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A novel method of detecting raised intracranial pressure from head computed tomography using optic nerve sheath diameter

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Introduction

Raised intracranial pressure (ICP) can cause secondary brain injury, which is associated with severe disability and mortality [1]. Invasive ICP monitoring has been linked to increased mortality [2]. Sekhon, et al. [3] demonstrated a strong correlation between optic nerve sheath diameter (ONSD) on CT scan and ICP, with the potential to use this non-invasive method to detect raised ICP.

Objectives

To assess the efficacy of ONSD as a predictor of raised ICP and to determine whether predictive value can be improved by controlling for variables measurable on CT.

Methods

Single centre, retrospective study of patients receiving ICP monitoring during 2013. For each patient, the following measurements were recorded (***A***, ***B*** and ***L*** recorded bilaterally):

- ONSD 3mm behind the globe - maximum recorded (***A***)
- ONSD half way between the globe and the superior orbital fissure (SOF) - average recorded (***B***)
- Distance from the globe to the SOF (***L***)
- Anterior-posterior diameter of the foramen magnum (***FM***)

Optic nerve ratio (ONR) and ValX were calculated using equations 1 and 2, respectively (Figyre 1). The strength of the relationship between ValX and ICP was assessed using Pearson´s correlation coefficient (r). A receiver operating characteristic (ROC) curve was produced to assess the ability of ValX to predict ICP above 15mmHg. A subset was re-measured by a second assessor and interclass correlation coefficient (ICC) was used to assess inter-rater reliability.

Results

57 head CTs were identified where simultaneously recorded ICP was available. The mean value of ValX was 1.02 (SD = 0.138) and mean ICP was 14.1mmHg (SD = 4.8mmHg). No correlation was identified between ICP and ONSD (r = 0.032, n = 57). There was a moderate correlation between ValX and ICP (r = 0.427, p = 0.001). The ICC was 0.98 (95% CI 0.96 to 0.99). ValX had an area under the curve to discriminate elevated

1. $ONR = \frac{A}{B}$ 2. $ValX = \frac{ONR \times L}{FM}$

Figure 1 Calculation of ONR and ValX.

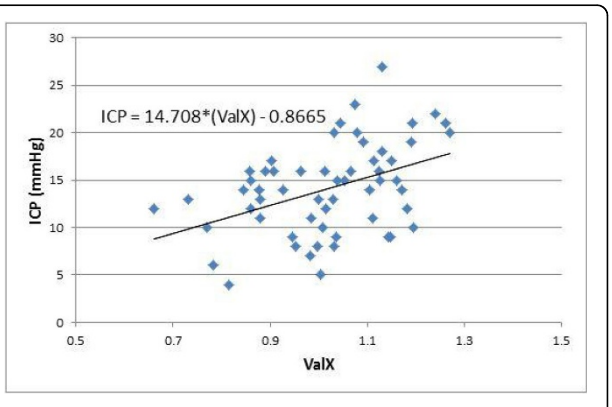

Figure 2 [Scatter graph of ICP against ValX].

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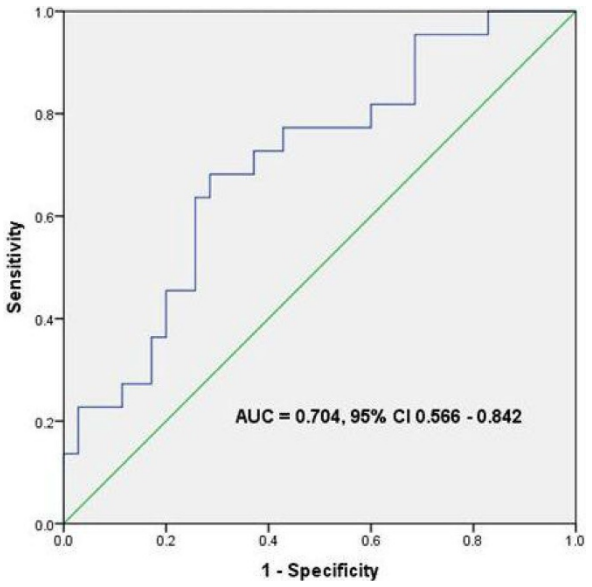

Figure 3 [ROC curve: Ability of ValX to identify ICP>15mmHg].

ICP (>15 mmHg) of 0.70 (95% CI 0.57 to 0.84). Using a cut-off of 1.03, ValX had a sensitivity of 73%, specificity of 63%, positive predictive value of 55% and a negative predictive value of 79%.

Conclusions

We were unable to replicate the relationship observed by Sekhon et al. [3] between ICP and ONSD. However, by controlling for measurements ***L*** and ***FM***, we found a moderately strong relationship. This novel technique has good inter-rater reliability. More work is required to develop this method of excluding raised ICP.

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