Noninvasive intracranial pressure monitoring

- Bone Graft Expansion in Cranioplasty Using a Split-Bone Technique
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- Intracranial Pressure

Intracranial pressure monitoring is necessary in many neurological and neurosurgical diseases.

There is no established method of noninvasive intracranial pressure (NI-ICP) monitoring that can serve as an alternative to the gold standards of invasive monitoring with external ventricular drainage or intraparenchymal monitoring.

To avoid lumbar puncture or intracranial ICP probes, non-invasive ICP techniques are becoming popular.

HeadSense HS-1000

HeadSense HS-1000.

Ultrasound

Flanders et al. compared non-invasive and invasive ICP measurements in infants with hydrocephalus. Infants born term and preterm were eligible for inclusion if clinically determined to require cerebrospinal fluid (CSF) diversion. The ventricular size was assessed preoperatively via ultrasound measurement of the fronto-occipital (FOR) and fronto-temporal (FTHR) horn ratios. Invasive ICP was obtained at the time of surgical intervention with a manometer. Intracranial hypertension was defined as invasive ICP ≥15 mmHg. Diffuse optical measurements of cerebral perfusion, oxygen extraction, and non-invasive ICP were performed preoperatively, intraoperatively, and postoperatively. Optical and ultrasound measures were compared with invasive ICP measurements, and their change in values after CSF diversion was obtained.

They included 39 infants; 23 had intracranial hypertension. No group difference in ventricular size was found by FOR (p=0.93) or FTHR (p=0.76). Infants with intracranial hypertension had significantly higher non-invasive ICP (p=0.02) and oxygen extraction fraction (p=0.01) compared with infants without intracranial hypertension. Increased cerebral blood flow (p=0.005) and improved oxygen extraction fraction (P < .001) after CSF diversion were only observed in infants with intracranial hypertension.

Noninvasive diffuse optical measures (including a non-invasive ICP index) were associated with intracranial hypertension. The findings suggest impaired perfusion from intracranial hypertension was independent of ventricular size. Hemodynamic evidence of the benefits of Cerebrospinal fluid shunt was seen in infants with intracranial hypertension. Non-invasive optical techniques hold promise for aiding the assessment of CSF diversion timing [1].

Transcranial Doppler

Transcranial Doppler for Noninvasive intracranial pressure monitoring.

Optic nerve sheath diameter ultrasonography

see Optic nerve sheath diameter ultrasonography.

Optic disc height

Optic disc height

CT radiomic features

Fifty patients from the primary cohort were enrolled in this study. The clinical data, preoperative cranial CT images, and initial intracranial pressure readings were collected and used to develop a prediction model. Data of 20 patients from another hospital was used to validate the model. Clinical features including age, gender, midline shift, basilar cistern status, and ventriculocranial ratio were measured. Radiomic features, i.e., 18 first-order and 40 second-order features were extracted from the CT images. Lasso method was used for features filtration. Multivariate logistic regression was used to develop three prediction models with clinical (CF model), first-order (FO model), and second-order features (SO model). The SO model achieved the most robust ability to predict intracranial hypertension. Internal validation showed that the C-statistic of the model was 0.811 (95% confidence interval [CI]: 0.691-0.931) with the bootstrapping method. The Hosmer Lemeshow test and calibration curve also showed that the SO model had excellent performance. The external validation results showed a good discrimination with an area under the curve of 0.725 (95% CI: 0.500-0.951). Although the FO model was inferior to the SO model, it had better prediction ability than the CF model. The study shows that the radiomic features analysis, especially second-order features can be used to evaluate intracranial hypertension noninvasively compared to conventional clinical features, given its potential for clinical practice and further research [2]

[1]

Flanders TM, Lang SS, Ko TS, Andersen KN, Jahnavi J, Flibotte JJ, Licht DJ, Tasian GE, Sotardi ST, Yodh AG, Lynch JM, Kennedy BC, Storm PB, White BR, Heuer GG, Baker WB. Optical Detection of Intracranial Pressure and Perfusion Changes in Neonates With Hydrocephalus. J Pediatr. 2021 May 15:S0022-3476(21)00447-9. doi: 10.1016/j.jpeds.2021.05.024. Epub ahead of print. PMID: 34004191.

2)

Li Y, Zhang G, Shan Y, Wu X, Liu J, Xue Y, Gao GY. Noninvasive assessment of intracranial hypertension in patients with traumatic brain injury using CT radiomic features a pilot study. J Neurotrauma. 2022 Sep 13. doi: 10.1089/neu.2022.0277. Epub ahead of print. PMID: 36097763.