

Transorbital Ultrasound Measurement as a Non-invasive Marker of Intracranial Pressure (ICP)

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Introduction

Reliable assessment of intracranial pressure (ICP) remains crucial in managing neurosurgical conditions in children. The present study examined the relationship between transorbital ultrasound measurement of the optic nerve sheath diameter (ONSD) and invasively measured ICP in children.

Methods

This was a prospective, observational study comparing ONSD measurement to invasive ICP measurement. All patients were under general anaesthesia and physiological variables including systolic and diastolic blood pressure, mean arterial pressure, pulse rate, temperature, respiratory rate and end tidal carbon dioxide level were recorded at the time of ONSD measurement. The ONSD measurements were analysed for intra- and inter-observer variability. The diagnostic accuracy of ONSD measurement for detecting ICP at thresholds of 20, 15, 10 and 5 mmHg was analysed, including evaluation of age-related thresholds in children.

Results

196 children were evaluated. The median age was 36 months (IQR 8-82). Etiology included, hydrocephalus (52.9%), traumatic brain injury (17.2%), tumour (9.2%), craniosynostosis (9.2%), cystic malformation (6.9%), other (4.6%). ONSD measurement demonstrated good correlation with ICP across the entire patient cohort ($r = 0.66$, $p < 0.001$), but was better in children > 1 year or with a closed anterior fontanelle (AF) ($r = 0.7$, $p < 0.001$). The ONSD values with the best diagnostic accuracy for detecting ICP above 20 mmHg in older children was 5.75 mm, with a sensitivity of 85.9%, specificity of 70.4%, PPV of 77.5%, NPV of 80.9% and AUROC of 0.78. The diagnostic OR was 14.5. Diagnostic testing was performed at ICP thresholds of 15, 10 and 5 mmHg as well.

Conclusions

Measurement of the ONSD is a sensitive surrogate marker of raised ICP with limited specificity. This relationship was more reliable in older children, particularly when the AF was closed. This study provides the first data supporting the relationship between ONSD measurement and invasively measured ICP at various thresholds.

Learning Objectives

evaluation of non-invasive ICP assessment