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Original Research Article

B-scan measurement of optic nerve sheath diameter as a marker of elevated intracranial pressure

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ABSTRACT

Background: Elevated intracranial pressure is a complication of several traumatic as well as non-traumatic medical conditions. Clinical diagnosis can be difficult as it may present with non-specific complaints such as headache, vomiting, blurred vision, vomiting and altered sensorium. The expertise to perform ophthalmoscopy is not always immediately available in emergency rooms and the access to cross sectional imaging may be limited. Distention of the optic nerve sheath is an early sign of raised ICP as it is in direct communication with the subarachnoid space. Ultrasound is a widely available tool in emergency situations which can be used to measure the optic nerve sheath diameter (ONSD).
Methods: In this prospective observational study, 36 patients suspected of having elevated intracranial pressure underwent high resolution B-scan ultrasound to measure the ONSD. Further, patients underwent CT scan of head and were evaluated for signs of raised ICT. Sensitivity and specificity of B-scan measurement of ONSD with CT scan was compared.
Results: The ONSD measurement was 88.5% sensitive (95% CI 68% to 97%) and 90% specific (95% CI 55% to 99%) with CT as the reference.
Conclusions: Bedside ultrasound B-scan measurement of the optic nerve sheath diameter provides information about raised intracranial pressure with a high sensitivity and specificity.

Keywords: B-scan ultrasound, Elevated intracranial pressure, Optic nerve sheath diameter

INTRODUCTION

Elevated intracranial pressure is a common condition encountered in the emergency room and is often difficult to diagnose clinically as it presents with a variety to non-specific signs and symptoms.

Ultrasound is a readily available portable bed side imaging modality available to physicians which can be used to visualize the proximal portion of the optic nerve for detection of elevated intracranial pressure. Elevated intracranial pressure is a complication of several traumatic as well as non-traumatic medical conditions. Clinical diagnosis can be difficult as it may present with non-specific complaints such as headache, vomiting, blurred vision, vomiting and altered sensorium.[1] Distention of the optic nerve sheath is an early sign of raised ICP as it is in direct communication with the subarachnoid space.[2]

The objective of this study was to determine the sensitivity and specificity of ultrasound B scan measurement of optic nerve sheath diameter (ONSD) as a marker of elevated intracranial pressure with CT scan as imaging standard.

METHODS

A prospective observational study designed from 1st January to 30th June 2015. Study conducted in Emergency room at Dr. Ram Manohar Lohia Institute of Medical Sciences, Lucknow, Uttar Pradesh, India.

Adult cases presenting in the emergency room of Dr. Ram Manohar Lohia Institute of Medical Sciences, Lucknow with a clinical suspicion of elevated intracranial pressure eg. complaints of headache, vomiting, blurred vision and vomiting or altered sensorium underwent bedside B-scan measurement of optic nerve sheath diameter using the technique detailed below.

Technique of B-scan measurement of ONSD

The ONSD was measured bilaterally on a Hitachi HI VISION Avius® ultrasound unit using a 10-MHz linear probe on the closed upper eyelid of supine patients with adequate aqueous gel as coupling agent. The oblique axial view was used to focus the optic nerve with a straight or downward gaze. In case of frontal gaze deviation, the lower eyelid was used. In extreme gaze deviations, the lateral axial view was used if the previous two views failed. As the most distensible part of the optic nerve sheath lies approx. 3 mm behind the vitreo-retinal interface, ONSD was measured at this level perpendicular to the axis of the nerve.[2] For each patient, the average of the bilateral ONSD measurements was calculated.

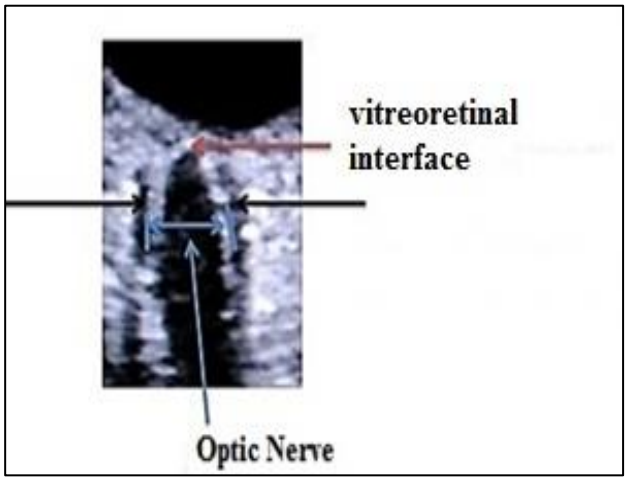

Figure 1: The optic nerve sheaths are the echogenic stripes external to the hypoechoic subarachnoid space (black arrows) surrounding the optic nerve.

Subsequently, patients had CT head scans on a Philips Brilliance® 64 slice MDCT scanner with acquisition parameters as detailed below. Scans were evaluated for signs of raised ICP. CT findings indicative of raised ICP were: effacement of sulci and abnormal mesencephalic cisterns in early and the presence of mass effect with a midline shift of ≥3 mm and hydrocephalus in late cases. B-scan ONSD measurements and CT findings were correlated. Sensitivity and specificity of B-scan ONSD measurement using a cutoff of 5 mm were calculated.[3-6]

Non-contrast head CT acquisition

Patient was placed head first in gantry with head within head holder and external auditory meatus at the centre of gantry. Axial slices were planned on a lateral scout view of the head taken at 120 kV and 30 mAs.

To reduce exposure to ocular lens, scans were angled parallel to a line extending from supraorbital ridge and the inner table of the posterior margin of the foramen magnum whenever possible.

Table 1: CT scan parameters.

Scan range	From top of C1 lamina through top of calvarium
kV	120
mAs	300
Collimation	64 × 0.625 mm
Slice thickness	5 mm
Increment	0.75 mm
Reconstruction slice thickness	1.5 mm

Table 2: Observations.

	CT findings of raised ICP present	CT findings of raised ICP absent
ONSD ≥ 5 mm	23	1
ONSD < 5 mm	3	9
Total	26	10

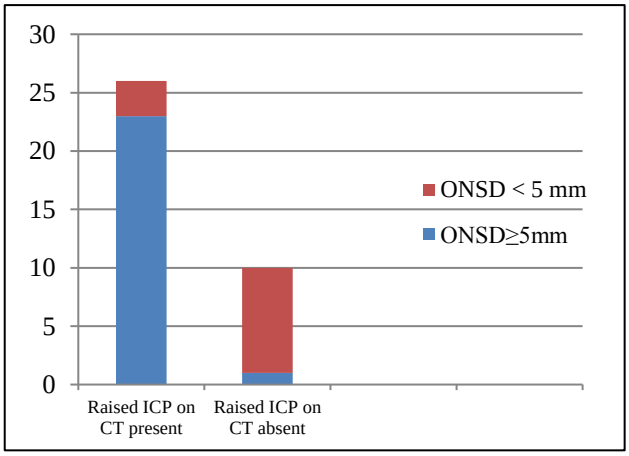

Figure 2: B-scan ONSD measurement with CT findings of raised ICP.

RESULTS

36 patients were enrolled, of which 26 had CT signs of raised ICP.

The average ONSD in patients without CT signs of raised ICP was 4.45 mm while average ONSD in those with raised ICP was 6.1 mm.

The ONSD measurement was 88.5% sensitive (95% CI 68% to 97%) with CT as the reference.

The ONSD measurement was 90% specific (95% CI 55% to 99%) with CT as the reference.

DISCUSSION

B-scan ultrasound for evaluation of ONSD is a widely available technique requiring minimal training which can be performed at the bedside of critically ill patients. Sex, age, gender, anthropometric factors and medical history are likely to influence an individual's ONSD. The variation in the cut-off value for ONSD across studies ranges from 4.8 mm to 6.0 mm. However, the bulk of studies have used 5 mm as cut off.[7-10]

Example B-scan ultrasound measurement of ONSD in a case of raised ICT

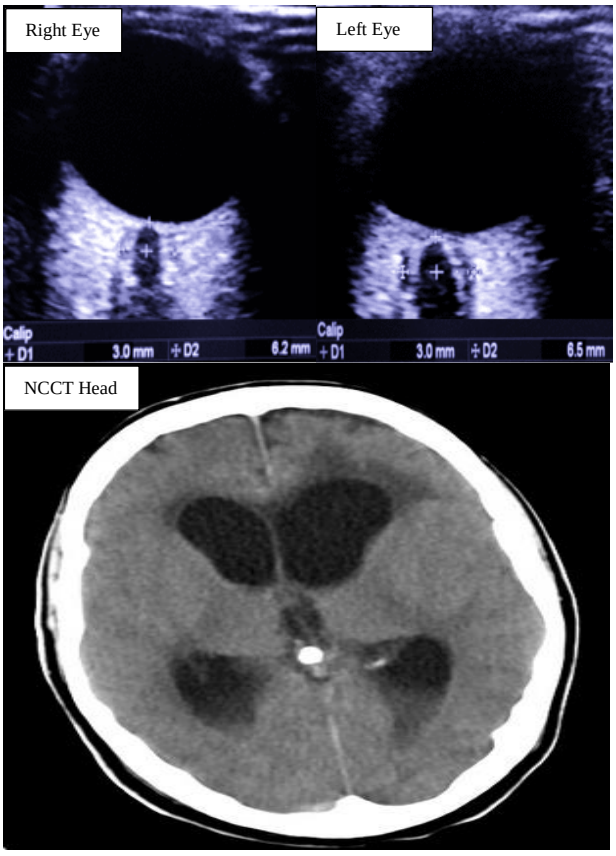

Figure 3: 63-year-old male with altered sensorium - B scan ultrasound with measurement performed 3 mm (D1) behind vitreoretinal interface for the ONSD (D2)- ONSD measures 6.2 mm on right and 6.5 mm on left side. The average ONSD of both the eyes measures 6.35 mm which correlated with a head CT scan showing dilatation of bilateral lateral ventricles.

While papilloedema may take time to develop, dilatation of the optic nerve sheath occurs much earlier and may be a near-instantaneous manifestation of raised intracranial pressure.[11] The main value of ultrasound lies in early evaluation, during the initial assessment and resuscitation or transport phases, where cross-sectional imaging is unavailable.

CONCLUSION

B-scan measurement of optic nerve sheath diameter is a useful tool for detecting raised ICP in adults. As a portable modality, it can be used both in hospitals as well as in the field. It can serve as an aid to confirm clinical suspicion thereby expediting therapy.

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