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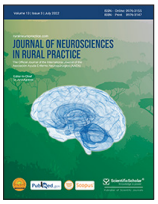

Editorial

Intracranial pressure monitoring in craniosynostosis

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The incidence of raised ICP is low (approximately 17%) in single suture synostosis and is seen more frequently in midline sutures, namely, sagittal and metopic.[1] It has been reported to be 15–20% in multisutural (non-syndromic) going up to 30–40% in syndromic craniosynostosis.[2] The cause of raised ICP in craniosynostosis is obviously the smaller cranial volume. In addition, venous congestion due to anomalous venous drainage, hydrocephalus, and upper airway obstruction also contribute.

The need for ICP Monitoring in craniosynostosis cases depends on the following factors:

1. *Clinical parameters may be unreliable.* Tuite *et al.* studied ICP and ophthalmoscopic findings prospectively in 122 pts. Papilloedema had high sensitivity (87% pts with Papilloedema had ICP>15 mm Hg) but low specificity (68% pts with ICP> 15 did not have papilloedema). Papilloedema was 100% sensitive in children older than 8 years old but only 22% in younger subjects.[1]
   Eide *et al.* in two large series of pediatric patients with craniosynostosis, hydrocephalus, shunt failure, or idiopathic ICP found that symptoms classically associated with raised ICP (headache, irritability, sleep disturbance, nausea, psychomotor delay, and seizures) did not correlate with or predict raised ICP in children.[3] The Oxford group had similar inferences in 284 patients with sagittal craniosynostosis.[4]
2. *Radiology parameters can also be unreliable.* Copper beaten appearance is common in craniosynostosis and its incidence increases with age, therefore, unreliable as a sign of raised ICP.[5]
3. *Electrophysiological parameters such as VEPs* hold promise but the high incidence of abnormal responses in craniosynostosis children and its variability is well known in normal subjects.[6]
   Indications for ICP monitoring in craniosynostosis may be categorized as below:

a. *When a non-operative line of management is proposed*: The Oxford group recommends using it in all cases of sagittal craniosynostosis irrespective of the severity of the deformity as the incidence of raised ICP is almost 44%[4]
b. *Delayed diagnosis of Craniosynostosis:* Scott and colleagues (2009) reported alleviation of symptoms after vault expansion was done in response to raised ICP in their cohort of children older than 2 years.[7] Iyengar *et al.* reported a similar experience in a 17 years old, where invasive intraparenchymal monitoring was used to make the decision for vault expansion.[8]
c. *To choose between a posterior expansive cranioplasty versus anterior frontal-orbital advancement*: Tamburrini reported the use of ICP values to devise a surgical plan for their patients with craniosynostosis. Out of 12 children with syndromic craniosynostosis, 11 had abnormal ICP values. Two out of the 11 had relatively low ICP values and only underwent an anterior bifrontal-orbital advancement as a delayed definitive procedure. The remaining nine underwent an early occipital expansive cranioplasty followed by multiple procedures including, namely, VP shunt before definitive bifrontal-orbital advancement.[2]
d. *Post-operative evaluation of operated patients*. As clinical and radiological parameters are not reliable, ICP monitoring can be employed for the early detection of raised ICP to prevent irreversible changes. Christian *et al.* did a meta-analysis of seven studies that employed invasive ICP monitoring postoperatively after various remodeling procedures. Intracranial hypertension (IH) was reported to be present in 5% of patients postoperatively with sagittal synostosis and 4% of patients with all forms of non-syndromic craniosynostosis. Cranial

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remodeling procedures without orbital involvement (including strip craniectomies) were compared to craniofacial procedures that included advancement of the orbital rim. The incidence of IH was found to be 5% in cranial remodeling procedures versus 1% in craniofacial procedures.[9]

METHODOLOGY

*ICP Overnight Monitoring (ONM)***:** Zipfel *et al.* studied 34 children with primary or secondary craniostenosis with suspected raised ICP with overnight ICP monitoring. They reported their experience with computerized ICP ONM in relation to imaging parameters (narrowed external CSF spaces on MRI and skull X-ray changes). They calculated a correlation index called RAP which represented intracranial reserve capacity. (RAP Index) enhances the diagnostic gain by the identification of an exhausted status. Higher RAP especially during REM sleep can be considered a sign of diminished compensatory capacity, but with still some reserve. The existence of a rather lower RAP in moderate-to-severe skull x-ray changes indicates that the reserve capacity is already exhausted and cerebrovascular integrity is affected by rising ICP and surgery should be performed rather earlier than later.[10]

Intraoperative monitoring: This has prompted studies on intraoperative monitoring during reconstruction (Judy *et al*, J Neurosurg Ped, 2018).They regulated end-tidal carbon dioxide and the monitoring site for subdural recordings under general anesthesia to record consistent ICP readings. They found a remarkable reduction in 43 out of 45 patients.[11]

The work from NIMHANS published here suggests further use by modifying the degree of reconstruction during the procedure[12] and reporting the conversion of ICP ventricular catheter to VP shunt in non-responsive patients. Maybe, further information on ventricular size or status of venous anatomy, etc., in these patients will help us decide on advising regular use of this procedure.

Although ventricular ICP readings are the most accurate, they are fraught with a higher risk of complications (seizures, hematoma, catheter blockade, and CSF infections). Refinement in non-invasive devices and better accuracy may make it possible to carry out routine ICP monitoring during complex craniosynostosis surgery.

REFERENCES

1. Tuite GF, Evanson J, Taylor D, Jones BM, Hayward RD. The effectiveness of papilledema as an indicator of raised intracranial pressure in children with craniosynostosis. N Neurosurg 1996;38:7.
2. Tamburrini G, Caldarelli M, Massimi L, Santini P, Di Rocco C. Intracranial pressure monitoring in children with single suture and complex craniosynostosis: A review. Childs Nerv Syst 2005;21:913-21.
3. Eide PK, Helseth E, Due-Tønnessen B, Lundar T. Assessment of continuous intracranial pressure recordings in childhood craniosynostosis. Pediatr Neurosurg 2002;37:310-20.
4. Wall SA, Thomas GPL, Johnson D, Byren JC, Jayamohan J, Magdum SA, *et al*. The preoperative incidence of raised intracranial pressure in nonsyndromic sagittal craniosynostosis is underestimated in the literature: Clinical article. J Neurosurg Pediatr 2014;14:674-81.
5. Tuite GF, Evanson J, Chong WK, Thompson DN, Harkness WF, Jones BM, *et al*. The beaten copper cranium: A correlation between intracranial pressure, cranial radiographs, and computed tomographic scans in children with craniosynostosis. Neurosurgery 1996;39:691-9.
6. Andersson L, Sjölund J, Nilsson J. Flash visual evoked potentials are unreliable as markers of ICP due to high variability in normal subjects. Acta Neurochir (Wien) 2012;154:121-7.
7. Scott JR, Isom CN, Gruss JS, Salemy S, Ellenbogen RG, Avellino A, *et al*. Symptom outcomes following cranial vault expansion for craniosynostosis in children older than 2 years. Plast Reconstr Surg 2009;123:289-97.
8. Iyengar RJ, Klinge PM, Chen W, Sullivan SR, Taylor HO. Management of craniosynostosis at an advanced age: Clinical findings and interdisciplinary treatment in a 17 year-old with pan-suture synostosis. Interdiscip Neurosurg 2015;2:61-4.
9. Christian EA, Imahiyerobo TA, Nallapa S, Urata M, McComb JG, Krieger MD. Intracranial hypertension after surgical correction for craniosynostosis: A systematic review. Neurosurg Focus 2015;38:E6.
10. Zipfel J, Jager B, Collmann H, Czosnyka Z, Schuhmann MU, Schweitzer T. The role of ICP overnight monitoring (ONM) in children with suspected craniostenosis. Childs Nerv Syst 2020;36:87-94.
11. Judy BF, Swanson JW, Yang W, Storm PB, Bartlett SP, Taylor JA, *et al*. Intraoperative intracranial pressure monitoring in the pediatric craniosynostosis population. J Neurosurg Pediatr 2018;22:475-80.
12. Bansal S, Konar S, Shukla D, Srinivas D, Pandey V, Jayan M, *et al*. Intraoperative measurement of intracranial pressure during cranial vault remodeling in children with craniosynostosis. J Neurosci Rural Pract 2022;13:80-6.

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