Pickleball Associated Abrasion and Iritis: A Case Study

Mariam Alkawally, OD, MS; Vin T. Dang, OD, FAAO

Abstract

Pickleball is a fast-growing sport in the US over the past decade. It is a singles or doubles volley sport combining tennis, badminton, and ping-pong. It utilizes a paddle and a small plastic whiffle ball on a court similar to but much smaller than a tennis court. Like other volley sports, the light, high velocity ball poses a risk of ocular injuries, as well as other facial, and musculoskeletal injuries. In this report, we describe the case of a 39-year-old male presenting with trauma secondary to a direct hit to the eye by a pickleball at high velocity. Despite a large corneal abrasion and traumatic iritis, the patient quickly healed with no scarring or permanent effects to his vision. Nonetheless, this case highlights the importance of patient education on protective eye wear, and the importance of immediately seeking clinical help of an eyecare professional for treatment after an accident. To the best of our knowledge, this is the first case report of an anterior segment related injury related to pickleball.

Case Presentation

A 39-year-old Asian male presented to the after-hours emergency clinic in March 2021 with a history of a painful eye after being hit with a pickleball, one hour prior to presentation. He reported that the ball had ricocheted off his own paddle and hit his left eye at high speed. Immediately upon impact, the patient noted mildly blurred vision, worsening pain, and photophobia, but no diplopia. His last comprehensive exam was in 2016, and pertinent ocular history was remarkable for Photorefractive Keratectomy (PRK) in both eyes in 2016, which has since been followed by a series of micro erosions. His history also included lattice degeneration with atrophic holes in both eyes, as well as dry eye disease and meibomian gland dysfunction. He had an unremarkable medical history and was not taking any medications except for fish oil supplements. There were no known drug allergies.

Uncorrected visual acuity was 20/20 OD and 20/20 with some difficulty OS. All preliminary testing and exam findings OD were unremarkable, and remained so throughout all his follow ups, and therefore will not be mentioned further throughout this article. Intraocular pressure (IOP) by iCare™ was 13mmHg OD and 14mmHg OS. Pupillary testing, confrontation visual fields and extraocular motilities were normal for the left eye. No pain on palpation was noted along either the superior or inferior orbital rim. Slit lamp examination of the left eye revealed 2+ lower and upper lid edema, and a mild temporal subconjunctival hemorrhage but no conjunctival abrasion. Corneal examination showed a large temporal backwards C shaped corneal abrasion with loosely hanging epithelium measuring 8 mm tall along the lateral aspect, and 5.4 mm wide at the superior and inferior aspects (Figure 1). The abrasion did not involve the visual axis. There was no foreign body or foreign body debris found on the cornea or the conjunctiva. In the anterior chamber, there was 2+ cell with no hyphema, Seidel sign or iridodialysis. Dilated fundus exam revealed an intact retina with no holes, tears, or detachments apart from the lattice degeneration associated with atrophic holes. Assessment of the optic nerve revealed pink and healthy rim tissue and distinct margins, with a cup-to-disc ratio of 0.2 in both eyes.

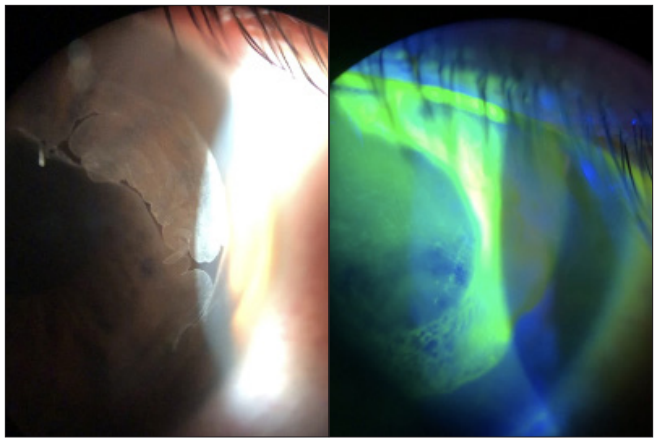

Figure 1. Initial presentation of a Corneal abrasion with loosely hanging epithelium on the lateral aspect (Left) and superior and lateral aspect with Sodium Fluorescein (Right).

Management and Outcome

Due to the large area of loosely hanging epithelium, careful debridement after numbing the cornea with proparacaine was performed. The loose epithelium was debrided with an autoclaved Visitec® PRK spatula, and the edges were pressed

Mariam Alkawally, OD, MS- Empire Eye and Laser Center, Bakersfield, CA
Vin T. Dang, OD, FAAO- Empire Eye and Laser Center, Bakersfield, CA
Correspondence to: Correspondence to: Mariam Alkawally, OD, MS
Empire Eye and Laser Center, 4105 Empire Dr. Bakersfield, CA 93309
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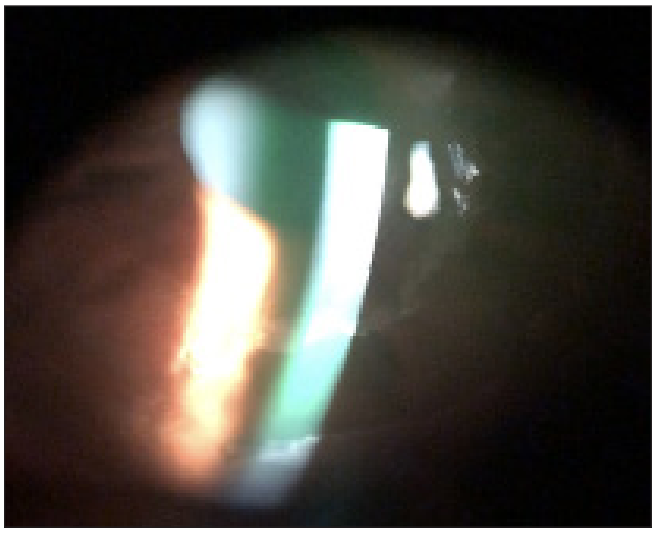


Figure 2. Corneal abrasion immediately post mechanical debridement.

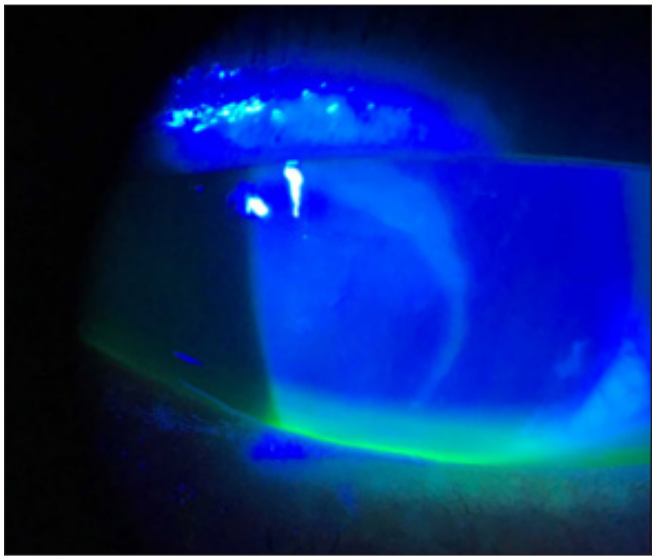
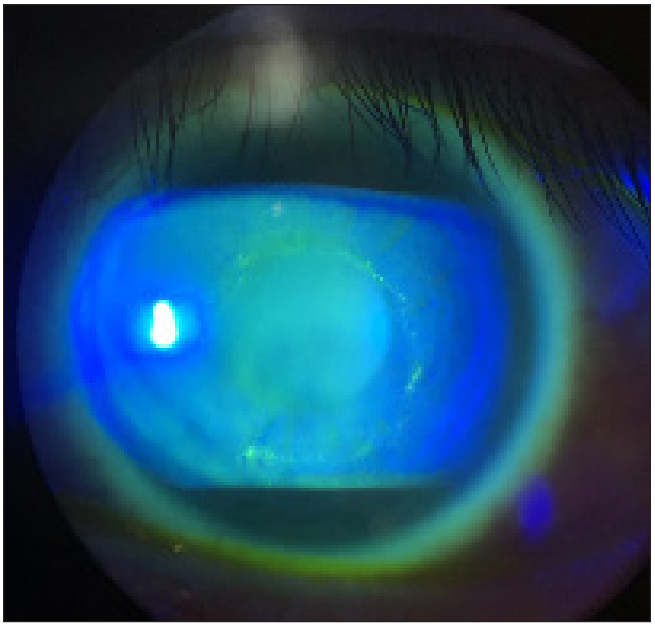


Figure 3. Corneal abrasion one day post trauma. Abrasion is seen here behind the amniotic membrane.

down (Figure 2). After instilling one drop each of Pred-Gati-Brom® (1% Prednisolone Acetate/0.5% Gatifloxacin/0.075% Bromfenac) and 1% Cyclopentolate Hydrochloride, a PROKERA® SLIM amniotic membrane (AM) was inserted and tape applied to the eyelid to help with comfort. No steroids or antibiotics were prescribed afterwards due to concern of amniotic membrane retention of the medicated compounds, risking prolonging epithelial healing due to continued exposure. However, the patient was prescribed one drop of cyclopentolate once a day for two days afterwards.

On next day follow-up, slit lamp examination revealed a much smaller abrasion through the AM (Figure 3), however it was not possible to view the anterior chamber through the non-dissolved AM. It was nonetheless decided to keep the AM for another day as the abrasion had not yet fully healed. The AM was removed on the third day, revealing a C shaped healing epithelial line (Figure 4). Unaided vision through that eye was 20/20-2, and there was only trace cell in the anterior chamber. The patient used Durezol® (0.05% difluprednate) twice a day in the left eye for two days, after which the anterior chamber cell



F**igure 4.** Day 3: Healing C shaped line post amniotic membrane removal.

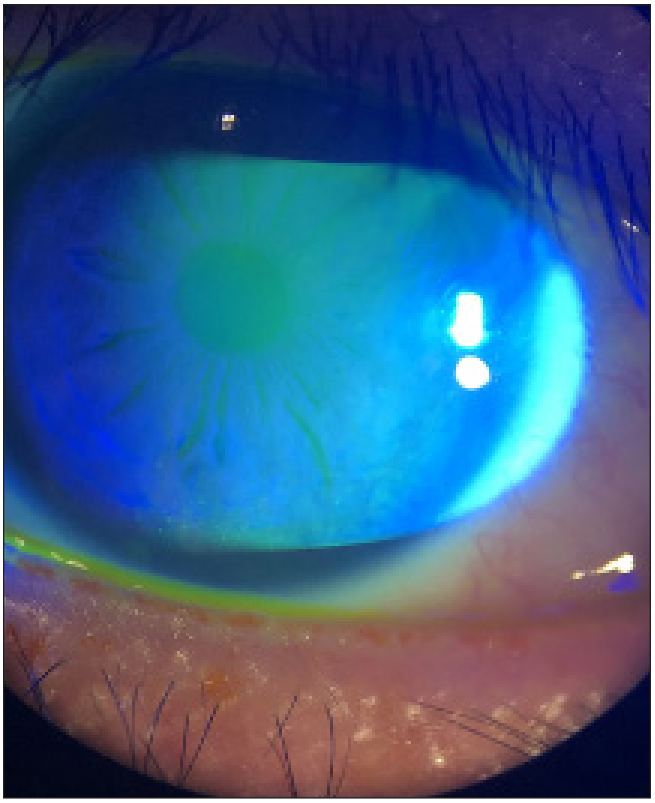


Figure 5. Day 7: Completely healed cornea.

had completely resolved, and steroid use was discontinued. Due to the low dose and short duration of steroid therapy, as well as the small amount of inflammation being treated, there was no concern of rebound uveitis upon discontinuation without tapering. Seven days after the original incident, the cornea was completely healed with trace superficial punctates inferiorly (Figure 5), and cell in the anterior chamber was completely resolved. The patient felt that the quality of vision had returned to normal, with unaided visual acuity of better than 20/15 by day 10.

Discussion

Ocular trauma tends to occur mainly in males (66%) under 60 years of age (91%)[1] and can present in many forms; therefore, the first step is assessing the extent of damage. Anteriorly to posteriorly, the physician can begin by examining for any blowout fractures by palpation and by assessing ocular motilities. Acute anterior segment findings include subconjunctival hemorrhage, embedded foreign bodies in the conjunctiva or cornea which would need to be assessed for penetration or perforation, corneal and conjunctival abrasions, hyphema, iridodialysis, and traumatic uveitis. Other sequelae more posterior include lens subluxation, choroidal ruptures, and retinal detachments. Long term damage can include increased risk of glaucoma in the affected eye, traumatic cataract, and recurrent corneal erosions.

This discussion will focus on the diagnosis and management of corneal abrasions and traumatic iritis, as related to this case, with brief mentions of other ocular traumas commonly associated with sports similar to pickleball. A comprehensive overview of traumatic ocular conditions is outside the scope of this article.

Corneal and Conjunctival Trauma

In the presence of a corneal abrasion or iritis, as was the case in our patient, instillation of numbing and dilating drops aid in the accurate assessment of the injuries. No debris or foreign body was found on the cornea or conjunctiva, but a large corneal abrasion had resulted from the pickleball contact to the cornea. Corneal abrasions are among the most frequent ocular conditions encountered in the emergency departments, with a study by McGwin et al finding that contusions and abrasions cause 44.4% of ocular emergency presentations in the US.[2] Corneal abrasions can vary from insignificant to potentially vision-threatening. Usually they can cause debilitating pain affecting the patient's ability to function normally for up to 24-72 hours, which is how long the corneal tissue takes to heal.[3]

Corneal abrasions tend to present with severe eye pain, tearing, photophobia, foreign body sensation, and may sometimes include injection, or reduced visual acuity if involving the visual axis. A slit lamp examination with fluorescein will reveal the location and extent of the abrasion. The use of sodium fluorescein dye is crucial in cases of a full thickness corneal trauma, in which event a positive Seidel sign will be apparent, and the patient will likely need surgical intervention.

Typical treatments for small partial thickness abrasions involve topical ointments to maintain ocular surface hydration and speed up healing and topical prophylactic antibiotics.[4] Pupil dilation may also be used to help relieve photophobia due to spastic miosis, which results from a reflex that travels from the irritated cornea to the iris via the trigeminal nerve. Topical non-steroidal anti-inflammatory use has proven to be effective in managing pain,[3,5] but a randomized controlled trial showed no benefit in pain scores with oral analgesia use.[5] Clinical studies including a meta-analysis have shown that patching was not found to improve healing rates or reduce pain in cases of partial thickness traumatic corneal abrasions,[6,7] causing a shift in practice away from this treatment modality.[8]

Bandage contact lens (BCL) use is common in recurrent and persistent corneal erosions. Due to the similarity in presentation (albeit the different history), the evidence can be extrapolated to traumatic corneal abrasions. Although the actual mechanism of how BCL tends to speed up the healing process of an erosion is poorly understood, it has been hypothesized that BCLs provide a mechanical shield to the eye, thereby preventing the exacerbation of the erosion from the mechanical shearing force of the lid while blinking.[9] Additionally, they may promote re-epithelization by providing a scaffold improving the spread of tear fluid over the ocular surface.[9] However, a soft BCL may increase the risk of microbial keratitis,[10] and therefore requires careful monitoring, and ideally the use of prophylactic antibiotics.

Due to the large size of the abrasion and presence of significant loose epithelium in our case, we opted for mechanical debridement to improve the chances of corneal healing and to reduce the chances of a recurrent corneal erosion in the future. Epithelial debridement is thought to work by strengthening the adhesion of the basal epithelial cells to the basement membrane. It is important to debride no closer than 1 mm from the limbus, to avoid damage to the stem cells. There are a variety of tools used for mechanical debridement, including a bent 21G or 25G needle, Beaver blade No. 64 or 57 (Beaver-Visitec International, Waltham, MA) or Bard Parker blade (No. 11 & 15) (BD Medical, Franklin Lakes, NJ).[11] In our case, we used a Visitec® PRK spatula. The blade or needle is held tangentially to prevent corneal perforations and reduce micro scratches to Bowman's membrane, with short and swift motions across the corneal surface. Finally, the clinician should attempt to smooth down the ragged edges of the remaining epithelium. Diamond burr polishing was shown to be superior to mechanical debridement as it tended to produce fewer corneal erosion recurrences,[12] however the large tip available at the time at clinic made it more difficult to accurately maneuver, and therefore was deemed unsuitable to our needs to target the edges of the erosion while avoiding disrupting the epithelium on or close to the visual axis. Finally, studies show that alcohol delamination with 20% ethanol maintained for 30 seconds is superior to any of the aforementioned debridement methods as it does not disrupt the lamina lucida of the basement membrane, thereby reducing the risk of excessive scarring and alteration

of the optical properties.[13] Since the abrasion was strictly epithelial and did not involve the visual axis, the risk of scarring affecting visual outcome was already minimal. Additionally, the maneuverability of the cotton tip soaked in alcohol would not have been as accurate as using the blade for mechanical debridement.

After debridement, autologous serum can also be used in treating corneal abrasions. Autologous serum is manufactured by obtaining the patient's blood and isolating the serum for use in ophthalmic drops. The serum was found to be useful in recurrent corneal erosions,[14] as it provides glucose, proteins and calcium, helping the rapid migration of the epithelium to the wound site. Additionally, autologous serum contains fibronectin, vitamin A, neurotrophic factors and other extracellular matrix components, promoting epithelium migration and anchorage.[15] However, due to the acute nature and the lead time of the patient's blood draw and manufacturing the serum, it is not suitable for acute management.

After corneal trauma, a repair cascade soon begins which involves the production of cytokines, growth factors, and interleukins by the exposed stromal keratocytes, adjacent corneal epithelium, and lacrimal glands.[16,17] Like autologous serum, amniotic membranes (AM), which are obtained from placental membrane, contain neurotrophic and growth factors, however they also contain more anti-inflammatory factors, and are therefore used to augment the corneal healing process.[17] AM has been successfully used in a variety of conditions, including neurotrophic keratitis,[18] recurrent epithelial erosions,[19] high-risk corneal grafts,[20] partial and total stem cell deficiency,[19] and in corneal nerve regeneration in dry eye disease.[21] There are no studies comparing the efficacy of AM compared to BCL in incidences of traumatic corneal abrasions. In post-PRK patients, cryopreserved AM sped up corneal re-epithelization one day after surgery; however, it was not faster than a bandage contact lens in hastening complete re-epithelization or reduction of corneal haze.[17,22] Unlike soft BCL however, transplanted amniotic membrane was not shown to increase incidence of microbial keratitis.[23] Although both autologous serum and AM seem to have similar compounds, AM also contains more stem cells and anti-inflammatory effects that are not as common in autologous serum. There are not many studies comparing the two, however in one study comparing the efficacy in Neurotrophic Keratitis, AM seemed to outperform autologous serum in deep ulcers with post-herpetic neurotrophic keratitis.[24] In our case, since the patient had history of dry eye disease, and since we needed to cover the exposed stroma to prevent lid shearing forces, we opted for the amniotic membrane.

Recurrent corneal erosions are possible long-term sequelae from any traumatic corneal abrasions, especially if the trauma was caused by organic matter. Therefore, it is important to warn patients about the possibility of corneal erosion recurrence, so they know to return to clinic for prompt treatment. Additionally, the patient should be continually monitored for any signs of heaped up or irregular epithelium to start management, ideally before the patient suffers from a recurrent corneal erosion.

Anterior Chamber Trauma

As with general ocular trauma, traumatic uveitis occurs more frequently in young males.[25] Traumatic iritis comprises 20% of all uveitis cases,[26] and can be a damaging condition, leading to the formation of synechia, as well as causing damage to the drainage system and potential glaucoma.

Traumatic anterior uveitis presents with unilateral photophobia, peri-limbal injection, ocular pain, floaters, possible vision reduction, and a new onset of different IOP compared to the unaffected eye. If severe or long standing, pupillary abnormalities may also be observed. Pathophysiology involves the development of necrotic cells due to impact, which then stimulate the inflammatory reaction and increased permeability of the blood-aqueous barrier, releasing white blood cells and inflammatory mediators into the eye, which present as cells or flare in the aqueous chamber. Those cells and compounds may precipitate in the inferior anterior chamber, creating a hypopyon.

A synechia may form due to the inflamed iris sticking to the anterior lens, and if formed circumferentially, may block the flow of aqueous fluid, increasing IOP and increasing risk of intractable secondary glaucoma formation. Therefore, a mydriatic is recommended to keep the iris away from the center of the lens to prevent synechia formation. Additionally, mydriasis helps reduce reflex painful ciliary body and pupillary spasm and stabilizes the blood-aqueous barrier to prevent further leakage of protein or white blood cells. Therefore, in our case, we used 1% cyclopentolate once a day for three days. Strong steroids, such as 1% prednisolone acetate two to eight times a day or Durezol® one to four times a day, based on the severity of the cell reaction, are typically prescribed, except in cases of corneal abrasion, as they can negatively impact corneal healing. We used one drop of Durezol® and one containing 1% prednisolone acetate prior to inserting the AM to help reduce the inflammatory load in the anterior chamber, afterwards the patient was prescribed only cyclopentolate to reduce blood-aqueous leakage until the resolution of the corneal abrasion. Once the epithelium had fully healed, steroids were restarted to eliminate any traces of inflammation. Since the patient was only on a small dose of steroids for two days, no tapering was needed. However, if the inflammation were more severe or the steroids were used for a longer period or with higher frequency, then the patient would have had to taper the dose to prevent rebound uveitis. If IOP increases are noted, the treatments should be limited to either an alpha agonist, beta-blocker or carbonic anhydrase inhibitor, as they are all involved in reducing aqueous production. In cases of uveitis, where the trabecular meshwork is inflamed and already compromised, utilizing agents that target filtration through the trabecular meshwork may have suboptimal efficacy. Prostaglandin analogs are contraindicated in cases of uveitis since they can contribute to the inflammatory cascade, and the IOP lowering effect is delayed. Pilocarpine is also contraindicated in uveitis treatment

as it was shown to increase the vascular permeability, thereby contributing to the uveitis.[27]

Possible complications due to delay in care of traumatic uveitis may lead to the formation of a cataract, glaucoma, cystoid macular edema, or irregular pupil due to synechia.

Traumatic hyphema, especially if mild, tends to be self-limiting, and is rarely the sole cause of permanent vision loss. However, it can be associated with corneal blood staining which may affect vision if the staining occurs in the visual axis. Patients should therefore remain in an upright position, or when resting keep the bed elevated to 30-45°, in order keep the pooled blood from crossing the visual axis. Hyphema is associated with increased IOP risk, especially those filling 50% or more of the anterior chamber.[28] This risk tremendously increases in any patient with sickle cell disease or trait, and therefore any patients of African descent presenting with hyphema should be screened for sickle cell or at the very minimum, carefully observed due to the higher prevalence of the condition in this population. The risk of IOP spike also increases in rebleeds, increasing the risk of glaucoma and synechia in those patients.[28] Gonioscopy should not be performed on a patient with an active hyphema, but rather one month after resolution to reduce the risk of a rebleed and assess the trabecular meshwork for angle recession.

Traumatic iridodialysis can occur if the iris root is detached from the ciliary body, possibly causing a lens subluxation or a hyphema. Iridodialysis can increase the risk of glaucoma development and due to damage of the trabecular meshwork or ciliary body, or synechia. The iris will likely need to be surgically repaired if the iridodialysis is large enough to reduce glare and visual effects, and filtration surgery may need to be performed if the pressure is inadequately controlled by medications. Additionally, the patient will need to be monitored for the development of glaucoma or early cataract.

Lens Trauma

A Vossius ring on the lens may be formed, which is composed of the pupil pigment imprint on the anterior lens due to the force of the trauma driving the iris into the lens. This finding is benign and should not cause any significant visual effects.

Lens subluxation can include either complete or incomplete detachment of zonular fibers, causing the dislocation of the lens, and should be considered whenever the pupil is misshapen after a traumatic event.[29] Lens subluxation will have to be treated surgically.

Posterior Pole Trauma

Commotio retina is a self-resolving traumatic retinopathy secondary to trauma. Transient retinal opacification, or whitening, associated with commotio retina is due to loss or disruption of the photoreceptor outer segments, not edema as previously thought.[30] Macular involvement (known as Berlin's edema) tends to be associated with poorer visual outcomes.[31] The clinical appearance of commotio retinae tends to resolve within one week (Figure 6), and complete functional resolution is expected within one month in mild cases. In severe cases, permanent vision reduction may occur.[32] There is no treatment for commotio retina other than observation.

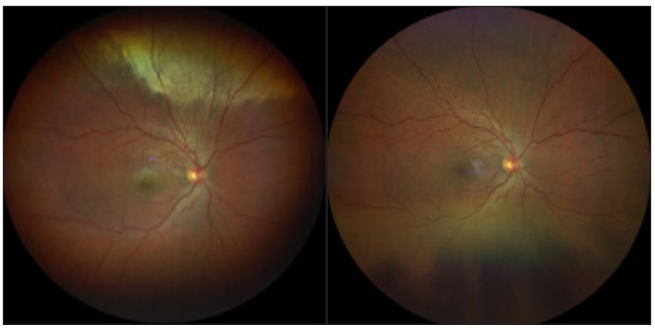


Figure 6. Commotio retinae on the superior posterior pole on initial presentation of a 35 year old Hispanic male 1 day after aiming an air pressure hose to his eye (Left) and almost complete resolution 6 days later (Right).

Blunt trauma can also be associated with retinal tears or detachments, especially in those with pre-existing retinal conditions, such as lattice degeneration. Only one paper was published covering two case reports with retinal tears due to pickleball injury, and therefore it is uncertain whether this type of injury is rare in pickleball or whether the sport is not popular enough yet for more patients to be reported.

Eyewear Standards

Ocular trauma can be associated with significant short-term reduction in quality of life, possible permanent vision reduction or even blindness. Therefore, it is crucial to recommend high quality safety eyewear for patients frequently engaging in high impact activities.

The American Society for Testing and Materials International (ASTM) is a non-profit organization tasked with developing the appropriate ocular wear safety standards. Although there is no specific guidelines for pickleball, the closest found is ASTM F3164-19 – Standard Specification for Eye Protectors for Racket Sports (Racquetball, Squash, Tennis).[33]

Conclusion

This case report reviews traumatic ocular injury causing a corneal abrasion and iritis. There are many possible treatment modalities, and in our case, we were able to successfully manage the patient to complete resolution by day 10. It is important to highlight the importance of protective eyewear to patients who frequently engage in high impact activities. Additionally, patient education and continuous monitoring for potential future sequelae is critical in preventing visually significant outcomes.

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