

EVALUATION OF OPTIC NERVE SHEATH DIAMETER MEASUREMENT AND OPTIC FUNDI EXAMINATION DONE IN ED TO DETERMINE THE RAISED INTRACRANIAL PRESSURE IN ADULTS IN ACUTE TRAUMA SETTING.

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ABSTRACT: Study objective: The objective of the present study is to determine whether a bedside ultrasonographic measurement of optic nerve sheath diameter and optic fundus examination can accurately predict the computed tomographic (CT) findings of elevated intracranial pressure in adult head injury patients in the emergency department (ED).

METHODS: We conducted a prospective, blinded observational study on adult ED patients with suspected intracranial injury with possible elevated intracranial pressure. Exclusion criteria were age younger than 18 years or obvious ocular trauma. All patients underwent fundus examination by a single examiner immediate and after 6 hours of admission. Using a 7.5-MHz ultrasonographic probe on the closed eyelids, a single optic nerve sheath diameter was measured 3 mm behind the globe in each eye. A mean binocular optic nerve sheath diameter greater than 5.00 mm was considered abnormal.

Cranial CT findings of shift, edema, or effacement suggestive of elevated intracranial pressure were used to evaluate optic nerve sheath diameter accuracy. **RESULTS:** 200 patients were studied during the study period of 2 years from 2011-2012. Average age was 38 years, and mean Glasgow Coma Scale score was 9. 22 patients with an optic nerve sheath diameter of 5.6 mm or more had CT findings that correlated with elevated intracranial pressure. The sensitivity for the ultrasonography in detecting elevated intracranial pressure was 100% (95% confidence interval [CI] 68% to 100%) and specificity was 63% (95% CI 50% to 76%). Fundus examination in these 22 patients found to have poor correlation with the CT findings of elevated intracranial pressure with low sensitivity of 64% (95% confidence interval [CI] 56% to 80%) and specificity of only 64% (95% CI 50% to 76%). **CONCLUSION:** Bedside ED optic nerve sheath diameter ultrasonography has potential as a sensitive screening test for elevated intracranial pressure in adult head injury. However fundus examination was not found to be sensitive screening test in these conditions.

KEY WORDS: ONSD, optic nerve sheath diameter, fundus examination, ICT, Emergency Medicine

INTRODUCTION: The recognition that elevated intracranial pressure (ICP) is transmitted through the optic nerve and its sheath has been known for many years. This physiological process is the basis for the physical exam finding of papilledema on fundoscopic examination. Recently, interest has turned to measurement of the optic nerve sheath diameter (ONSD) through non-invasive imaging technologies to provide surrogate markers for early elevated ICP.

We are among the first centres in India running the Medical Council of India recognized Emergency Medicine academic program. We do receive a lot trauma patient. We do emergency ultrasound, as it is easily available and mandatory as per MCI guidelines as well. Hence we studied both these parameters to judge raised Intra Cranial Pressure (ICT) in acute trauma settings in adult victims.

MATERIALS AND METHODS:

STUDY DESIGN: We conducted a prospective, blinded, observational study on adult ED patients suspected of having elevated intracranial pressure as a result of acute head trauma. Patients or their representatives were provided informed consent before their inclusion in the study.

SETTING: This research was conducted at a large, urban, regional, teaching ED and Level I trauma center.

All adult patients presenting to the ED with suspected acute head injury were eligible for the study. Exclusion criteria included age younger than 18 years, patients with obvious bilateral ocular trauma, or enrolment delaying or interfering with formal diagnostics or interventions. Patients suspected of having acute intracranial injury who were scheduled to undergo head CT were enrolled in the study when a participating ED physician was available. The treating physician was asked for his assessment of the patient's intracranial pressure according to physical examination alone. Immediately and after 6 hours, all patients underwent Fundus examination by a single examiner to avoid observational bias.

METHODS OF MEASUREMENT: All enrolling study physicians were emergency physicians. A study physician scanned both eyes, using a 7.5-MHz linear probe on the closed eyelids of all study patients. If one eye was injured or was known to be artificial, only a uniocular optic nerve sheath diameter measurement was made over the unaffected eye. 'SonoSite' ('Micromax') gray-scale ultrasonographic machines were used for ultrasonographic measurements. Ultrasonography was performed by using the following protocol described in the literature.

All patients were examined in the supine position. The linear probe was placed lightly over the closed upper eyelid(s) of the patient. The structures of the eye were visualized to align the optic nerve directly opposite the probe, but with the optic nerve sheath diameter width perpendicular to the vertical axis of the scanning plane

(Figure 1 A). A single optic nerve sheath diameter was measured 3.00 mm behind the globe (Figure 1 B) in each eye, and then the optic nerve sheath diameter measurements from each eye were averaged to create a binocular optic nerve sheath diameter measurement. A binocular optic nerve sheath diameter or uniocular measurement in those with one eye measurement (see above) greater than 5.00 mm was considered abnormal.

A CT scan of the head was performed on all patients, and the results were evaluated by an on-site radiologist blinded to the optic nerve sheath diameter ultrasonographic results. The patient's CT scan result was considered to be positive for ICP if the radiologist's reading

ORIGINAL ARTICLE

described findings suggestive of elevated intracranial pressure previously suggested in the literature, namely, significant edema, midline shift, mass effect, effacement of sulci, collapse of ventricles, or compression of cisterns².

PRIMARY DATA ANALYSIS : Ultrasonographic measurements, patient demographics, fundus examination and cranial CT results were entered into a relational database (Microsoft Access; Microsoft Corp., Redmond, WA). Sensitivity and specificity of mean binocular optic nerve sheath diameter (using 5.00 mm as the cutoff point) and optic fundi findings (consistent with raised papilloma) for detection or exclusion of elevated intracranial pressure were calculated using the radiologist's reading of the CT as the criterion standard for presence or absence of elevated intracranial pressure. Corresponding 95% confidence intervals (CIs) were calculated.

RESULTS: 200 patients were enrolled in the study, with an average age of 34 +/- 17 (SD) years, with 72% male sex. Most of our patients were motor vehicle crash patients (70%), but other mechanisms of injury were represented, including falls (11%), blunt assault (8%), and penetrating assault (8%).

The sensitivity for the mean binocular optic nerve sheath diameter ultrasonography in detecting elevated intracranial pressure was 100% (95% CI 68% to 100%), and the specificity was 63% (95% CI 50% to 76%).

Fundus examination in these 22 patients did not correlate well with the CT findings of elevated intracranial pressure with low sensitivity of 64% (95% confidence interval [CI] 56% to 80%) and specificity of only 64% (95% CI 50% to 76%). Hence, papilledema in acute elevation of ICP is an uncommon event. Its absence does not preclude the presence of ICP elevation.

LIMITATIONS: The study centre physicians were experienced with ultrasonography in the emergency setting, and those centers with less experience may find varying results.

Fundus examination of papilledema is also subjective and it takes time to develop in trauma setting, hence it may a poor marker of the same.

The criterion standard used as follow-up and comparison with the optic nerve sheath diameter ultrasonography is not a direct measurement of ICP. Direct measurement of ICP is an unrealistic and aggressive requirement, especially for patients with minor head injury. As a surrogate, head CT in the setting of acute trauma has shown limited accuracy in the identification and exclusion of elevated intracranial pressure in several published studies.

DISCUSSION: The evaluation of the head injury patient with elevated intracranial pressure in the setting of multiple trauma presents significant challenges. Most head injury patients have concomitant injuries that require detection and treatment¹.

Findings of severe head injury can be various and nonspecific. The findings of severe head injury with elevated intracranial pressure often alter the treatment for trauma patients².

Such decisions include transfer to the operating room versus the CT suite, treatment with medications such as mannitol, and placement of intracranial pressure monitors or drainage catheters^{3,10}.

There is no means of detecting elevated intracranial pressure in a rapid, non-invasive, bedside manner, with the exception of the physical examination. Unfortunately, the ability to detect elevated intracranial pressure by examination alone is difficult and inexact. Additionally,

ORIGINAL ARTICLE

the limitations increase significantly if the patient is unconscious, sedated, or paralyzed and intubated⁴.

Altered respiratory patterns from increasing ICP are extremely variable⁵. Papilledema and pupillary changes are late findings that can take hours to appear⁶. Performing a lumbar puncture during the trauma resuscitation is not feasible and, at worst, could be dangerous for the patient. Although cranial CT is available to most physicians in the US emergency practice environment, cranial CT requires both time and transport away from the monitoring or resuscitative resources of the emergency or critical care suite.

This study suggests that a bedside sonographic test performed by the treating physician can rule out elevated ICP. This study also suggests that fundus findings are late to develop and has very low sensitivity and specificity to rule out raised ICP.

We suggest that optic nerve sheath diameter offers further tools for physicians who treat head injury beyond physical examination and GCS. The fact that optic nerve sheath diameter had a reasonable sensitivity for any traumatic head injury suggests the need for further research in other settings and age ranges for the evaluation, stratification, and possible acute treatment of head injury.⁷

Those with bedside sonographic experience may be able to learn this technique relatively quickly⁸.

The practical extension of the study results, if validated in larger studies, is that with small portable sonographic machines, the evaluation of the head injured patient for elevated intracranial pressure could possibly occur with triage and management implications. In the setting of disaster or simultaneous multiple trauma patients, a rapid bedside test would be helpful.

The ability to rule out elevated intracranial pressure among several unconscious victims would help select the person most in need of rapid transport to an appropriate facility. Portable ultrasonography could be used during long transport times to better monitor acutely ill patients and institute treatment protocols for possible elevated intracranial pressure. Monitoring of hospitalized patients with elevated intracranial pressure would be assisted by such a test, as the movement of such patients requires tremendous expenditure of nursing and hospital resources.

Bedside ED optic nerve sheath diameter ultrasonography has potential as a sensitive screening test for elevated intracranial pressure in adult head injury^{10, 11}. Further work using optic nerve sheath diameter in these patients and other elevated intracranial pressure patients is warranted.

Some research on MRI measured optic nerve sheath diameter to evaluate raised ICT is also going on and showing promising result. But feasibility is a question¹².

CONCLUSION: Currently, non-invasive assessments of ICP do not obviate the need for invasive ICP monitoring. Invasive monitoring detects minute to minute variations in ICP and, in the case of intraventricular drains, can also be therapeutic. However, non-invasive screening tests like ONSD measurement with ultrasound may be useful in selected cases of acute traumatic brain injury.

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