Two Depth Transcranial Doppler

Measurement of intracranial pressure (ICP) is necessary in many neurological and neurosurgical diseases. To avoid lumbar puncture or intracranial ICP probes, non-invasive ICP techniques are becoming popular.

Innovative method using Two-Depth Transcranial Doppler (TDTD) of monitoring intracranial pressure (ICP) relies on the same fundamental principle used to measure blood pressure with a sphygmomanometer.

The TDTD method uses Doppler ultrasound to translate principle of blood pressure measurement with a sphygmomanometer to the measurement of ICP. Ophthalmic artery (OA) - a unique vessel with intracranial and extracranial segments is used as a natural pair of scales for absolute ICP measurement. Blood flow in the intracranial segment is affected by intracranial pressure, while flow in the extracranial segment is influenced by the externally applied pressure to the orbital tissues. As with a sphygmomanometer, a pressure cuff is used - in this case to compress the tissues surrounding the eye and change the characteristics of blood flowing from inside the skull cavity into the eye socket. In place of the stethoscope, a Doppler ultrasound beam measures the blood flow in intracranial and extracranial segments of the Ophthalmic Artery. The aICP meter based on this method gradually increases the pressure over the eye so that the blood flow parameters in two sections of artery are equal. At this point, the applied external pressure equals the intracranial pressure.

This measurement method eliminates the main limiting problem- the individual patient calibration problem by direct comparison of aICP and externaly applied pressure – same fundamental principle used to measure blood pressure with a sphygmomanometer. The mean value of OA blood flow, it's systolic and diastolic values, pulsatility indexes are almost the same in both OA segments in the point of balance aICP=aPe. As a result of that all individual influential factors (ABP, cerebrovascular autoregulation impairment, individual pathophysiological state of patient, individual diameter and anatomy of OA, hydrodynamic resistance of eye ball vessels, etc.) do not influence the balance aICP=aPe and, as a consequence, such natural "scales" do not need calibration. This method is further developed by Company Vittamed (Kaunas, Lithuania) together with consortium partners in EU FP7 project Brainsafe http://www.fp7brainsafe.com/)

The aim of a study was to investigate how well non-invasively-measured ICP and invasively-measured cerebrospinal fluid (CSF) pressure correlate. Koskinen et al performed multiple measurements over a wide ICP span in eighteen elderly patients with communicating hydrocephalus. As a reference, an automatic CSF infusion apparatus was connected to the lumbar space. Ringer's solution was used to create elevation to pre-defined ICP levels. Bench tests of the infusion apparatus showed a random error (95 % CI) of less than ±0.9 mmHg and a systematic error of less than ±0.5 mmHg. Reliable Doppler signals were obtained in 13 (72 %) patients. An infusion test could not be performed in one patient. Thus, twelve patients and a total of 61 paired data points were studied. The correlation between invasive and non-invasive ICP measurements was good (R = 0.74), and the 95 % limits of agreements were -1.4 ± 8.8 mmHg. The within-patient correlation varied between 0.47 and 1.00. This non-invasive technique is promising, and these results encourage further development and evaluation before the method can be recommended for use in clinical practice [1].

[1]
Koskinen LD, Malm J, Zakelis R, Bartusis L, Ragauskas A, Eklund A. Can intracranial pressure be

measured non-invasively bedside using a two-depth Doppler-technique? J Clin Monit Comput. 2016 Mar 14. [Epub ahead of print] PubMed PMID: 26971794.

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