolacrimal sac. This system can be disrupted with any trauma or lacerations to the nasal aspect of the lids or orbit. The cornea is a thin layer of tissue in the centre of your eye and is the first layer that light passes through. The cornea is abundant in innervation so even the smallest damage to your cornea is extremely painful. The anterior chamber is a fluid filled portion in the front of your eye and fluid balance in this portion is the primary contributor to your intraocular pressure. High intraocular pressure typically indicates inadequate drainage of aqueous humor, the fluid that fills the anterior chamber, either by direct damage or clogging by blood such as in hyphema. Low intraocular pressure can be due to open globe injuries which allow aqueous humor to leak outside the eye. Many structures within your eye are delicate and highly vascularized so they can bleed easily if damaged through shearing forces secondary to blunt impact. These include: 1) your iris, which is the part of your eye that can be different colours between individuals and determines pupil size; 2) the ciliary body, which is a rim of tissue behind your iris that produces aqueous humor and provides stability to your lens; and 3) the retina which is the thin layer of tissue at the back of your eye which is continuous with the optic nerve and transmits visual inputs to your brain. The retina is susceptible to detachment or bleeding with sufficient blunt or shearing forces which can result in severe vision loss if not adequately managed.

Clinical Presentation and History

Now that we have defined blunt ocular trauma and the structures that can be impacted, let's learn how to obtain an ocular trauma history.² First, assess the patient's level of consciousness and ensure their vitals are stable. Then it is important to understand the mechanism of injury to narrow down your differential – what activity was the patient doing? Did it affect one eye or both? What was the velocity? Where does the patient think impact was made? What object was used? Was the patient wearing any sort of eye protection?

Next you want to ask about any visual symptoms and how quickly after the injury they developed – how would they describe their vision? Are they seeing double? Have they

noticed any blind spots in their vision? Are there any flashing lights or does it seem like things seem to be “floating” in their vision? Does it feel like something is “in” their eye?

Although less likely in children compared to adults, you want to ask about previous ocular history such as whether they’ve had any eye operative procedures previously. Do they wear glasses or contact lens? Did they have any congenital issues with their eyes such as cataracts, anisocoria or strabismus? Previous eye injuries may explain findings on exam that are unrelated to their current presentation.

Even if a patient presents with strictly an eye complaint, the rest of their medical history is still important! For example, bleeding disorders or anticoagulant use can result in excessive bleeding. You also want to know if they have any allergies. Many systemic diseases and medications can have ocular manifestations but that is beyond the scope of this podcast. If there is concern about concurrent eyelid laceration or penetrating trauma, meaning that the inside of the eye could be exposed to the outside environment, you want to know if the patient’s tetanus vaccination is up to date.

Physical Exam

The exam begins with assessment of the patient’s general condition and vital signs. Then you will want to do a screening neurological exam to assess for potential mild traumatic brain injury, known as concussion. The general outline of an eye exam starts with checking vision, ensuring best possible refractive correction or through a pinhole. This is followed by checking the pupil response, extraocular movements, and confrontational visual fields. When examining the pupils, be sure to look for a relative afferent pupillary defect or RAPD via the swinging flashlight test. Ensure that extraocular movements are equal on both sides. Any restrictions in extraocular movement could be due to neurological dysfunction or entrapment of extraocular muscles secondary to orbital fractures.

At this point you’re ready to examine the anterior segment. Apply local anaesthetic and fluorescein drops in each eye. Note: only apply eye drops if there is no frank open globe. You should note whether the patient’s pain resolves with administration of the anaesthetic drops which typically represents an injury to the highly innervated cornea. Many paediatric patients struggle tolerating eyedrops. If needed, retract the patient’s eyelids by placing your fingertip near their eyelid margin and gently pull back. Be careful not to put any pressure on the globe itself. It should not require excessive force to keep a child’s eyelids open. It is typically easiest if you ask the patient to look up and aim the eyedrop in the inferior fornix, the pocket that is created between the patient’s lower eyelid and eye.

If accessible in your clinical setting, use a slit lamp to systematically examine the right then left eye. Focus your examination on areas which were of concern during the history. Foreign bodies can be difficult to visualize so be sure to use high magnification if needed. Remember to flip the upper eyelid to explore the upper fornix and gently retract the lower eyelid to explore the lower fornix.

You will then examine the posterior segment of the eye. In most clinical settings this will be done using a direct ophthalmoscope in a dimly lit room to visualize the optic nerve head and retinal blood vessels. The last step is to check the intraocular pressure, typically with a tonopen. Some emergency departments may have the iCare tonometer which is typically easier to use and does not require anesthetic. Note: do not check intraocular pressure if there is concern about an open globe or penetrating injury.

Then complete an external exam of the adnexa, the structures surrounding the eye. Palpate firmly around the orbital rim for any step deformities or points of tenderness suggestive of fracture. Check sensation on the cheek and ask about numbness of the teeth, which would suggest damage to the infraorbital nerve, a commonly damaged structure in orbital floor fracture.

Differential Diagnosis and Initial Management

Damage as a result of blunt ocular trauma has a large differential but can be broadly categorized into either extra-ocular or ocular injuries. This is not an exhaustive list but includes the most common and vision-threatening manifestations.

First, extra-ocular injuries include: bruising to peri-ocular soft tissues, orbital fractures, and eyelid lacerations. Peri-ocular bruising, known colloquially as a “black eye”, will commonly resolve spontaneously and is managed conservatively with ice. Bilateral peri-ocular bruising, known as “raccoon eyes”, is concerning for a basal skull fracture. Orbital fractures are commonly associated with an area of point tenderness on the orbital rim and infraorbital numbness due to damage of the infraorbital nerve, if there is an orbital floor fracture. Inferior rectus muscle entrapment is most common in an orbital floor fracture and may require surgical repair. Classic exam findings include diplopia in up gaze due to the inability to look up fully. Eyelid lacerations can be sutured yourself if they are superficial. Ophthalmology should be consulted for eyelid lacerations if: 1) it involves the medial 1/3 of the lid due to risk of canaliculi injury; 2) involves the lid margins; or 3) the patient has ptosis, drooping of the eyelid, which suggests involvement of levator palpebrae muscle.

Now moving onto ocular injuries, starting with those of the eye’s surface. Corneal abrasions are the most common eye injury to ED. It is characterized by pain, tearing, photophobia, and foreign body sensation. Abrasions will stain green with fluorescein when viewed under cobalt blue light. Most abrasions will heal on their own in a couple of days. Management typically involves antibiotic ointment to avoid infection and oral pain killers as needed. An ointment is a slightly thicker consistency than eyedrops and provides more comfort and lubrication while the cornea heals. You may also identify a foreign body on the conjunctiva or cornea. Make sure anesthetic eyedrops are applied and use a cotton swab to remove the object. If that doesn’t work, then ophthalmology should be consulted.

Moving to the anterior chamber, hyphema is common after blunt trauma and refers to bleeding into the anterior chamber typically due to shearing forces on the small blood vessels of the iris and ciliary body. Hyphemas on slit lamp examination can range from red blood cells floating in the anterior chamber to cells layering out inferiorly. Severe cases can result in clotted blood occupying the entire anterior chamber, often referred to as blackball or 8-ball hyphema due to its appearance. Most hyphemas will resolve spontaneously but be sure to check if your patient is anti-coagulated for any reason. Rest is a critical part of management. Additional recommendations include elevating the head of the bed to 30-45°, shielding the eye, and pain control while avoiding the antiplatelet effects of certain NSAIDs. Hyphemas always require a referral to ophthalmology due to the risk of elevated intraocular pressure and re-bleeding. Deep injuries to the ocular surface can result in partial thickness corneal or scleral lacerations and warrant assessment by ophthalmology who will decide on the need for surgical repair.

A critical diagnosis to always rule out is an open globe. If the rupture is anterior, it can present with a tear drop pupil secondary to the iris prolapsing through a corneal laceration or visualization of a foreign body penetrating into the anterior chamber. You can confirm the diagnosis with the Seidel test. This involves applying fluorescein dye to the area of injury and observing under cobalt blue light whether aqueous humor leaks out from the site and dilutes the dye. Initial management involves urgent ophthalmology referral, shielding the eye, pain and nausea relief, tetanus prophylaxis, and broad-spectrum IV antibiotics. Also make the patient NPO in preparation for surgery.

There are also injuries that can be sustained to the posterior segment, or back of the eye. These may be difficult for a non-ophthalmologist to diagnose since they often require the patient's pupils to be dilated and special lenses. Thus, these patients will often need an ophthalmology consult but it's still important for you to know the signs and symptoms a patient will present with. A posterior vitreous detachment, or PVD, is detachment of the jelly-like substance that makes up the majority of the eye's volume from the retina. Patients will often present with "flashers and floaters" in their field of vision. Vitreous hemorrhage, or bleeding in the back chamber of the eye, can be caused by trauma and will cause vision loss with an inability for you to see the retina. A retinal detachment is when the retina itself detaches from the underlying tissue. These patients will often also have "flashers and floaters" but may additionally have large areas of their visual field which they cannot see. Always ask these patients if they noticed a dark curtain moving into their visual field. A critical diagnosis in the posterior segment to recognize quickly is retrobulbar hemorrhage, which is a progressive and sight-threatening accumulation of blood in the retrobulbar space behind the eye. It can result in an orbital compartment syndrome with sufficient pressure to block perfusion to the eye. Any patients developing vision loss or elevated intraocular pressure require an emergency lateral canthotomy. This procedure involves cutting of the lateral canthal tendon to relieve increased pressure in the orbit and is often done by emergency physicians as it cannot wait for ophthalmology referral!

Further Investigations

Most cases of blunt ocular trauma will not require further investigations unless there are concerns about fractures, open globe injuries, and retinal detachments if the visual axis is not clear. For example, a patient with a hyphema could also complain of flashes and floaters. You are concerned about a retinal detachment but you cannot directly visualize the retina due to the media opacity. B scan ultrasound, a type of ultrasound specific for the eye, would be useful in this scenario to assess the posterior segment including the retina. X ray or CT can be used to assess suspected orbital fractures or foreign bodies that cannot be seen on exam however consider the risk of radiation exposure when ordering these tests in children. Note: never order an MRI of the orbits in cases of suspected foreign bodies as they could be metallic. Always consider if the patient's presentation could be the result of non-accidental or inflicted trauma. Refer to child protection services if you are concerned.

Follow up

Many cases of blunt ocular trauma associated with any abnormal exam findings will involve non urgent referral to a general or pediatric ophthalmologist for follow up. Cases with completely normal exams or demonstrate only superficial bruising may not require referral. Taking the opportunity to educate patients and families about eye safety is an important risk reduction measure. Nearly 90% of eye injuries could have been prevented or decreased in severity with better education. Inform your patients about the appropriate use of safety eyewear and recognition of high-risk situations.

Indications for Urgent Ophthalmology Referral

While most cases of blunt ocular trauma can be acutely assessed and managed in a primary care setting, urgent referral to an ophthalmologist should be considered if:

1. There are abnormal ocular vitals which include visual acuity, pupil response, and intraocular pressure.
2. There are penetrating injuries such as an open globe as confirmed by the Seidel test or partial thickness lacerations of the cornea or sclera.
3. There is a suspicion of orbital fracture with significant extraocular muscle entrapment resulting in restricted extraocular movements.
4. Lacerations involving the lid margin or at risk of involving the lacrimal system or levator palpebrae superioris muscle
5. History or exam findings suggestive of a retinal tear or detachment such as "a curtain coming down vision" or flashers/floaters.

Conclusion

Now let's go back to the case with Jack, the 11-year-old boy who presented to the ED after being struck in the eye by a badminton birdie. Given that he did not lose consciousness or hit his head – you quickly rule out the need for an in-depth systemic exam. His screening neurological exam was normal. You proceed to collect ocular vital signs with vision being 20/20 in the right and hand motions only in the left. His pupils were 3mm equal and reactive. He did not have a relative afferent pupillary defect. Note: in hyphema the pupil can be obscured by blood in which case your pupil exam will be

limited. He had full extraocular movements and no boney tenderness when palpating the superior and inferior orbital rims. There were no deformities or lacerations to the other extraocular structures. His slit lamp exam showed dark red clouding of the anterior chamber consist with a hyphema. You did a seidel test to confirm that he does not have an open globe. You then used a tonopen to determine his intraocular pressures were normal at 12 mmHg each eye. Since you could not see the fundus due to the blood, you arranged for a B scan ultrasound in the ED which was normal. You should still call ophthalmology given the risk of rebleeding and developing high intraocular pressure – they will generally see such patients every 1-2 days to monitor progress. You discuss with Jack and his family that a hyphema should resolve on its own within approximately 1 week and that Jack should rest, keep his head above 30 degrees, shield his eye to prevent additional trauma, not partake in any physically strenuous activity, and use non-NSAID pain relief as needed.

A month later, you hear from the ophthalmologist that Jack had a full visual recovery. He did not demonstrate any rebleeding, which usually happens at about 5 days after injury. However, on an in-depth ophthalmic exam, a month later, Jack did have evidence of angle recession. This finding is only appreciated with a gonioscopic examination, done with a special lens, once the hyphema has completely resolved and the risk of rebleed has passed. So while asymptomatic, he will require continued follow up due to the risk of developing glaucoma. The ophthalmologist thanks you for recognizing the need and value for non-urgent ophthalmology referral in this patient!

Take home points

Let's review a few of the key take home points:

1. Blunt ocular trauma is a common presentation and the leading cause of preventable vision loss or blindness. Vision changes can be due to damage to the eye and/or other extra-ocular structures.
2. Make sure to assess for other less obvious injuries such as non-displaced orbital fractures or concussions.
3. Ocular vitals include visual acuity, pupil response, and intraocular pressure. Changes in one of these are more concerning for a serious pathology and warrant urgent ophthalmology referral.
4. Always rule out open globe as it requires urgent ophthalmology referral and is a contraindication to many parts of the standard ophthalmic exam such as checking intraocular pressures.
5. Many ocular structures can be impacted in blunt trauma so be sure to conduct a thorough slit lamp examination and have a low threshold for arranging non-urgent follow up by an ophthalmologist.

Thank you for listening to our podcast on an approach to blunt ocular trauma. Thanks again to Dr. Jane Gardiner for her mentorship and expertise on this topic. We hope you now feel equipped with an approach to blunt ocular trauma!

References

Developed by Cody Lo and Dr. Jane Gardiner for PedsCases.com
April 24, 2021

1. Pediatric Ocular Trauma [Internet]. American Association for Pediatric Ophthalmology and Strabismus. [cited 2020 Aug 25]. Available from: <https://aapos.org/glossary/pediatric-ocular-trauma>
2. Salvin JH. Systematic approach to pediatric ocular trauma. *Curr Opin Ophthalmol*. 2007 Sep;18(5):366–72.
3. Bunting H, Stephens D, Mireskandari K. Prediction of visual outcomes after open globe injury in children: A 17-year Canadian experience. *J Am Assoc Pediatr Ophthalmol Strabismus JAAPOS*. 2013 Feb 1;17(1):43–8.