CASE REPORT

THE UTILITY OF OCULAR IMAGING IN TRAUMATIC OPTIC NERVE AVULSION: A CASE REPORT

Ikhwanuliman Putera,[1] Syntia Nusanti,[2] Nur Aisyah Rahmawati,[1] Annisa Nindiana Pertiwi,[1] Mario Marbungaran Hutapea[3]

[1]Resident of Department of Ophthalmology, Faculty of Medicine Universitas Indonesia – Cipto Mangunkusumo Kirana Eye Hospital, Jakarta, Indonesia

[2]Neuro-Ophthalmology Division, Department of Ophthalmology, Faculty of Medicine Universitas Indonesia – Cipto Mangunkusumo Kirana Eye Hospital, Jakarta, Indonesia

[3]Vitreo-Retina Division, Department of Ophthalmology, Faculty of Medicine Universitas Indonesia – Cipto Mangunkusumo Kirana Eye Hospital, Jakarta, Indonesia

Email: Ikhwanulimanputera@gmail.com

ABSTRACT

Objective: To describe a detailed presentation and the utility of ocular imaging, both ocular ultrasound and orbital computed tomography (CT), to confirm the diagnosis of traumatic ONA in which megadose steroid would give no advantage.

Case Presentation: A five-year-old boy came with a unilateral sudden visual loss after incidentally falling with his left eye struck to a handlebar of a parked bicycle. His left eye had no light perception, ophthalmoplegia, and showing 4+ relative afferent pupillary defect. A hallmark "pit" sign and a pale retina without a tear were noted. B-scan ocular ultrasound displayed retinal step sign, vitreous hemorrhage in front of the optic canal, lamina cribrosa defect, edematous retina, and retracted optic nerve. Orbital computed tomography scan showed a disruption of the optic nerve-globe junction. Steroid infusion was decided not to be given.

Conclusion: Ocular imaging, especially ultrasound, along with a thorough examination, is satisfactorily adequate to confirm the diagnosis of traumatic ONA.

Keywords: Avulsion, optic nerve, steroid, ultrasound

INTRODUCTION

Optic nerve avulsion (ONA) is a rare yet severe blunt trauma complication. It is regarded as one of many spectra of traumatic optic neuropathy (TON), with severe and immediate visual loss following the insulting event. The true incidence of ONA is hard to be determined. It is estimated that the probability of TON after closed head injury varied between 0.5-5%, and those expected to have traumatic ONA are far less below.[1,2]

The diagnosis of ONA is often made clinical, with the appearance of optic nerve head excavation. However, until recently, there is still no consensus to diagnose ONA and exclude usual TON based on the clinical manifestations; therefore, clinicians need objective evidence of optic nerve damage. On some occasions, the fundus view is also often obscured due to vitreous or pre-retinal hemorrhage. Thus imaging, such as ultrasound, MRI, or CT-scan, can

help the diagnosis, especially in the emergency setting, when the prompt diagnosis is needed. Advanced neuroimaging studies may not always be readily available, and its selection and interpretation had not been widely reported in a large study. Furthermore, ocular USG is relatively inexpensive, quick for bedside diagnosis, and more readily available even though its considered operator-dependent.[3–6]

The appropriate management in the case of TON poses controversy. Despite many cases that have been reported, high/mega-dose steroid therapy or decompression of the optic nerve provides no additional benefit over conservative treatment, based on a recent meta-analysis.[7] However, experts agreed to withhold steroid treatment in those suffering from ONA.[8] Treatment consideration in TON cases is usually based on the hypothesis that injury to the axons occurs with a significant role of vasospasm and swelling within the canal.[2] Thus, visual recovery may still be expected even in severe cases.[1,9] However, this is not applicable in ONA as the nerve poses significant anatomical injury.

This case report aimed to describe a detailed presentation of traumatic ONA and the utility of ocular imaging to confirm the diagnosis, which is considered beneficial in the acute setting. This can help attending ophthalmologists strictly withhold steroid to avoid the adverse effects following its administration, especially in a child, and to predict the visual prognosis early.

CASE ILUSTRATION

A 5-year-old boy came with a unilateral sudden visual loss after incidentally falling with his left eye struck to a handlebar of a parked bicycle. His left eye became no light perception, ophthalmoplegia (Figure 1), and showing 4+ relative afferent pupillary defect. Immediate dilated fundus examination using a 20D lens in the emergency unit showed blood emanating from the optic canal with a hallmark pit and pale retina without a retinal tear (Figure 2).

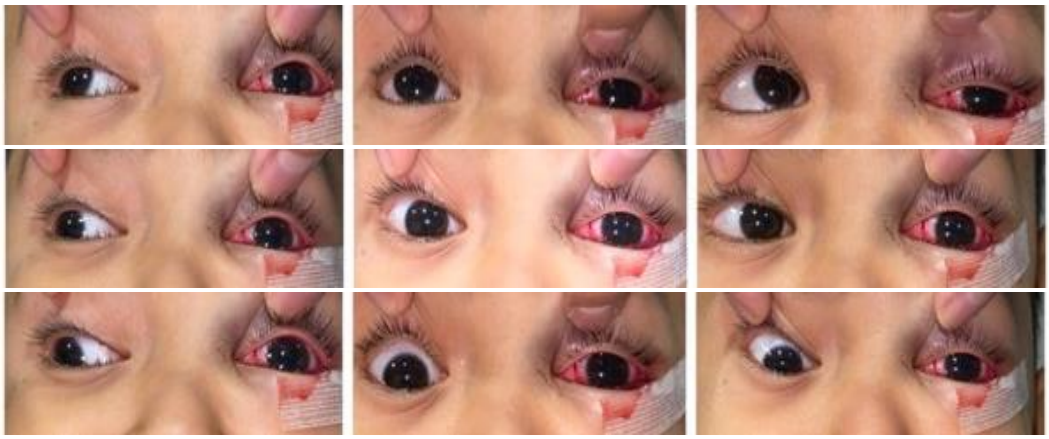

Figure. 1 Clinical appearances of the patient with restricted left eye movement to all direction

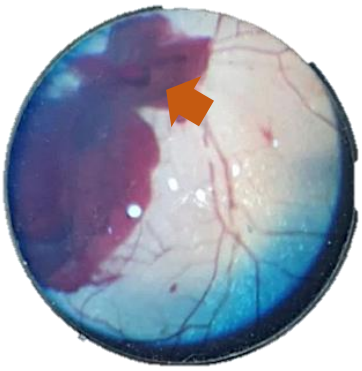

Figure. 2 Blood leaking from optic nerve with the hallmark "pit" sign (arrow) in the fundus photograph

Orbital computed tomography (CT) scan confirmed avulsion along with a comminuted fracture of the superior orbital wall and ruptured superior rectus muscle (Figure 3). B-scan ultrasound displayed retinal step sign, vitreous hemorrhage in front of the optic canal, and retracted optic nerve (Figure 4). Steroid infusion was then decided not to be given. After one week, the patient returned with still no light perception visual acuity and vitreous hemorrhage obscuring the posterior pole examination.

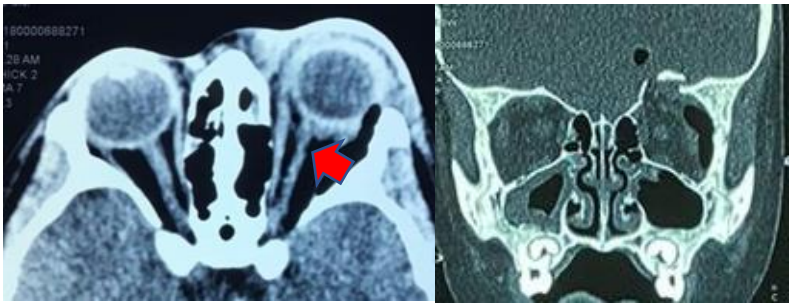

Figure. 3 Orbital CT scan showed disrupted optic nerve-globe junction (red arrow) with orbital roof fracture

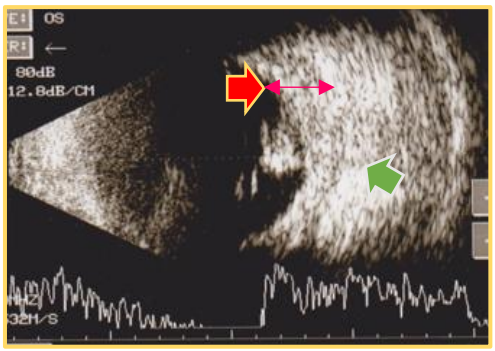

Figure. 4 Ocular ultrasound showed retinal step sign (red arrows), elevated edematous retina, and obscured optic nerve (green arrow)

DISCUSSION

Retro-displacement of the optic nerve that occurred after a sudden incline of IOP or rotation of the globe following blunt trauma could lead to ONA.1,10 The optic nerve surrounded by pia, arachnoid, and dura mater located in the canal is fragile to trauma as it is

tightly fixed within a confined space. The optic nerve injury mechanism in ONA is regarded as direct TON, in which an interruption, either complete or partial, occurred after mechanical trauma, thus warrant a worse prognosis.8,11

The clinical appearance of ONA will be varied depending on the onset of the insulting event and the first contact with the attending ophthalmologist. In an acute setting that is less than 24 hours, as seen in our case, the reported clinical findings were including ocular movement restriction, visual acuity of no light perception, unresponsive pupillary reaction to light stimuli, edematous retina, and an obscured optic nerve head with overlying hemorrhage or "pit" sign.3–5 Some reports also showed signs of iritis or anterior chamber cells. Besides, cherry-red spot, extensive vitreous hemorrhage, or attenuated vessels were reported in some cases.3,5 In later time, the diagnosis could be challenging as posterior examination could only reveal vitreous hemorrhage. In clinically undifferentiated cases, ocular imaging is mostly beneficial to establish the diagnosis of ONA.3,11

In our case, we showed a complete picture of traumatic ONA in an acute setting. We found similarities in terms of ocular ultrasound characteristics as compared to other studies (table 1). We also showed a disruption in the optic nerve-globe junction based on the orbital CT scan. A CT scan may be performed as a modality of choice as small fracture fragments and acute orbital/intracranial hemorrhages as preferentially chosen in the (poli-)trauma care setting.11,12 In most cases, single imaging could be satisfactory to guide the diagnosis. However, if a CT scan performed at the first place find inconclusive finding, ocular ultrasound could be a solutive option.

Table 1. Summary of ocular ultrasound findings in ONA from published case reports

No	Study	Ocular ultrasound (B-scan) findings				
		Retinal step sign	Obscured optic nerve/ any hypolucency posterior to optic nerve	Vitreous hemorrhage adjacent to the optic canal	Retinal detachment	Posterior wall defect
1	This case	Yes	Yes	Yes	No	No
2	Sindhu et al (2019)[5]	Yes	Yes	Yes	No	No
3	Sherief et al (2018)[6]	Not stated	Yes	Yes	No	No
4	Jain et al (2018)[4]	Yes	Yes	No	No	No
5	Barnard and Ajlan (2018)[13]	Not stated	Yes	Not stated	Not stated	Not stated
6	Babitha et al (2017)[14]	Not stated	Not stated	Not stated	Yes	No
7	Almezeiny (2011)[11]	No	Yes	Yes	Yes	Yes
8	Oliver and Mandava (2007)[15]	Yes	Yes	Yes	No	No
9	Sawhney et al (2003)[3]	Not stated	Yes	Yes	Yes	No
10	Taiwar et al (1991)[16]	Not stated	Yes	Not stated	Not stated	Yes
11	Hykin et al (1990)[17]	Unclear	Yes	No	No	No

As previously described, in some cases, a CT scan could fail to elucidate optic nerve-globe junction disruption. With consideration of potential error in the interpretation, CT scan could reveal no abnormality. Besides, it could show only a tortuous or thickened optic nerve (table 2). Furthermore, ocular ultrasound provides an inexpensive modality and is practically beneficial in the setting of suspected ONA. Ultrasound provides better real time visualization toward posterior part of the globe.[18] Several features of ultrasound findings displayed in table 1 with obscured or hypolucency posterior to the optic nerve as the leading characteristic of ONA. Other modalities could also help to guide the diagnosis with variable findings and interpretations, as described in detail in table 2.

Table 2. Ocular imaging findings from modalities other than ultrasound from previous studies

Modalities	Spectra of imaging interpretations
Computed tomography (CT)	• No abnormality in optic nerve.[3] • Partial optic nerve avulsion with intact globe contour.[14] • Soft tissue swelling around the globe without radiographic evidence of optic nerve avulsion or bony fractures along with notable thickening of the optic nerve.[10] • Complex fractures of the midfacial and left orbital walls. No obvious retrobulbar hematoma but significant disruption of the orbital apex with possible impingement on the optic nerve. Intact globe and probable injury of both the medial and lateral rectus muscles.[11] • Intact globe, avulsion of the superior and lateral rectus muscles, marked proptosis, and a severed optic nerve with its free end lying within the orbit without fracture.[19] • Avulsion of the globe with transection of superior and medial rectus muscles and optic nerve, as well as hemorrhage near the chiasm.[20] • No visible optic nerve damage, but the optic nerve was reported to be tortuous.[21] • Disruption of optic nerve at its attachment to the eyeball was present with fluid density in-between.[22] • A widened and altered optic nerve -globe junction.[23]
Magnetic resonance imaging (MRI)	• Disruption in the area of lamina cribrosa of the right eye.[6] • Empty optic canal except for the cuff of remaining dura of the optic nerve closely adherent to the periosteum.[19] • Focal contrast enhancement was observed at the optic nerve.[24] • Hypo-intensities in the posterior globe.[13] • Tearing of the left optic nerve distal to the optic chiasma. High diffusion-weighted imaging (DWI) signal of the optic chiasma to the optic tract indicated nerve injury.[25] • Disruption in the lamina cribrosa region.[23] • No pathology except sporadic vitreous hemorrhage and lamina cribrosa irregularity.[26]
Optical Coherence Tomography (OCT)	• Deep cavity with thin retinal nerve fiber layer (RNFL)[24]
Fundus Fluorescein Angiogram (FFA)	• Hypoperfusion of the disc in the region corresponding to the avulsed area with peripapillary blocked and minimal delay in vascular filling of the inferior vessels.[16] • Delayed filling of the retinal circulation was seen as the simultaneous appearance of the late venous phase. Complete non-perfusion of the optic disc, with mild late fluorescein leakage.[17] • Masking of fluorescence due to intravitreal hemorrhage around the optic disc.[24] • Delayed filling of retinal arterioles and delayed arteriovenous transit time along with normal choroidal perfusion.[21]

Currently, no evidence of aggressive treatment, either medically or surgically, proves beneficial for ONA. From a retrospective analysis of ONA due to door-handle trauma in children, only 1 out of 14 patients retain light perception while the others were in no light perception visual acuity after some time of follow-up.[27] In addition, steroids and orbital decompression surgery trials obtained from published case reports could not restore the visual acuity as the patient with ONA would end up with no light perception.[4,10,11] Immediate diagnosis can avoid unnecessary steroid that may otherwise harm systemically with a higher risk of steroid therapy complications in children: growth and adrenal suppressions, especially if given in a long time with the continuation of oral route therapy.[28] The paradigm in view of no benefit but more complication risk to give megadose steroid has been adopted in the acute spinal injury care recommendation in pediatric patient. In their large study, Caruso et al[29] found that more than half of patients receiving megadose intravenous methylprednisolone (55.6%) had complications, significantly higher than those who did not receive steroid (24.2%; p =0.008). In short-term of observation, nausea/vomiting, bradycardia, and hyperglycemia were among the commonest adverse reactions occurred during the hospital stay. Thus, they recommend withholding steroids in acute spinal cord injury in pediatric patients due to its lack of benefit. This may also implicate our decision

CONCLUSION

Not all traumatic optic nerve injury cases required aggressive treatment, such as in ONA, which signs should be aware of following a blunt trauma based on a thorough examination. Ultrasound might become the preferred diagnostic imaging to help to confirm ONA, especially in an acute setting. CT scan is also helpful to some extent, primarily when performed as a part of ancillary tests in trauma patients where facial or bone fracture is also suspected. Megadose steroid or surgical decompression could be withheld in a confirmed ONA case as its lack of evidence to restore visual function.

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