Editorial

Optic nerve sheath diameter: An ultrasonographic window to view raised intracranial pressure?

Jose Chacko

Access this article online
Website: www.ijccm.org
DOI: 10.4103/0972-5229.144007
Quick Response Code:

Raised Intracranial Pressure (ICP) is a dreaded complication of neurological disease that often leads to adverse outcomes. Clinical signs of raised ICP are often unreliable or too late to manifest and may lead to unacceptable delay in therapeutic intervention. Neuroimaging by computed tomography (CT) or magnetic resonance imaging (MRI) scans entail transfer of a critically ill patient out of the Intensive Care Unit (ICU), besides being an impracticable tool for repeat examinations at frequent intervals as may be necessary in patients with raised ICP. Invasive measurement by an intraventricular or intraparenchymal catheter is the gold standard and used extensively in the management of traumatic brain injury; however, it may not be feasible in a heterogenous group of medical patients.

The optic nerve sheath is an anatomical extension of the duramater and the subarachnoid space around the optic nerve is continuous with the intracranial subarachnoid space. Any pressure rise within the intracranial compartment impacts on the optic nerve head as swelling of the optic disc and papilledema. However, papilledema evolves over time and may be a delayed manifestation, besides requiring a skilled observer for precise identification. Dilatation of the optic nerve sheath has been shown to be a much earlier manifestation of ICP rise.[1,2] The optic nerve sheath is fairly easy to visualize by ultrasonography by insonation across the orbit in the axial plane. A-mode ultrasonography was used to view the optic nerve sheath more than four decades ago; B-mode scanning was performed subsequently to assess intraocular lesions.[3] Evolution of ultrasound technology and the development of high frequency (> 7.5 MHz) linear probes with improved spatial resolution have enabled excellent views of the optic nerve sheath. The optic nerve sheath diameter (ONSD), measured at a fixed distance behind the retina has been evaluated to diagnose and measure intracranial hypertension in traumatic brain injury and intracranial hemorrhage.[4,5]

Shirodkar and colleagues[6], in the current edition of IJCCM, studied the efficacy of ONSD measurement by ultrasonography to predict intracranial hypertension. The case mix studied included meningoencephalitis, stroke, intracranial hemorrhage and metabolic encephalopathy. Using cut-off values of 4.6 mm for females, and 4.8 mm for males, they found a high level of sensitivity and specificity for the diagnosis of intracranial hypertension as evident on CT or MRI imaging.

There is wide variation reported in the optimal cut-off values, when ONSD was compared with invasive ICP monitoring, ranging from 4.8 to 5.9 mm.[7,8] In a study that tested the accuracy of ultrasonography with MRI scans, the maximum ONSD noted was as high as 6.4 mm among healthy volunteers. Opening cerebrospinal fluid (CSF) pressure on lumbar puncture has been compared to ONSD in previous studies; using a cut off of 5.5 mm, Amini *et al*. found a high sensitivity and specificity for ICP of >20 cm H_2O.[9] However, using similar methodology, Caffery *et al*. could not demonstrate a reliable estimate using a cut-off of 5.0 mm.[10] There seems to be considerable differences across studies

From:
Department of Critical Care Medicine, Sakra World Hospital, Bengaluru, Karnataka, India

Correspondence:
Dr. Jose Chacko, Sakra World Hospital, Varthur Hobli, Bengaluru - 560 037, Karnataka, India.
E-mail: chackojose@gmail.com

on the cut-off values used as well as the efficacy of ultrasonographic ONSD measurements to predict ICP. Besides, intra-and inter-observer variability needs to be considered with measurements down to a standard deviation of 0.1 mm.[11]

The current study adds to the body of knowledge that supports the use of ONSD as a bedside tool to diagnose intracranial hypertension in a general ICU setting. The investigators used neuroimaging to assess efficacy of ONSD, unlike previous studies[8,9] that sought correlation with lumbar CSF pressures. Despite its limitations, ultrasonographic ONSD measurement is likely to be more reliable than clinical assessment in the diagnosis of intracranial hypertension especially in situations, when an altered level of sensorium or administration of sedative medication precludes such assessment.[12] Neuroimaging, although helpful in arriving at a specific diagnosis, may not reveal elevated ICP at an early stage.[13] The obvious utility of bedside ultrasonography to assess intracranial hypertension must be tempered with the occurrence of wide variations in cut-off values reported, inter- and intra-individual variability in measurements and the requirement for adequate observer experience. Although no adverse effects have been reported with the optic nerve ultrasonography, there is a potential to cause harm through heating and cavitation of soft tissue,[14] besides possible damage from inadvertent application of excessive pressure. It would also make sense to cut down examination times to as low as possible.

Last but not the least, ONSD should not be considered in isolation, but must form part of a holistic approach towards the management of a patient with possible intracranial hypertension.

References

1. Hansen HC, Helmke K. Validation of the optic nerve sheath response to changing cerebrospinal fluid pressure: Ultrasound findings during intrathecal infusion tests. J Neurosurg 1997;87:34-40.
2. Helmke K, Hansen HC. Fundamentals of transorbital sonographic evaluation of optic nerve sheath expansion under intracranial hypertension. I. Experimental study. Pediatr Radiol 1996;26:701-5.
3. Gangemi M, Cennamo G, Maiuri F, D'Andrea F. Echographic measurement of the optic nerve in patients with intracranial hypertension. Neurochirurgia (Stuttg) 1987;30:53-5.
4. Geeraerts T, Merceron S, Benhamou D, Vigué B, Duranteau J. Non-invasive assessment of intracranial pressure using ocular sonography in neurocritical care patients. Intensive Care Med 2008;34:2062-7.
5. Moretti R, Pizzi B. Optic nerve ultrasound for detection of intracranial hypertension in intracranial hemorrhage patients: Confirmation of previous findings in a different patient population. J Neurosurg Anesthesiol 2009;21:16-20.
6. Shirodkar CG, Rao SM, Mutkule DP, Harde YR, Venkategowda PM, Mahesh MU. Optic nerve sheath diameter as a marker for evaluation and prognostication of intracranial pressure in Indian patients: An observational study. Ind J Crit Care Med 2014;18:728-734
7. Rajajee V, Vanaman M, Fletcher JJ, Jacobs TL. Optic nerve ultrasound for the detection of raised intracranial pressure. Neurocrit Care 2011;15:506-15.
8. Geeraerts T, Launey Y, Martin L, Pottecher J, Vigué B, Duranteau J, *et al.* Ultrasonography of the optic nerve sheath may be useful for detecting raised intracranial pressure after severe brain injury. Intensive Care Med 2007;33:1704-11.
9. Amini A, Kariman H, Arhami Dolatabadi A, Hatamabadi HR, Derakhshanfar H, Mansouri B, *et al.* Use of the sonographic diameter of optic nerve sheath to estimate intracranial pressure. Am J Emerg Med 2013;31:236-9.
10. Caffery TS, Perret JN, Musso MW, Jones GN. Optic nerve sheath diameter and lumbar puncture opening pressure in nontrauma patients suspected of elevated intracranial pressure. Am J Emerg Med 2014;S0735-6757 doi: 10.1016/j.ajem.2014.09.014.
11. Bäuerle J, Schuchardt F, Schroeder L, Egger K, Weigel M, Harloff A. Reproducibility and accuracy of optic nerve sheath diameter assessment using ultrasound compared to magnetic resonance imaging. BMC Neurol 2013;13:187.
12. Tayal VS, Neulander M, Norton HJ, Foster T, Saunders T, Blaivas M. Emergency department sonographic measurement of optic nerve sheath diameter to detect findings of increased intracranial pressure in adult head injury patients. Ann Emerg Med 2007;49:508-14.
13. Girisgin AS, Kalkan E, Kocak S, Cander B, Gul M, Semiz M. The role of optic nerve ultrasonography in the diagnosis of elevated intracranial pressure. Emerg Med J 2007;24:251-4.
14. Barnett SB, Ter Haar GR, Ziskin MC, Rott HD, Duck FA, Maeda K. International recommendations and guidelines for the safe use of diagnostic ultrasound in medicine. Ultrasound Med Biol 2000;26:355-66.

How to cite this article: Chacko J. Optic nerve sheath diameter: An ultrasonographic window to view raised intracranial pressure?. Indian J Crit Care Med 2014;18:707-8.

Source of Support: Nil, **Conflict of Interest:** None declared.