American Academy of Optometry: Case Report 2

Clinical Findings and Management of Commotio Retinae with Berlin's Edema

Ting Zhang
4985 Moorhead Ave, Unit 3718, Boulder, CO 80305
(720) 722-3377
Ting.zhang@us.af.mil

Abstract: Commotio retinae is a common manifestation of blunt trauma to the eye. This case report follows the clinical course of a patient presenting with commotio retinae after being struck with a kicked soccer ball. It highlights the clinical value of ocular coherence tomography in documenting and identifying various morphologic changes from blunt trauma over time.

Keywords: Blunt Ocular Trauma, Commotio Retinae, Berlin's Edema, Contrecoup Injury, Ecchymosis, Ocular Contusion, Retinal Hemorrhages, Incomplete Posterior Vitreous Detachment, Serous Retinal Detachment, Optical Coherence Tomography

Introduction

Blunt ocular trauma can damage various parts of the globe and adnexa to varying degrees. The damages are caused by coup and contrecoup trauma as well as by anterior-posterior compression and horizontal expansion of the globe from the impact.[1] Coup injuries are damages at the local site of impact, while countercoup injuries result from shockwaves that traverse to distal sites of the globe. [1] The globe can also compress along the axis of impact and expand in perpendicular planes or suffer a rupture.[1] When a patient presents with ocular concerns after sustaining a blunt trauma to the eye, it is important to carefully examine all areas of the eyes in order to rule out all possible injuries and ensure debilitating sequelae are not overlooked.[2]

Case Report

A 12-year-old, white, female, new patient presented to clinic on April 4, 2016 with her mother after sustaining an impact to her left eye from a soccer ball the previous night. She reported seeing flashes and floaters in the left eye after the injury. She denied any loss of consciousness before, during, or after the incident. The patient reported a pain level of 5 out of 10 whenever she touched the eye. She described the pain as bruise-like. The patient also reported that her vision in the left eye after the trauma had been blurry and contained a bubble. The patient denied double vision, watery eyes, and photophobia. She had taken Advil the night before for pain relief.

The patient came in wearing unknown toric contact lenses, and her visual acuity in the contacts measured 20/30 in both the right and the left eye. Intraocular pressures measured 25 mmHg OD and 23 mmHg OS at 11:20 AM with a non-contact tonometer, and 21mmHg OD and 20mmHg OS, via Goldmann Applanation Tonometry at 11:50 AM. Extraocular motilities were normal in both eyes without diplopia or restrictions in eye movements. Pupillary testing was normal without afferent pupillary defect. Slit lamp examination showed a moderately-sized patch of ecchymosis in the upper lateral part of left eyelid, no subconjunctival hemorrhages, no traumatic iritis, no hyphema, clear lens and clear vitreous with trace syneresis but no cells or hemorrhages. Her right anterior segment evaluation was unremarkable.

The patient was instructed to remove her contact lenses, and was scoped at -4.00-1.25x180 OD and -4.25-1.50x180 OS via retinoscopy. She manifested a refractive error of -4.25-1.25x175 in the right eye with a best corrected visual acuity (BCVA) of 20/25, and -4.00-1.00x005 in the left eye with BCVA of 20/30-2. She was then dilated with her mother's permission at 11:55AM with one drop of 0.5% Proparacaine hydrochloride ophthalmic solution, followed by one drop of 1% Tropicamide ophthalmic solution, and one drop of 2.5% Phenylephrine hydrochloride in each eye.

Her dilated fundus exam revealed 0.10Vx0.10H healthy pink nerves OU. Both vitreous humors had some syneresis but were without cells or hemorrhages. The right eye was unremarkable with a flat retina without breaks or detachments in all 360 degrees and a clear macula. The left eye revealed large areas of retinal whitening supranasal, superior, supratemporal and temporal arcades to periphery, three small hemorrhages temporal periphery and a small supratemporal juxtafoveal elevated bump.

Differential diagnoses considered at this point include:

Acute Posterior Vitreous Detachment (PVD)
Traumatic Retinal Detachment
Chorioretinitis Sclopeteria
Choroidal Rupture
Commotio Retinae
Purtscher Retinopathy
Branch Retinal Artery Occlusion

- Acute Posterior Vitreous Detachment occurs when fluid flows from the vitreous through a break in the posterior hyaloid, a pseudomembrane that surrounds the posterior vitreous, and causes a condensation of collapsed vitreous gel seen as floaters, and/or an intermittent traction in the peripheral retina seen as flashes. Complications of PVD can include vitreous hemorrhages from tearing of superficial retinal vessels or full thickness retinal breaks in more severe cases.[3]
- Traumatic retinal detachment is the separation of sensory retina and the RPE caused by fluids that have extravasated from the vitreous cavity through a retinal hole or tear into the subretinal space. The loss of central vision is reported if the macula is involved. The retina will appear gray and opaque, and if the fluid collection is significant, the retina may appear to billow with numerous folds.[3] In blunt ocular trauma, the retinal breaks can result from vitreous base avulsion or retinal dialysis. Vitreous base avulsion is the separation of vitreous base from pars plana and the anterior retina pathognomonic of blunt ocular trauma.[2] The avulsed vitreous can appear as a floating ribbon in the peripheral vitreous cavity.[1] Retinal dialysis is a circumferential separation of the retina from the ora serrata due to ocular contusion, usually in the supranasal quadrant.[4]
- Chorioretinitis Sclopeteria is a rare retraction of retina and choroid that exposes underlying sclera due to blunt ocular trauma. Preretinal and vitreous hemorrhages are often present in acute stages; and pigmentary hypertrophy and fibrosis form in later stages.[2]
- Choroidal Rupture is a tearing of choroid, RPE and Bruch's membrane caused by rapid deformation of the globe during blunt ocular trauma. It presents as curved white lines that concave toward the optic nerve head. Subretinal hemorrhages are common acutely, and choroidal neovascularization can develop around the edges of the rupture over the years.[3]

- Commotio retinae is the damage to outer segments of rods and cones caused by blunt trauma to the globe. This damage appears as whitening of deep retinal tissue. Some retinal hemorrhages may also be present.[3]
- Purtscher Retinopathy is an acute capillary ischemia resulting from a crushing injury to the head, chest, or long bones. It can also present in cases of acute pancreatitis, lupus erythematosus, or amniotic fluid embolization. It usually presents as bilateral multiple patches of superficial retinal whitening with cotton wool spots and peripapillary hemorrhages.[3]
- Branch retinal artery occlusion presents as superficial, edematous, whitening of an area of the retina supplied by an occluded branch of retinal artery. The occlusion is typically caused by an embolus. Although the retinal artery may appear normalized and the retinal edema resolved, permanent visual field defects persist in the area as evidence of the retinal infarction.[3]

Branch retinal artery occlusion was ruled out based on recent history of blunt trauma, the areas of retinal whitening spanning across different arterial supplies, and the absence of emboli or other vascular abnormalities. Purtscher retinopathy was ruled out based on the more subdued presentation in this case, since there were no Purtscher flecken, cotton wool spots, peripapillary hemorrhaging, nor history of bone-crushing trauma. Choroidal rupture was ruled out in the absence of classic curvilinear RPE disruption and subretinal hemorrhages. Chorioretinal sclopeteria was ruled out by the absence of scleral show and pigmentary disruptions. Traumatic retinal detachment was ruled out in the absence of retinal breaks, vitreous avulsions, and retinal dialysis.

The appearance of large patches of retinal whitening, **Figure 1**, suggested a diagnosis of commotio retinae of peripheral retina of the left eye. The appearance of elevated, whitened juxtafoveal bump suggested the presence of Berlin's edema, to which the decreased 20/30 vision OS was attributed. Fundus photographs and optical coherence tomography (OCT) were taken for patient education purposes. A macula thickness OCT, **Figure 2**, showed a hyperreflectivity under the ellipsoid zone (EZ), also known as the inner segment/outer segment junction (IS/OS), and is suggestive of a disruption of the outer photoreceptor segments under the fovea. Normative data was not available for the patient's age group, but were no obvious swelling or edema in the macula thickness scan. A 5-line raster OCT scan of the midperpheral retinal whitening, **Figure 3**, revealed thickening of the EZ as well as wrinkling in the inner and outer retinal layers due to small pockets of subretinal fluid accumulation. In the absence of retinal breaks and dialysis on fundus exam, rhegmatogenous detachment was ruled out in favor of the diagnosis of exudative or serous detachment of the retina based on the OCT findings. The OCT scans also revealed a hint of optical emptiness above the retinal and faint suggestions of posterior hyaloid membrane in both superior retina and the macula. Thus, an incomplete posterior vitreous detachment was also suspected based on these incidental findings on the OCT.

Aside from the lid ecchymosis, the majority of the impact was sustained in the posterior pole.

The patient and her mother were educated on the findings of Berlin's edema and commotio retinae. In the absence of significant pigmentary changes, the patient and her mother were

reassured a good prognosis with expected resolution around 6 weeks.[5] The patient was referred to a local retinal specialist within the week for continued monitoring, and for further evaluations for any leakages contributing to the subretinal serous detachment and potential complications. The patient and her mother were advised to apply an ice pack to the bruised lid, take 200mg of Advil, four times a day by mouth if needed for pain relief. The patient and her mother were also advised limit physical activity, and to return to the clinic sooner if symptoms change or worsen.

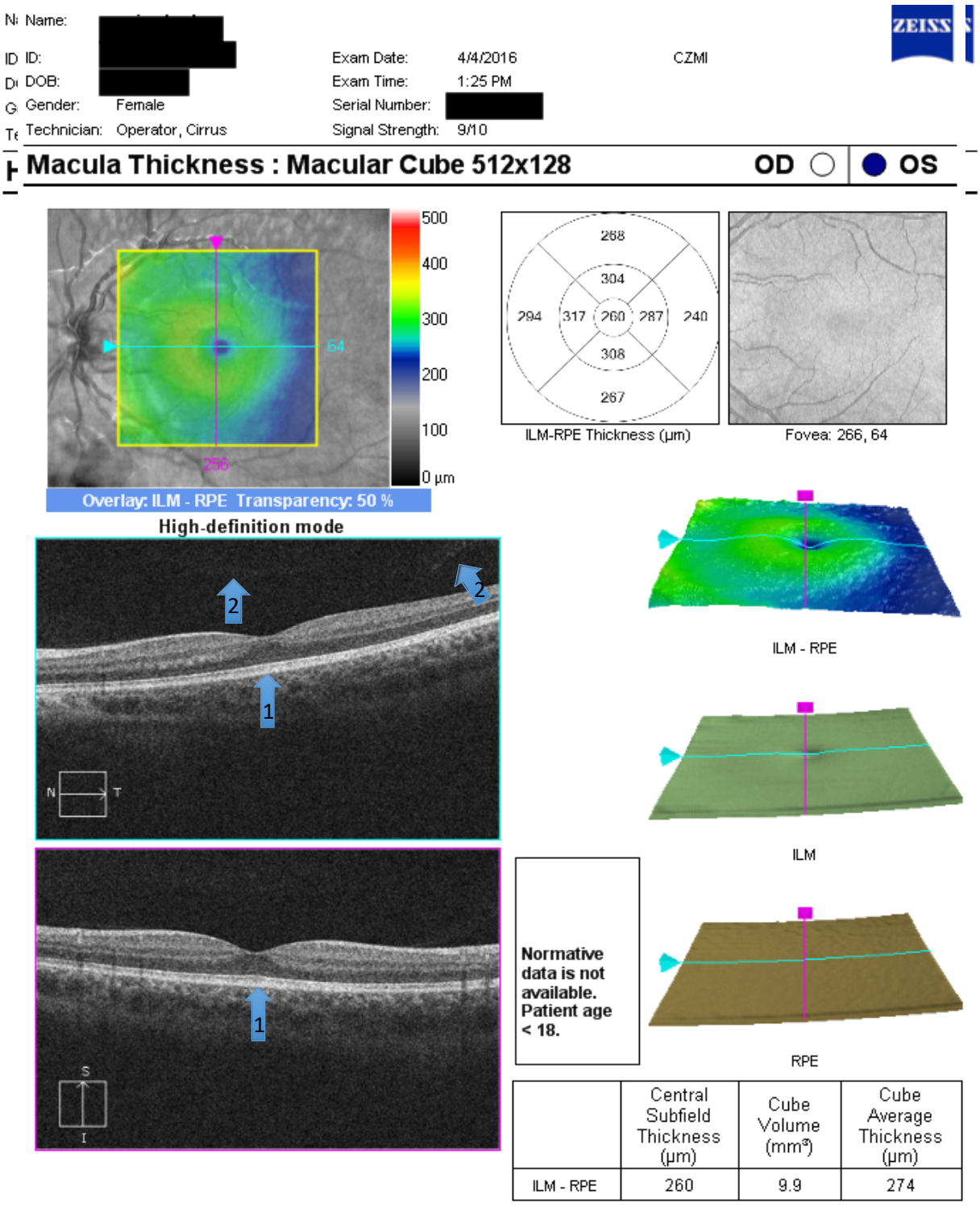
Figure 1– Fundus photograph showing retinal lesions in the superior fundus of the left eye and an area of retinal edema supratemporal of the fovea.
Figure 2– Macula thickness OCT showing a central subfield thickness of 260 microns and an average thickness of 274 microns. A mild hyperreflectivity under the ellipsoid zone (EZ) (Arrow 1) suggests a disruption of outer photoreceptor segments. A faint hyperreflective line over the optically empty space over the macula (Arrow 2) suggests a possible separation of posterior hyaloid.
Figure 3– 5-line raster OCT of midperipheral Retinal disruption as evidenced by a thickened EZ (Arrow 1). Small pockets of subretinal serous detachments were found incidentally on the scan in the area of commotio retinae (Arrow 2). The optically empty space with a faint overlying hyperreflective line is suggestive of a separation of posterior hyaloid (Arrow 3).

Follow-up #1

The patient followed up with Dr. Rebecca Manning, M.D. of North Carolina Retinal Associates on April 11, 2016. The patient reported that the flashes and floaters have subsided by April 5, and denied any ocular pain. The patient reported headache as the only complaint. The patient entered with habitual glasses with a corrected VA of 20/32 OD and 20/50 OS, pinholed to 20/32. Intraocular pressures measured 17 and 15 at 12:05 PM in the right and left eye, respectively. Pupils, extraocular motilities, anterior segment evaluations were unremarkable for both eyes. The eyes were dilated with one drop of 1% Tropicamide and one drop of Paremyd in each eye at 12:08 PM.

Dilated fundus exam revealed lattice degeneration in the temporal retina of both eyes. Additionally, left eye had diffuse whitening superior and temporal periphery, and mild whitening and edema in the macula. The retinal specialist did not find any retinal tears or detachments on examination, and confirmed the diagnosis of extensive commotio of peripheral retina with mild commotio of macula that was resolving. The patient was educated on retinal detachment precautions and to return to clinic in one month for dilation of left eye only.

Follow-up #2



	Central Subfield Thickness (µm)	Cube Volume (mm^3)	Cube Average Thickness (µm)
ILM - RPE	260	9.9	274

The patient returned to Dr. Manning on May 9, 2016 for further evaluation of the left eye. At this visit, the patient reported seeing floaters in the left eye only, and denied flashes and pain. Her vision in glasses was 20/25 in each eye. Intraocular pressures were 20 in each eye at 12:28 PM. Entrance exams and anterior segment evaluations were unremarkable both eyes. The left eye was dilated with one drop of 1% Tropicamide and one drop of Paremyd at 12:41 PM. The peripheral

commotio retinae of the left eye was reportedly resolved with only a large bed of lattice temporally and inferiotemporally remaining stable. There was persistent mild whitening and edema of the left macula, which was continuing to resolve. The patient was advised to return in three months for a follow up visit.

Follow-up #3

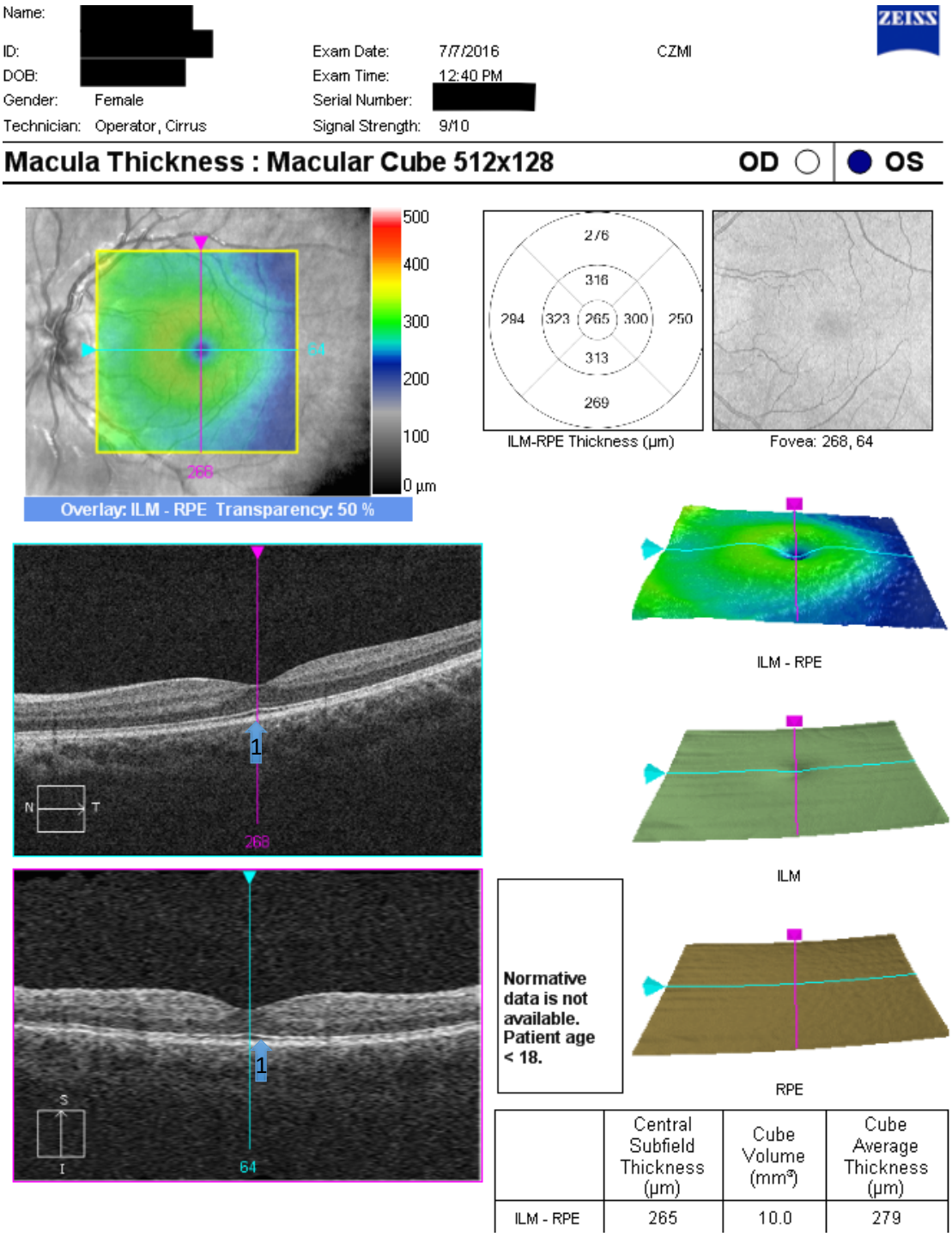
The patient returned to clinic with her mother on July 7, 2016 for follow-up. She reported her vision had been improving, but still saw clear blobs floating around her vision. She denied pain in either eye and did not have any other complaints or concerns. The patient was wearing her habitual glasses, OD: -4.25-1.00x149, OS: -4.25-0.75x159, and her corrected entering visual acuity was 20/20 right eye and 20/30 left eye. She was refracted to 20/20 in each eye with a refraction of OD: -4.25-1.00x149 and OS: -4.25-1.50x170. Her pupils, extraocular motilities, and anterior segment evaluations were unremarkable OU. She was dilated at 10:46 PM with one drop of 0.5% Proparacaine hydrochloride ophthalmic solution, followed by one drop of 1% Tropicamide ophthalmic solution, and one drop of 2.5% Phenylephrine hydrochloride in each eye. Dilated retinal exam revealed lattice degeneration temporally in both eyes and trace area of retinal whitening just beyond the supratemporal arcade next to a 1/2DD area of dark without pressure. The macula appeared normal foveal reflex without signs of whitening, edema, or elevation in either eye. The macula thickness OCT at this visit, **Figure 4,** showed a restoration of the hyporeflective space beneath the ellipsoid zone of the fovea.

Figure 4– Macula thickness OCT showing a thin optically empty space below the EZ where the hyperreflectivity had previously been (Arrow 1), suggesting a restoration of normal outer segment organization.

Without findings of retinal breaks and Weiss ring, the patient's complaint of clear blobs were attributed to the vitreous syneresis from a presumed incomplete posterior vitreous detachment in her left eye. The patient and her mother were educated on the exam findings, and based on history of steady resolution of symptoms and signs of Berlin's edema, were recommended to follow up in six months for a complete eye exam, sooner if the vision changes or symptoms of retinal detachment arise. However, the patient was lost to follow up, and reportedly returned to her prior private practice optometrist the routine eye care.

Discussion

Epidemiologic data on eye injuries both current and past have been patchy and limited. One study found that 85,961 patients presented to emergency departments across the United States for sports-related eye injuries between 2010 and 2013.[6] This does not account for cases of ocular trauma that present to optometry or ophthalmology practices, such as the case in this report.



Another study found that 25.9% of serious eye injuries occurred at a sports and recreation facility, 44.4% of eye injuries resulted from blunt objects, and 42.6% of eye injuries had an initial diagnosis of commotio retinae.[7] Soccer-related eye injuries such as this case are not uncommon,[8,9] and thus is it important for health care providers to be aware of all potential consequences of eye trauma to better care for the injury.

In this case report, the primary manifestation of blunt trauma was on the outer retinal layers in the form of commotio retinae. Commotio retinae, Latin for retinal contusion, also known as Berlin's edema in the posterior pole, was first described in 1873 by R. Berlin as a transient whitening or opacification of retina due to extracellular edema after blunt ocular trauma.[2] However, 100 years later, histologic and fluorescein angiography studies involving human and primate subjects suggested that the whitening or opacification is caused by the disruption of the photoreceptor layer rather than a process of extracellular edema as originally thought.[1,10]

As the shockwaves from the impact at the front of the eye traverse through the globe toward the posterior structures, they spread across the retina, and stress the outer retinal layers and the choroid.[9] Sipperley et al studied commotio retinae in owl monkeys for 12 weeks.[10] They observed a retinal opacification 4 to 12 hours after injury, and found no leakage of extracellular fluids on fluorescein angiography.[10] Histology under microscopy showed immediate disruption of outer segments of photoreceptors after the injury, followed by inner segment degeneration after 21 hours.[10] After 48 hours, phagocytosis of the outer segments was evident in the RPE migrations into the outer retina.[10]

With advancements in diagnostic imaging technology, morphologic changes to the retina can now be viewed in situ with Spectral-domain optical coherence tomography (SD-OCT).[11] Recent studies in SD-OCT findings of commotio retinae corroborated with the histologic studies of the 1970s.[8,9] A study by Souza-Santos et al found a hyperreflectivity in the outer segment layer of the retina on OCT that correspond to areas of commotio retinae in 9 of the 11 eyes at initial presentation.[8] The hyperreflectivity resolved in all cases after few days. The study also found significant scotomas on visual fields in 83.3% of cases with pigmentary changes.[8] This study also identified hyperautofluorescent dots on Fundus Autofluorescent scans that correspond to the histologic evidence of RPE migration to outer retina during the regeneration of the outer segment.[8]

Another study proposed a grading scale based on morphologic changes to the macula on OCT that was predictive of final anatomic and visual outcomes of macular commotio retinae. This study identified 4 grades of distinct morphologic changes.[9] Grade 1 macular commotio is seen as an increased reflectivity of the inner and outer segment junction (IS/OS) with a disappearance of thin hyporeflective space under the fovea on macular OCT.[9] Grade 2 macular commotio reflects a disappearance of reflectivity of the cone outer segment tips (COST).[9] Grade 3 macular commotio reflects a loss and disruption of both COST and IS/OS layers.[9] Grade 4 macular commotio reflects a loss and disruption of COST, IS/OS, as well as the external limiting membrane (ELM).[9] This study found that 100% of grade 1 and 2 macular commotio recovered all 3 photoreceptor layers completely, while only 14% and 5.9% of the grade 3 and 4 commotio, respectively, showed a full anatomical recovery.[9]

The visual acuity in patients presenting with commotio retinae can vary from 20/20 to worse than 20/400.[1,9] Of the 49 eyes in the study by Anh et al., 73.5% presented with Grade 3 or 4 macular commotio and had an average BCVA of 20/400, 10% presented with Grade 2 and an average BCVA of 20/100, and 16.3% presented with Grade 1 and an average BCVA of 20/40.[9] By the final visit, the BCVA of the Grade 1 eyes improved to an average of 20/30 with over half of the eyes achieving BCVA of 20/20 or better.[9] The final BCVA of the Grade 4 eyes averaged 20/250, with over 50% of the eyes seeing worse than 20/200.[9] These results suggest that a disruption of the IS/OS junction and ELM on OCT is associated with persistent photoreceptor damage, where complete recovery becomes less likely.[9] The author suggests that damage to cone cell bodies, as indicated by IS/OS disruption, is likely to result in irreversible photoreceptor loss and permanently compromise the visual function in that area.[9]

Conclusion

In this case of commotio retinae with Berlin's edema resulting from a blunt impact to the left eye by a soccer ball, the patient recovered without significant sequelae. The extent of the initial damage was captured on optical coherence tomography, and revealed a more favorable Grade 1 macular commotio damage. Ultimately, the patient healed predictably without complications. Although diagnoses of commotio retinae and Berlin's edema are made empirically based on patient history and fundus appearance on dilated fundus examination, the use of OCT provides valuable insight and confirmation of the morphological changes in the retina. The OCT is also useful in monitoring the progress of recovery, and can be valuable in both medical and legal contexts of disease management.[9] In conclusion, understanding the pathophysiology of blunt ocular trauma and recognizing morphologic features of ocular abnormalities are essential to providing an accurate assessment and prognosis for the patient.

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