International Journal of Applied Research 2016; 2(8): 456-460

International Journal of Applied Research

ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 5.2
IJAR 2016; 2(8): 456-460
www.allresearchjournal.com
Received: 08-06-2016
Accepted: 09-07-2016

Dr. Chirag Patel
Associate Professor, Department of Emergency Medicine, B.J. Medical College, Ahmedabad, India

Dr. Samira Parikh
Professor & HOD, Department of Emergency Medicine, B.J. Medical College, Ahmedabad, India

Dr. Harshal Soni
3rd year resident, Department of Emergency Medicine, B.J. Medical College, Ahmedabad, India

Ultrasonographic measurement of optic nerve sheath diameter in head injury patients

Dr. Chirag Patel, Dr. Samira Parikh and Dr. Harshal Soni

Abstract
Introduction: The rapid recognition and timely treatment of elevated ICP is of paramount importance so that it could reduce morbidity and mortality, as well as improve patients' outcome. This study is trying to evaluate the diagnostic accuracy of sonographic optic nerve sheath diameter (ONSD) in detection of EICP.
Methods: Sonographic ONSD of patients with head trauma suspicious for EICP were evaluated by a trained resident of emergency medicine, who was blind to the clinical and brain computed tomography scan (CT) findings of patients. Immediately after ultrasonography, CT was performed and reported by an expert radiologist without awareness from other results of the patients. Finally, ultrasonographic and BCT findings regarding EICP were compared. To evaluate the ability of sonographic ONSD in predicting the BCT findings, receiver operating characteristic (ROC) curve were used. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (PLR), and negative likelihood ratio (NLR) of sonographic ONSD in determining of EICP was calculated. $P<0.05$ was considered to be statistically significant.
Results: There were 260 patients (84% male), with mean age of 41.2 $\pm$ 15.4 years. BCT showed signs of EICP, in 200 cases (76.92%). The means of the ONSD in the patients with EICP and normal ICP were 5.43 $\pm$ 0.55 and 4.75 $\pm$ 0.55 mm, respectively ($P<0.01$). Sensitivity, specificity, PPV, NPV, PLR, and NLR of ONSD for prediction of EICP were 94.34%, 93.75%, 98.52%, 78.52%, 13.42, and 0.06, respectively.
Conclusion: Sonographic diameter of optic nerve sheath could be considered as an available, accurate, and noninvasive screening tool in determining the elevated intracranial pressure in cases with head trauma.

Keywords: Intracranial pressure, traumatic brain injury, ultrasonography, optic nerve, tomography

1. Introduction

Optic nerve sheath diameter (ONSD) has been used to indirectly assess the intracranial pressure (ICP). Elevated intracranial pressure (EICP) is seen in head trauma, hydrocephalus, intracranial tumors, and cerebral edema. Head injury is the most common cause of road-traffic-related morbidity and mortality of all ages. Intractable elevated ICP can lead to death or devastating neurological damage either by reducing cerebral perfusion or by compressing and causing herniation of the brainstem or other vital structures [1].

Prompt recognition is crucial in order to intervene appropriately [2].

Outcomes tend to be good in patients with normal ICP, whereas those with elevated ICP are much more likely to have an unfavorable outcome. Elevated ICP carries a mortality rate of around 20% [10].

The rapid recognition of elevated ICP is therefore of obvious and paramount importance so that it can be monitored and so that therapies directed at lowering ICP can be initiated. A raised ICP is measurable both clinically and quantitatively [4].

There are some invasive, expensive or expert needed methods as lum-bar puncture, magnetic resonance imaging (MRI), and computed tomography scan (CT-scan) for detection of EICP. Physical examination is not always reliable and also, some signs of EICP such as pupil edema are late coming or hardly detected.

Correspondence
Dr. Chirag Patel
Associate Professor, Department of Emergency Medicine, B.J. Medical College, Ahmedabad, India

So, a reliable, accessible, easy to learn and noninvasive technique for this purpose, like Sonography, is of interest for clinician [5-9].

In this study, we prospectively evaluated the diagnostic accuracy of sonography for detecting EICP in a setting of emergency patients with head trauma.

2. Method

2.1 Study design

This was a single center prospective observational study done in Department of Emergency Medicine in a tertiary care hospital over a period of 18 months from May 2014 to November 2015. Total 260 patients were taken as per case definition. Patients and their relatives were explained about the study protocol. Informed written consent was taken from the relatives of the patient. Structured data forms were filled by the physician. Approval of the institutional Ethics committee was obtained prior to data collection.

2.2 Study setting

Ours is an urban Level 1 Trauma Center with an annual ED census of approximately 1, 20, 000 patients. Emergency Medicine Department is staffed full-time with EM residents and attending physicians.

2.3 Inclusion Criteria

All patients presenting to the Emergency Medicine Department -

1. with suspected intracranial injury
2. With possible elevated intracranial pressure.

2.4 Exclusion Criteria

1. Age younger than 18 years or
2. Obvious ocular trauma.

2.5 Study Protocol

Initial assessment of all patients presented to emergency department (ED) was done. Among them patients as per case definition were resuscitated and managed. We did ultrasonography before awareness from the result of BCT to prevent diagnostic suspicious bias. Ultrasongraphies of the optic nerve was performed by 3rd year resident of emergency medicine who was trained for measurement of ONSD by a radiologist.

2.6 Description of ONSD Ultrasound

2.6.1 Patient position: The patient is positioned in 30^{o} dorsal elevation (head up).

2.6.2 Probe position: A high-resolution 7.5 to 10 MHz linear transducer was used to perform the ocular US examination. It was done using a closed-eye technique. A large amount of standard water-soluble US gel was applied to the patient's closed eyelid so that the transducer does not touch the eyelid. Without applying any pressure, the globe was scanned in sagittal and transverse planes. The scanning hand was stabilized over the bridge of the nose or on the forehead. Both eyes were scanned through closed eyelids for comparison. The eye was examined under the closed eyelid in the neutral position and during gentle eye movements from side to side and up and down to thoroughly evaluate the orbit. The probe was moved side to side in both scanning planes to demonstrate the full extent of the structures in the eye. Depth was appropriately adjusted so that the image fills the screen. Gain was also adjusted multiple times during the examination to identify subtle abnormalities and avoid artifacts [1].

Fig 1: Probe position for performing ONSD measurement

The ONSD measurement was obtained 3 mm posterior to the globe for both eyes, perpendicular to the optic nerve axis. For each optic nerve, 2 measurements were taken: 1 sagittal and 1 transverse [1]. First measurement was taken when the patient presented to the Emergency medicine Department. The other measurement was taken 6 hours after presentation.

* A mean binocular optic nerve sheath diameter greater than 5.00 mm in adults was considered to be abnormal [1].

2.7 Statistical Analysis

A structured data collection form was developed prior to the collection of prospective data. All data collection was done by a single abstractor, with quality review of selected charts. Collected data was entered into a Microsoft Excel database. Data were expressed and analyzed by Epi-Info software Version 7.0. The ONSD measurements were compared with the CT scan. Computed tomography (CT) findings defined as indicative of EICP were: the presence of mass effect with a midline shift 3 mm or more, a collapsed third ventricle, hydrocephalus, the effacement of sulci with evidence of significant edema, and abnormal mesencephalic cisterns.

All data are expressed as mean $\pm$ standard deviation, unless otherwise specified. The average ONSD between the two eyes was used for analysis. The performance of ultrasonographic optic nerve sheath diameter measurement for the detection of EICP was compared to the gold standard CT using Kappa agreement test. Kappa value <0.4 indicates low agreement while a value >0.75 indicates close agreement with the gold standard. P value less than 0.05 was considered as statistically significant. Estimates of sensitivity, specificity, positive predictive value, negative predictive value and likelihood ratios were calculated for US ONSD vs. CT and then compared by Chi-square test. A scatter plot was produced to examine ONSD and GCS. Student's t-test was used to compare the study patients and ONSD measurements with GCS greater or less than 10. P-0.001 was regarded as significant.

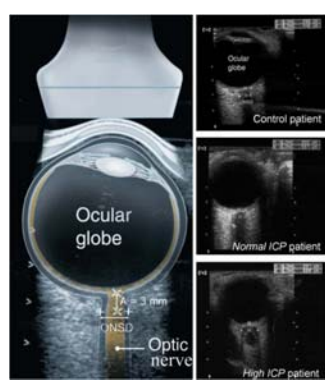

Fig 2: Optic Nerve Sheath Diameter Measurement

3. Results

ONSD was performed in 260 patients presenting with Head Injury to Emergency Department between May 2014 and November 2015 with mean age of 41.2 ± 15.4 years. A summary of patients' demographic data is presented in table 1. The commonest mode of injury was Road traffic accidents (RTA), 186 (71.5%) patients. On presentation, 234 (90%) patients presented with Loss of consciousness as the most common complaint. Maximum number of patients presented to ED within 1 hour, 118 (45.38%) patients. Glasgow Coma Scale was <8 in majority 126 (48.4%) patients, between 8 and 13 in 57 (21.9%) patients and more than 13 in 77 (29.6%) patients. On ONSD, findings in Right eye on presentation were 5.42 ± 0.55 mm, after 6 hours 5.49 ± 0.57 mm. In Left eye, on presentation 5.45 ± 0.55 mm, after 6 hours 5.51 ± 0.58 mm. Mean ONSD was 5.43 ± 0.55 mm.

Table 1: Comparison of ONSD with CT scan findings

		BCT findings		
Characteristics	**Total**	**Negative**	**Positive**	**P value**
Age	41.2 ± 15.4	35.64 ± 15.5	42.54 ± 13.5	0.5
GCS	11.3 ± 3.7	14.33 ± 0.35	7.89 ± 3.67	<0.001
Left ONSD	5.45 ± 0.55	4.74 ± 0.54	5.61 ± 0.54	<0.001
Right ONSD	5.42 ± 0.55	4.76 ± 0.56	5.57 ± 0.56	<0.001
Mean ONSD	5.43 ± 0.55	4.75 ± 0.55	5.58 ± 0.55	<0.001

In addition, positive and negative predictive values were 98.52% and 78.52% respectively. Positive and negative likelihood ratios of ONSD for detection of EICP were 13.42 and 0.06 respectively.

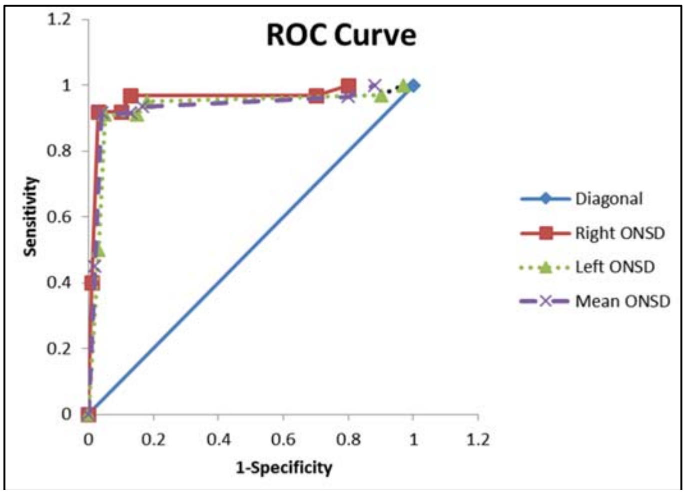

Fig 3: Receiver operator characteristic (ROC) curve at various thresholds of optic nerve sheath diameter

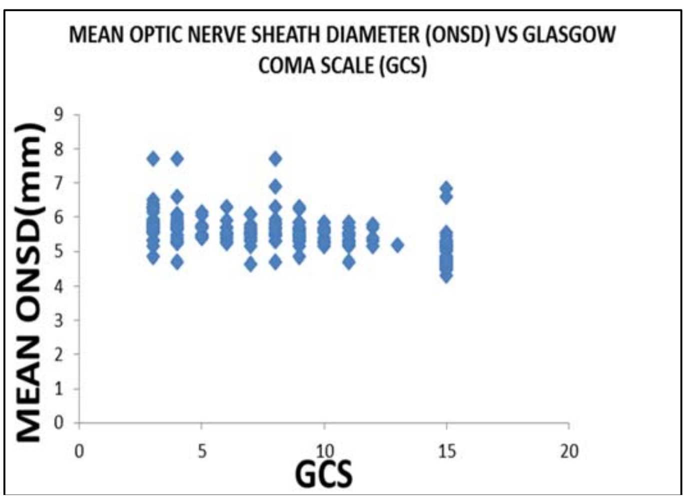

Fig 4: Mean Optic Nerve Sheath Diameter (ONSD) vs Glasgow Coma Scale (GSC)

In our study, Kappa index for ONSD findings was 0.821 indicating ONSD findings show very good correlation with CT scan findings for detecting raised intracranial pressure.

4. Discussion

Based on the main result of this study, ONSD had acceptable sensitivity, specificity, NPV, and PPV for detection of EICP at cut-off value of 5mm. During last decades, many studies have shown that the ONSD can noninvasively predict the EICP [8, 14]. One study has shown that increase of ONSD in cases with EICP occurs faster than any other ophthalmoscopic finding [7]. However, technique, accuracy, and cut off for detecting EICP are different be among these studies. Girisgin *et al* showed that mean OND in patients suspected to have EICP is significantly higher than the healthy subjects. The results of similar studies in emergency setting or ICU are summarized in table 2. As other studies have shown, optic nerve sonography has technical limitations and requires a high level of expertise [6]. Sonography may be impossible to perform because of superficial surgical wounds or severe anatomic alterations in patients with head trauma. Moreover, we should consider that BCT signs not always correspond to real elevation of the intracranial pressure.

Table 2: Summary of similar studies Study

	Sample	Study population	Cut off, gold standard	Sensitivity	specificity
Lee *et al* USA 2009	68	Cases with suspected or con-firmed increased ICP, presenting to the ED or ICU of an urban, academic, freestanding, tertiary-level children's hospital, 0-18 years	ONSD was considered in-creased when it was >4 mm in infants <1 year or >4.5 mm in children >1 year, CT-scan/ventriculostomy/ lum-bar puncture	96%	48%
Kimberly *et al* USA, 2008	15	adult patients in both the ED and the neurologic ICU who had in-vasive intracranial monitors placed as part of their clinical care, > 18 years old	ONSD > 5 mm, invasive intra-cranial monitors	88%	93%
Karakitsos *et al* Greece, 2006	54	patients with brain injury (GCS < 8), 40 ±18.6	OND > 5.9 mm, CT-scan	74%	65%
Blaivas *et al* USA, 2003	14	ED patients with a suspicion of EICP due to possible focal intra-cranial pathology, > 18 years old	ONSD > 5 mm, CT-scan	100%	95%
Bäuerle *et al* Germany, 2011	10	patients with idiopathic intra-cranial hypertension, ≥18 years old	ONSD > 5.8 mm, measuring the CSF opening pressure by lumbar puncture	90%	84%
Geeraerts *et al* France, 2008	37	adult patients requiring sedation and ICP monitoring after severe traumatic brain injury, sub-arachnoid hemorrhage, intracranial hematoma, or stroke, 18–76 years	ONSD > 5.86 mm, invasive measurement ICP via a parenchymal Device	95%	79%
Geeraerts *et al* UK, 2008	38	patients requiring ICP monitor-in after severe traumatic brain injury, 35 ± 14	ONSD > 5.82 mm,	90%	92%
Tayal *et al* USA, 2007	59	adult ED patients with suspected intracranial injury with possible elevated intracranial pressure without obvious ocular trauma, > 18 years old	OND > 5 mm, CT-scan	100%	63%
Soldatos *et al* Greece, 2008	76	critical care patients, > 18 years old	ONSD > 5.7 mm, invasive ICP measurement using an intra-parenchymal catheter	74%	100%
Major *et al* UK, 2011	26	adult patients who required CT from the ED, > 18 years old	ONSD > 5 mm, CT-scan	86%	100%
Our Study	260	Head injury patients presenting to the ED	OND > 5 mm, CT-scan	94.34%	93.75%

ED: emergency department, CT: computed tomography, GCS: Glasgow Coma Scale, ICP: intracranial pressure, ICU: intensive care unit, OND: optic nerve diameter, ONSD: optic nerve sheath diameter, mm: millimeter

5. Conclusion

Sonographic diameter of optic nerve sheath could be considered as an available, accurate, and noninvasive screening tool in determining the elevated intracranial pressure in cases with head trauma.

6. References

1. 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(4):508-14.
2. Major R, Girling S, Boyle A. Ultrasound measurement of optic nerve sheath diameter in patients with a clinical suspicion of raised intracranial pressure. Emerg Med J. 2011; 28(8):679-81.
3. 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(11):2062-7.
4. Blaivas M, Theodoro D, Sierzenski PR. Elevated intracranial pressure detected by bedside emergency ultrasonography of the optic nerve sheath. Acad Emerg Med. 2003; 10(4):376-81.
5. Kimberly HH, Shah S, Marill K, Noble V. Correlation of optic nerve sheath diameter with direct measurement of intracranial pressure. Acad Emerg Med. 2008; 15(2):201-4.
6. Soldatos T, Karakitsos D, Chatzimichail K, Papathanasiou M, Gouliamos A, Karabinis A. Optic

nerve sonography in the diagnostic evaluation of adult brain injury. Crit Care. 2008; 12(3):R67.
7. 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(4):251-4.
8. Hansen HC, Helmke K. The subarachnoid space surrounding the optic nerves. An ultrasound study of the optic nerve sheath. Surg Radiol Anat. 1996; 18:323-8.
9. Amini A, Kariman H, Arhami Dolatabadi A. Use of the sonographic diameter of optic nerve sheath to estimate intracranial pressure. The American Journal of Emergency Medicine. 2012; 31(1):236-9.
10. Karakitsos D, Soldatos T, Gouliamos A. Transorbital Sonographic Monitoring of Optic Nerve Diameter in Patients With Severe Brain Injury. Transplant Proc. 2006; 38(10):3700-6.
11. Bratton SL, Chestnut RM, Ghajar J. Guidelines for the management of severe traumatic brain injury. Indications for intracranial pressure monitoring. J Neurotrauma Brain Trauma Foundation; American Association of Neurological Surgeons; Congress of Neurological Surgeons; Joint Section on Neurotrauma and Critical Care, AANS/CNS 2007; 24(1):S37-S44.
12. Seestedt RC, Frankel MR. Intracerebral hemorrhage. *Curr Treat Options Neurol.* 1999; 1:127-137.
13. Geeraerts T, Launey Y, Martin L. Ultrasonography of the optic nerve sheath may be useful for detecting raised intracranial pressure after severe brain injury. *Intensive Care Med.* 2007; 33:1704-1711.
14. Hansen HC, Helmke K. Validation of the optic nerve sheath response tochanging cerebrospinal fluid pressure: ultrasound findings during intrathecal infusion tests. J Neurosurg. 1997; 87:34-40.
15. Ghajar J. Traumatic brain injury. Lancet. 2000; 356:923-929.
16. Helmke K, Hansen HC. Fundamentals of transorbital sonographic evaluation of optic nerve sheath expansion under intracranial hypertension. II. Patient study. *Pediatr Radiol.* 1996; 26:706-710.
17. 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.
18. 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.
19. Rajajee V, Vanaman M, Fletcher JJ, Jacobs TL. Optic nerve ultrasound for the detection of raised intracranial pressure. Neurocrit Care 2011; 15:506-15.
20. 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.