The Journal of Emergency Medicine, Vol. 56, No. 4, pp. 417–420, 2019

0736-4679/$ - see front matter

https://doi.org/10.1016/j.jemermed.2018.12.042

Ultrasound in Emergency Medicine

BEDSIDE TRANSORBITAL ULTRASOUND IN THE CLINICAL EVALUATION OF PEDIATRIC OPTIC NEURITIS IN THE EMERGENCY DEPARTMENT

Junaidah Badron, MBBS, MRCPCH, MMED and Gene Yong-Kwang Ong, MBBS, MRCPCH

Children's Emergency, KK Women's and Children's Hospital, Singapore

Reprint Address: Gene Yong-Kwang Ong, MBBS, MRCPCH, MMED, Children's Emergency, KK Women's and Children's Hospital, 100 Bukit Timah Road, Singapore 229899

☐ **Abstract—Background: Headache and monocular visual disturbance are worrisome pediatric presenting complaints in the emergency department. Appropriate and timely initial evaluation is critical. Most would opt for urgent computer tomography in such cases. Pediatric optic neuritis is a rare condition and is better evaluated by magnetic resonance imaging. With the increase in the use and scope of bedside ultrasound, there might be a potential role for transorbital ultrasound to be part of the emergency department evaluation of pediatric optic neuritis. Case Report: This is the first pediatric case report on the use of bedside transorbital ultrasound in the emergency department evaluation of a 15-year-old girl with optic neuritis who presented with unilateral headache and left visual disturbance. Transorbital ultrasound of her left eye revealed an irregularly enlarged optic nerve sheath with increased optic nerve sheath diameter (5.1 mm) and an elevated optic disc height (0.5 mm). Ultrasound examination of her right eye was contrastingly normal, showing an optic nerve sheath diameter of 3.8 mm and that the optic disc was not elevated. The ultrasound findings correlated well with her magnetic resonance imaging of her orbits. Why Should an Emergency Physician Be Aware of This?: The clinical findings and monocular ultrasound abnormalities facilitated the emergency department decision-making process and choice of neuroimaging. This highlights the use of transorbital ultrasound as a clinical adjunct and potential role in the emergency department clinical evaluation of a pediatric patient with optic neuritis. The finding of an irregularly enlarged optic nerve might be of potential clinical value but further studies are required.** © 2018 Elsevier Inc. All rights reserved.

☐ **Keywords—bedside transorbital ultrasound; emergency department; optic neuritis; pediatrics**

INTRODUCTION

Headache is a common complaint presenting to the busy emergency department (ED). The challenge in managing headache is to differentiate the serious causes, such as an intracranial hemorrhage and tumor, from the benign causes, like migraine. Pediatric optic neuritis is a rare condition and may present to the ED with visual disturbance and headache (1–5). There have been studies on the use of bedside transorbital ultrasound in the evaluation of increased intracranial pressure in the pediatric population (6–8). Transorbital sonography could also be a promising tool to support the clinical diagnosis of acute optic neuritis, but these are restricted to mainly adult studies in the non-ED context (9,10). However, there is a notable paucity of literature on the use of bedside transorbital ultrasound by emergency physicians in the evaluation of pediatric optic neuritis.

Written informed consent was obtained from the parents for publication of this case report and accompanying images. A copy of the written consent is available for review by the editor-in-chief of this Journal.

RECEIVED: 17 September 2018; FINAL SUBMISSION RECEIVED: 18 December 2018;
ACCEPTED: 24 December 2018

Except for a single case report in an adult patient, to the best of our knowledge, this is the only case report on the use of bedside transorbital ultrasound by a pediatric emergency physician in the clinical evaluation of pediatric optic neuritis (11).

CASE REPORT

A previously well 15-year-old Chinese girl was referred to our pediatric ED from another public non-pediatric hospital for headache and visual blurring. Prior to the current presentation, she had headache for 2 weeks, which was described as daily pain and worse on looking to the left. She also developed blurring of vision in the left eye 4 days after the onset of the headache. The visual disturbance was described to be progressively worsening and was associated with monocular color disturbance. There was no associated fever, rash, or focal neurologic signs (weakness, numbness, no change in behavior or speech disturbance). She denied any preceding illness or head injury. There was no history suggestive of autoimmune diseases. There was also no family history of autoimmune or eye diseases. There was no ophthalmoplegia or diplopia noted on the examination of her eye. The visual acuity on her right eye was normal and the left was abnormal, which did not improve with pin-hole correction. She was not able to "count fingers" when evaluating her visual acuity. Her pupils were mildly dilated at 4 mm bilaterally from her prior eye examination with mydriatics at the referring hospital.

The pediatric emergency physician performed a bedside transorbital ultrasound using a Sonosite™ M-Turbo 5–8 MHz micro-convex probe (FujiFilm Sonosite, Bothell, WA). The patient's eyes were examined sequentially. Transorbital ultrasound was performed without direct probe contact with the eyes. This was done as a general approach to prevent undue pressure on the eyes in view of possible differential, such as retinal detachment. Tegaderm 3 M transparent film (3M, Maplewood, MN) was applied to the eyelids, over which a generous amount of ultrasound gel was applied to ensure a good ultrasound interface. Both transverse and longitudinal views were obtained for each eye. Her right transorbital sonography was normal; with a right optic nerve sheath diameter measuring 3.8 mm (measured 3 mm behind the retina) and an optic disc height that was not elevated. Ultrasound examination of her left orbit (affected eye) showed an irregularly enlarged optic nerve with an optic nerve sheath diameter of 5.1 mm (Figure 1). A left optic disc nerve height of 0.5 mm was also noted. There was no "crescent sign" noted in either eye.

An urgent eye referral was made, and the patient was reviewed by the on-call ophthalmologist. Fundoscopy revealed right inferior blurring of disc margin and left blurring of disc margin with hyperemia. Formal eye examination showed reduced color discrimination of her left eye on Ishihara chart testing. She was admitted for further magnetic resonance imaging (MRI) investigations and management.

MRI of the patient's orbits, anterior visual pathway, brain, and spine was done. This revealed an isolated swollen left optic nerve with asymmetric, mild increased contrast enhancement, especially in the canalicular and cisternal portions (Figure 2). MRI of her right optic nerve, brain and spine were normal.

Lumbar puncture for cerebrospinal fluid analysis was performed and the results were essentially unremarkable (including culture, polymerase chain reaction, viral RNA or DNA, mycoplasma DNA, autoimmune antibodies, and oligoclonal bands). Blood investigations were also essentially unremarkable (including autoimmune screens), except for a mildly raised erythrocyte sedimentation rate of 26 mm/h (reference range 3–15 mm/h).

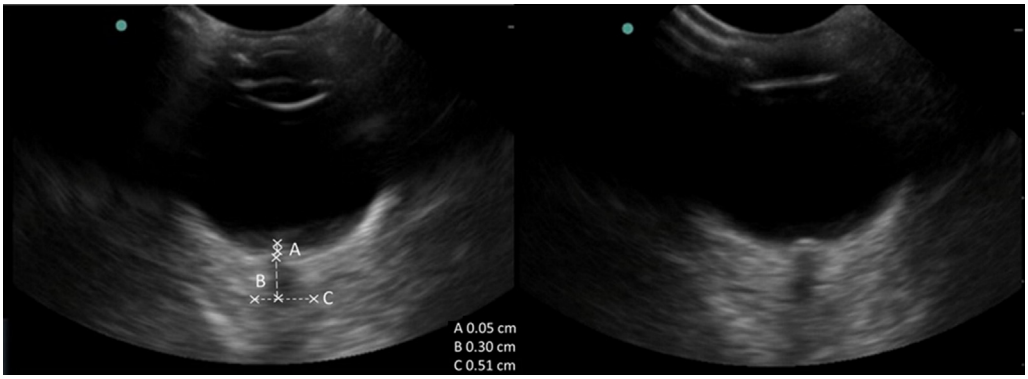

Figure 1. Left transorbital sonography (transverse) showing an optic disc height of 0.5 mm (A), optic nerve sheath diameter of 5.1 mm, (C) measured 3 mm (B) from the retina. Longitudinal view, on the right, showing an irregularly enlarged optic nerve sheath with an elevated optic disc.

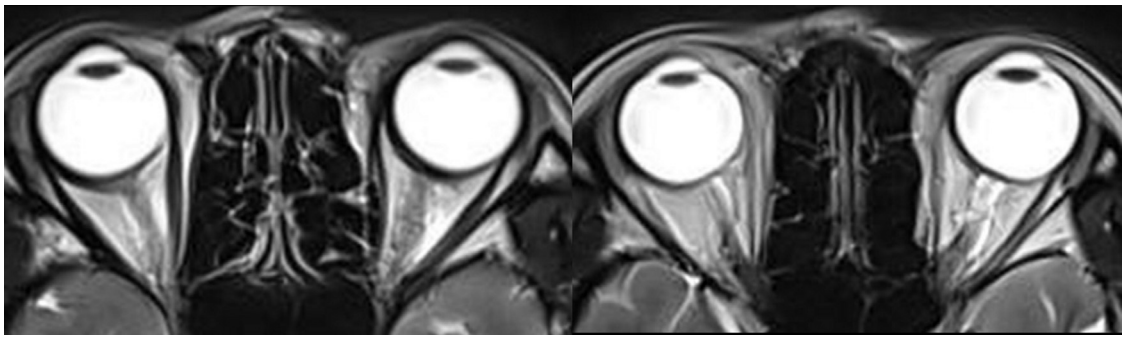

Figure 2. Magnetic resonance imaging showing left optic nerve to be more swollen compared to the right side and demonstrated high signal on T2 images.

She received a 5-day course of intravenous pulsed methylprednisolone of 1 gram daily and was discharged home with tapering doses of oral prednisolone (40 milligrams to 5 milligrams daily). Her vision improved gradually with the steroid therapy. Her visual acuity on discharge was near normal in her affected eye. The Ishihara test revealed 15/15 in both eyes.

DISCUSSION

Optic neuritis accounts for about 25% of acute pediatric demyelinating syndromes (1). Children present at a mean age of 9–11 years old (2). Among these children, those in the post-puberty age group tend to be females. However, in the pre-puberty group, optic neuritis occurs equally in both sexes. Pediatric optic neuritis is a rare condition and presents with decreased visual acuity or vision loss acutely or sub-acutely (3). Children with optic neuritis on presentation typically have poorer visual acuity at presentation compared to their adult counterparts. Most studies reported that 70–85% of patients had presenting visual acuity of 20/200 or worse (2). Pediatric patients tend to present with bilateral eye involvement that is age-dependent. In children younger than 10 years old, 72% of cases are bilateral, while 70% in those older than 10 years old are unilateral (4). Visual loss tends to occur over hours to days, usually reaching a maximum within several days of onset. Papillitis is more common in affected children. While eye pain, especially with ocular movement, is present in almost all adults, only half of the affected children experience pain.

Most studies report "good" visual recovery in 70–85% of children who received appropriate diagnosis and treatment (1). Wan et al. studied visual outcomes of pediatric patients with optic neuritis in a retrospective observational study over a 10-year period (5). In their study, it was found that the mean time to recovery of patients with pediatric optic neuritis was 61 days. The recovery was notably slower for pediatric patients with poor initial visual acuity who were not able to see "counting fingers" at presentation. The factors that influenced the rate and degree of visual recovery appeared to depend on whether corticosteroid therapy was given and if there was an underlying neurologic disease. Given that visual loss can occur within days in pediatric optic neuritis, the patient's poor initial visual acuity in her affected eye and the need for timely treatment were important factors for her visual outcome, it was crucial that pediatric optic neuritis, while rare, was appropriately diagnosed and managed.

In the context of a busy and noisy emergency department, fundoscopy, while still an essential part of the clinical examination, may be difficult to perform in younger children, especially when they are in pain or distressed. Fundoscopic examination when performed by non-ophthalmologists was reported to have more false-negative findings (12). An ultrasound machine is usually available in most EDs. Bedside transorbital ultrasound, while also physician-dependent, allows for image and data capture. Measurements can be obtained for evaluation and reviewed. Significantly, sonographic examinations are relatively simple to perform with low inter- and intra-observer variability and can be repeated as necessary (6). Pupillary reflexes are preserved, as mydriatics are not required. Serial examinations can also be performed easily for rapid re-evaluation and re-assessment.

The use of bedside transorbital sonography in the ED setting is increasingly reported, especially for correlation with increased intracranial pressure in the context of traumatic brain injury in the adult and pediatric populations (6–8). Unlike papilledema, pseudopapilledema is a result of structural elevations (drusen) of the optic nerve and is usually benign. It is, however, important to differentiate the two entities, despite the significant limitations of traditional bedside ophthalmic examinations. Transorbital ultrasound may be a promising tool in differentiating papilledema from pseudopapilledema (13).

An increased optic nerve sheath diameter measured 3 mm from the retina, raised optic nerve disc height

and "crescent sign" (fluid behind the optic nerve head) have been described and used as sonographic evidence of papilledema, which suggest increased intracranial pressure (6–8). In the pediatric population, an optic nerve sheath diameter of > 4.5 mm is considered abnormal (6–8). In the adult population, a raised optic nerve disc height is considered abnormal if > 0.6 mm (7). There are, however, no norms for optic disc nerve height reported for the pediatric population. It was observed that the pediatric patient had an irregularly enlarged left optic nerve with an optic sheath diameter of 5.1 mm and optic nerve disc height of 0.5 mm. Perhaps more importantly, there was a notable difference in the measurements of the optic nerve sheath diameters and disc heights between the two eyes. The finding of marked differences between the sheath diameters and disc heights should prompt differentials, which would include monocular optic nerve enlargement from any cause, such as primary tumors (e.g., optic nerve glioma or other neuronal tumors), unilateral papilledema (consider unilateral cavernous sinus thrombosis), or pseudopapilledema (optic nerve drusen). It was also noted that the optic nerve sheath was not uniformly enlarged (see Figure 1) on the transorbital ultrasound of her affected eye. This might also be a promising ultrasound feature (which was also noted on the MRI) to help differentiate the etiologies.

The finding of papilledema in the ED would usually require urgent evaluation. Use of ultrasound in such a context could also potentially help in the risk assessment of the need for urgent neuro-imaging. This, in turn, could potentially avoid unnecessary radiation exposure, such as computer tomography in the more vulnerable pediatric population.

Bedside transorbital ultrasound can be considered as a part of the clinical evaluation available to the emergency physician for evaluation of pediatric patients who present with headache and visual changes. It may facilitate a more direct initial management, including investigations, imaging, and timely referrals in pediatric patients with optic neuritis.

WHY SHOULD AN EMERGENCY PHYSICIAN BE AWARE OF THIS?

We present the first case that we are aware on the use of bedside transorbital ultrasound by a pediatric emergency physician to facilitate the evaluation of optic neuritis in a pediatric patient who presented with headache and left visual disturbance. The finding of only a single eye abnormality with an irregularly enlarged optic nerve sheath and an elevated optic nerve disc height in her affected eye, together with the history, other clinical findings, and clinical examination facilitated the diagnosis, initial investigations, and management of her optic neuritis. However, more studies are needed to define the potential roles for transorbital sonography as an adjunctive tool in pediatric optic neuritis in the ED setting.

Acknowledgments—Author contributions: Drs Junaidah Badron and Gene Yong-Kwang Ong both drafted, reviewed and revised the manuscript. Both authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

REFERENCES

1. Banwell B, Kennedy J, Sadovnick D, et al. Incidence of acquired demyelination of the CNS in Canadian children. Neurology 2009; 72:232–9.
2. Absoud M, Cummins C, Desai N, et al. Childhood optic neuritis clinical features and outcome. Arch Dis Child 2011;96:860–2.
3. El-Dairi MA, Ghasia F, Bhatti MT, et al. Pediatric optic neuritis. Int Ophthalmol Clin 2012;52:29–49.
4. Waldman AT, Stull LB, Galetta SL, et al. Pediatric optic neuritis and risk of multiple sclerosis: meta-analysis of observational studies. J AAPOS 2011;15:441–6.
5. Wan MJ, Adebona O, Benson LA, et al. Visual outcomes in pediatric optic neuritis. Am J Ophthalmol 2014;158:503–7.
6. Marchese RF, Mistry RD, Scarfone RJ, et al. Identification of optic disc elevation and the crescent sign using point-of-care ocular ultrasound in children. Pediatr Emerg Care 2015;31:304–7.
7. Malayeri AA, Bavarian S, Mehdizadeh M, et al. Sonographic evaluation of optic nerve diameter in children with raised intracranial pressure. J Ultrasound Med 2005;24:143–7.
8. Teismann N, Lenaghan P, Nolan R, et al. Point-of-care ocular ultrasound to detect optic disc swelling. Acad Emerg Med 2013;20:920–5.
9. Dehghani A, Giti M, Akhlaghi MR, et al. Ultrasonography indistinguishing optic neuritis from nonarteritic anterior ischemic optic neuropathy. Adv Biomed Res 2012;1:3.
10. Lochner P, Cantello R, Brigo F, et al. Transorbital sonography in acute optic neuritis: a case-control study. Am J Neuroradiol 2014; 35:2371–5.
11. Wayman D, Carmody KA. Optic neuritis diagnosed by bedside emergency physician-performed ultrasound: a case report. J Emerg Med 2014;47:301–5.
12. Morad Y, Barkana Y, Avni I, et al. Fundus anomalies: what the pediatrician's eye can't see. Int J Qual Health Care 2004;16:363–5.
13. Carter SB, Pistilli M, Livingston KG, et al. The role of orbital ultrasonography in distinguishing papilledema from pseudopapilledema. Eye (Lond) 2014;28:1425–30.