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Optic Nerve Sheath Diameter as an Early Prognosticating Marker in Predicting outcome of Patients with Raised Intracranial Pressure

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Abstract

Patients suffering Brain injury commonly develop Elevated intracranial pressure (EICP) . We need an easy, reproducible method to detect EICP earlier. *Objectives:* Measurement of optic nerve sheath diameter (ONSD) to identify earlier, the development of EICP. *Methods:* We did a prospective, blinded observational study in our Institute emergency department (ED) on patients with possible EICP due to brain injury over a 6 months period. ONSD was measured 3mm behind the globe by using a 10 MHz linear probe on both the eyelids of supine patients. An upper limit value of above 4.5 mm was taken as abnormally high. Brain Computed tomography (BCT) indicative of EICP were a midline shift of 3 mm or more, effacement of sulci, presence of significant edema, and effaced cisterns. Student's t test analyzed ONSDs in the normal and EICP groups and necessary values were documented separately for each patient. *Results:* Forty four patients in total were included in the study group. CT Brain showed features of raised ICP in 24 of them. All these patients were correctly identified by ONSD measurement with over 4.5 mm on USG. The sensitivity was 100%. Specificity was 95%. The positive predictive values were 93%. Negative prediction was 100%. *Conclusions:* USG measurement of ONSD is good and a possible bedside alternative in the early identification of EICP.

Keywords: Brain Injury; Computerized Tomography; Intracranial Pressure; Ultrasonography.

Introduction

Brain injury related disability and death is high among general population particularly in the younger age group [1], due to Elevated intracranial pressure (EICP). Patient outcome is poor in a scenario of delay in identifying EICP [2]. Early identification and managing EICP will help in reduction of disability as well as death. Magnetic resonance imaging (MRI), and computed tomography scan (CT-scan) detect EICP [3], but are not bedside tests. Pure clinical criteria is ambiguous and often leads to delay in identification [4]. ONSD is an easy to do, affordable, bedside test with fast and accurate results to identify EICP earlier than other imaging modalities. Several brain injury care centers world over have analyzed the usefulness and effectiveness of ONSD in an Accident and trauma setup [5-9]. Their results however are not suited for all groups of patients. Our attempt here is to analyze the predictive capability of ONSD to identify EICP earlier and at the bedside. This test that can be reproduced any number of times as needed and maybe useful also to continuously and serially monitor in brain injury subjects. If possible, to formulate an acceptable upper limit values for ONSD to detect EICP earlier than computed tomography scan (CT) or MRI.

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Materials and Methods

Study Design

In this prospective study, we included 44 patients with a possible diagnosis of EICP based on clinical picture, admitted to the Neurosurgical trauma ward, Institute of Neurosurgery, Madras Medical College and the associated, Rajiv Gandhi Government General Hospital over a period of 6 months. The study was

presented to, discussed and approved by the college Ethics Committee. Informed written consent and willingness to participate in the study was obtained from the attendants of patients, since self consent was not possible due to altered sensorium of the patients included in the study.

Participants

All patients with midline shifts in CT brain and all the patients with a GCS less than or equal to 12 /15 with or without midline shifts were included in the study. Patients with GCS above 12/15 and without midline shifts were excluded from the study.

Intervention

NSD values of both eyes for each patient was documented by ultrasonography before performing CT brain. All patients with traumatic brain injury satisfying the inclusion criteria were subjected to CT scan at the time of admission, immediately after surgery if surgery was performed and at the time of discharge. With each CT scan, the corresponding optic nerve sheath diameter is measured and the results were correlated with the outcome and midline shift. Ultrasonography was done before CT to avoid bias in identifying raised ICP. A 10 MHz linear transducer sized 5.5×1cm was used to measure ONSD with the subjects placed in supine position and eyes closed after careful application of appropriate recommended gel with utmost care. Optic nerve sheath was delineated 3 mm before it entered the globe. The ONSD was calculated as the distance between 2 cursors placed perpendicular to the longitudinal axis at that point for both optic nerves separately. The mean ONSD was the average of both right and left eye values. BCT was done and reported by an expert radiologist who was blinded of the ONSD value and documented as suggestive of raised intra cranial pressure or not suggestive of EICP. A master chart was prepared to analyze the predictive quotient of ONSD as against CT in early detection of raised ICP.

Statistical Analysis

Mean and standard deviation were documented. The relationship of GCS with ONSD was assessed using Pearson correlation coefficient. To find the usefulness of ONSD in early identification of raised ICP, and to predict a critical upper limit value of ONSD, receiver operating characteristic (ROC) curve was analyzed and documented. Sensitivity and specificity were determined. Positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (PLR), and negative likelihood ratio (NLR) were calculated. A $p\ value < 0.05$ was taken as statistically significant. We used SPSS version 11.0 statistical software for statistical analysis.

Results

There were a total of 44 patients (84.1% male, 15% female), with mean age of 29.90 years (range: 9-80 years) in this study group. BCT findings confirmed EICP in 27 subjects (61.3%). Among cases with GCS less than or equal to 12,13 patients (29.5%) also had features suggestive of raised ICP in CT. The mean ONSD of bilateral eyes were 4.2±0.8 in left side and 4.1±0.8 on right eye, with a p = 0.41. The mean diameter of the optic nerve sheath of the two eyes was 4.1±0.8 mm and interestingly, patient age (p=0.99) and gender (p=0.19) did not have a significant association with this finding. The mean ONSD in the patients with EICP was 5.5±0.56. Patients without significantly elevated ICP had a mean value of 3.93±0.53 mm with a P value <0.0001. GCS had an inverse relation to right (r=-0.37, p<0.001), left (r=-0.26, p<0.001) and mean ONSD (r=-0.33, p<0.001). Roc Sensitivity for early identification of EICP was 96.4% (95% CI: 83.9-99.8). Specificity was 95.3% (95% CI: 90.4-99.9). Positive predictive values of 72.2% (95% CI: 67.4-79.2) and negative predictive value of 98.9% (95% CI: 95.8-99.8) were found.

Discussion

In our study, ONSD as a bedside method to identify EICP early, had a fairly accurate sensitivity, specificity, Negative Prediction Value, and Positive Prediction Value. An upper limit value of 4.5 mm ONSD is a reasonable prediction based on our results; however we intend to continue with this study to further validate this value. The chance of any patient developing EICP if ONSD is less than 4.5 mm is 0.04. This Low Positive Prediction Value in this study, is due to low number of CT identified raised ICP, even though we had high scores for sensitivity as well as specificity.

Several studies have documented that ONSD can predict EICP earlier than other bedside tests and clinical findings [13-15]. High value of ONSD in cases with EICP happens earlier than other ocular signs [16]. Each study had promulgated different upper limit values for early identification of EICP. Girisgin et al. have shown mean ONSD in patients with EICP is higher than normal population [17]. An Iranian

study showed that children with EICP had significantly larger mean ONSDs [7].

It seems possible that, we can arrive at a reasonable upper limit ONSD value to identify EICP earlier in different types of patient population , with different types of pathology irrespective of their gender and age, that may alter the value of OND and ONSD. At the same time it is also important to note that the Negative prediction of EICP is harmless.

Optic nerve sonography is an easy and an effective bedside examination which does not require an expert to perform [18]. The learning curve is short. Reproducibility quotient is very high. Sonographic ONSD measurement could be made available in all emergency medical setups cost effectively also. However it could not be performed in a small subset of patient population with structural damage to the region of interest. But in future it should be considered as an effective means of identifying raised ICP even as the patient is being transported to the emergency setup. It could alert the emergency ward about the arrival of a patient with raised ICP

Conclusion

USG measurement of ONSD is an easy to perform , cost effective , repeatable, accurate, noninvasive bedside tool useful in the earlier identification of Elevated intracranial pressure in patients of Brain injury. It can be used to serially measure and monitor the effectiveness of ICP control measures. It can be performed at the scene of accident or en-route to the Accident and emergency care centre, and can be used to alert the trauma care physician about the impending arrival of a patient with raised ICP.

References

1. Montazeri A. Road-traffic-related mortality in Iran: a descriptive study. Public Health. 2004;118(2):110–3. [PubMed].
2. Vahedi K, Hofmeijer J, Juettler E, et al. Early decompressive surgery in malignant infarction of the middle cerebral artery: a pooled analysis of three randomised controlled trials. The Lancet Neurology. 2007;6(3):215–22. [PubMed].
3. Sankhyan N, Vykunta Raju KN, Sharma S, Gulati S. Management of raised intracranial pressure. Indian J Pediatr. 2010;77(12):1409–16. [PubMed].
4. Tuite GF, Chong WK, Evanson J, et al. The effectiveness of papilledema as an indicator of raised intracrani al pressure in children with craniosynostosis. Neurosurgery. 1996;38(2):272–8. [PubMed].
5. Hamilton DR, Sargsyan AE, Melton SL, et al. Sonography for determining the optic nerve sheath diameter with increasing intracranial pressure in a porcine model. J Ultrasound Med. 2011;30(5):651–9. [PubMed].
6. Le A, Hoehn ME, Smith ME, Spentzas T, Schlappy D, Pershad J. Bedside sonographic measurement of optic nerve sheath diameter as a predictor of increased intracranial pressure in children. Ann Emerg Med. 2009;53(6):785–91. [PubMed].
7. Akhavan Malayeri A, Bavarian S, Mehdizadeh M. Sonographic evaluation of optic nerve diameter in children with raised intracranial pressure. J Ultrasound Med. 2005;24(2):143–7. [PubMed].
8. Karakitsos D, Soldatos T, Gouliamos A, et al. Transorbital Sonographic Monitoring of Optic Nerve Diameter in Patients With Severe Brain Injury. Transplant Proc. 2006;38(10):3700–6. [PubMed].
9. Lagrèze WA, Lazzaro A, Weigel M, Hansen HC, Hennig J, Bley TA. Morphometry of the retrobulbar human optic nerve: comparison between conventional sonography and ultrafast magnetic resonance sequences. Invest Ophthalmol Vis Sci. 2007;48(5): 1913–7. [PubMed].
10. Amini A, Kariman H, Arhami Dolatabadi A, et al. Use of the sonographic diameter of optic nerve sheath to estimate intracranial pressure. The American Journal of Emergency Medicine. 2012;31(1):236–9. [PubMed].
11. Ballantyne SA, O'Neill G, Hamilton R, Hollman AS. Observer variation in the sonographic measurement of optic nerve sheath diameter in normal adults. Eur J Ultrasound. 2002;15(3):145–9. [PubMed].
12. Karim S, Clark RA, Poukens V, Demer JL. Demonstration of systematic variation in human intraorbital optic nerve size by quantitative magnetic resonance imaging and histology. Invest Ophthalmol Vis Sci. 2004;45(4):1047–51. [PubMed].
13. 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. [PubMed].
14. 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. [PubMed].
15. Skalka HW. Neural and dural optic nerve measurements with A-scan ultrasonography. South Med J. 1978;71:399–400. [PubMed].
16. Gangemi M, Cennamo G, Maiuri F, D'Andrea F. Echographic measurement of the optic nerve in patients with intracranial hypertension. Neurochirurgia (Stuttg) 1987;30(2):53–5. [PubMed].
17. 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. [PMC free article][PubMed].

18. 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. [PMC free article] [PubMed].