The assessment of bulging fontanel and splitting of sutures in premature infants: an interrater reliability study by the Hydrocephalus Clinical Research Network

Clinical article

JOHN C. WELLONS III, M.D., M.S.P.H.,1 RICHARD HOLUBKOV, PHD.,2 SAMUEL R. BROWD, M.D., PHD.,3 JAY RIVA-CAMBRIN, M.D., M.SC.,4 WILLIAM WHITEHEAD, M.D., M.P.H.,5 JOHN KESTLE, M.D.,4 AND ABHAYA V. KULKARNI, M.D., PHD.,6 FOR THE HYDROCEPHALUS CLINICAL RESEARCH NETWORK

1Section of Pediatric Neurosurgery, University of Alabama, Birmingham, Alabama; 2Division of Critical Care, Department of Pediatrics, University of Utah; 3Department of Neurosurgery, Division of Pediatric Neurosurgery, Primary Children’s Hospital, University of Utah, Salt Lake City, Utah; 4Division of Pediatric Neurological Surgery, Seattle Children’s Hospital, University of Washington, Seattle, Washington; 5Pediatric Neurosurgery, Texas Children’s Hospital, Department of Neurosurgery, Baylor College of Medicine, Houston, Texas; and 6Division of Neurosurgery, Hospital for Sick Children, Toronto, Ontario, Canada

Object. Previous studies from the Hydrocephalus Clinical Research Network (HCRN) have shown a great degree of variation in surgical decision making for infants with posthemorrhagic hydrocephalus, such as when to temporize, when to shunt, or when to convert. Since much of this clinical decision making is dictated by clinical signs of increased intracranial pressure (including bulging fontanel and splitting of sutures), the authors investigated whether there was variability in how these signs were being assessed by neurosurgeons. They wanted to answer the following question: is there acceptable interrater reliability in the neurosurgical assessment of bulging fontanel and split sutures?

Methods. Explicit written definitions of “bulging fontanel” and “split sutures” were agreed upon with consensus across the HCRN. At 5 HCRN centers, pairs of neurosurgeons independently assessed premature infants in the first 3 months of life for the presence of a split suture and/or bulging fontanel, according to the a priori definitions. Interrater reliability was then calculated between pairs of observers using the Cohen simple kappa coefficient. Institutional board review approval was obtained at each center and at the University of Utah Data Coordinating Center.

Results. A total of 38 infants were assessed by 13 different raters (10 faculty, 2 fellows, and 1 resident). The kappa for bulging fontanel was 0.65 (95% CI 0.41–0.90), and the kappa for split sutures was 0.84 (95% CI 0.66–1.0). No complications from the study were encountered.

Conclusions. The authors have found a high degree of interrater reliability among neurosurgeons in their assessment of bulging fontanel and split sutures. While decision making may vary, the clinical assessment of this cohort appears to be consistent among these physicians, which is crucial for prospective studies moving forward.

Key Words • hydrocephalus • prematurity • shunt

Abbreviations used in this paper: HCRN = Hydrocephalus Clinical Research Network; ICP = intracranial pressure.
Assessment of bulging fontanel and splitting of sutures

in premature infants. Therefore, we undertook a multicenter study within the HCRN to assess the interrater reliability of these 2 clinical signs.

Methods

Subjects of Assessment

A convenience sample was accrued between March 11, 2010, and July 30, 2010, of infants meeting the following criteria: premature birth (<37 weeks' gestational age), being treated in the neonatal ICU of 1 of 5 participating HCRN centers (Birmingham, Houston, Salt Lake City, Seattle, and Toronto), and being observed by the neurosurgery service.

Raters

All raters were pediatric neurosurgical faculty, fellows, or residents. Each infant was assessed independently by 2 raters within 6 hours of each other, and each rater was blinded to the assessment of the other. The raters assessed for the presence of a bulging anterior fontanel and splitting of the sagittal sutures. Raters were asked to adhere to the following definitions, which were derived based on consensus from the HCRN clinical investigators: 1) Bulging anterior fontanel (assessed with the patient supine and over a sufficient continuous period of time to ensure that maximum relaxation of the fontanel is allowed for; the rating is that of the fontanel in its most relaxed state). A bulging anterior fontanel is present when the fontanel is felt to be above the level of the surrounding external table of bone. Bulging anterior fontanel is not present when it is felt to be at or below the level of the surrounding external table of bone. 2) Split suture (assessed at the midparietal sagittal suture). Split suture is defined as a 2-mm separation or more of the parietal bones. Split suture is not present when the separation in the parietal bones is less than 2 mm.

Statistical Analysis

Each rater determined, as either present or absent, both bulging anterior fontanel and split suture. Interrater agreement between pairs of observers was calculated using the Cohen simple kappa coefficient (assessing magnitude of chance-corrected agreement) with 95% CIs. All analyses were performed using SAS version 9.2 (SAS Institute, Inc.).

Results

A total of 38 infants were assessed by 13 different raters (10 faculty, 2 fellows, and 1 resident). The mean head circumference and percentile head circumference for this sample were 34.7 ± 6.7 cm and 43.7 ± 36.0 percentile, respectively.

For a bulging fontanel (Table 1), the observers agreed 32 times (10 for bulging fontanel present and 22 for bulging fontanel absent) and disagreed 6 times. The kappa was 0.65 (95% CI 0.41–0.90). For split sutures (Table 2), the observers agreed 35 times (14 for split suture present and 21 for split suture absent) and disagreed 3 times. The kappa was 0.84 (95% CI 0.66–1.0).

Discussion

Despite how commonly clinical signs of increased ICP are used to guide important treatment decisions, little work has previously been done to assess the reliability of these signs. Kaiser and Whitelaw compared subjective assessment of the fontanel (classified as soft, full, or tense) to invasive ICP measurements from ventricular or lumbar taps in neonates. They found a reasonable degree of correlation with a mean ICP of 5.4 mm Hg in “soft” fontanels and 14.0 mm Hg in “tense” fontanels. There was substantial overlap of ICP among the different categories, however, leading the authors to suggest that digital palpation was not accurate, especially in the setting of a tense fontanel, in which 50% of patients had normal ICP readings of less than 10 mm Hg. The authors did not strictly define soft, full, or tense fontanels. Importantly, they also did not provide estimates of intra- or interrater reliability of assessments of the fontanel. In a study of 33 neonates, Simard et al. found perfect agreement between raters when assessing the anterior fontanel. This study was limited, however, by the fact that there was virtually no variability in the fontanels in their sample, and thus their results can only be extrapolated to a virtually normal population. This is problematic since this excludes the population in whom clinical assessment of the fontanel is most important and has the most significant management consequences. We are aware of no previous work examining the reliability in the assessment of split sutures.

Our study attempted to address the existing limitations in the literature. We included premature infants who were being observed by neurosurgery personnel, thus representing the population of greatest direct interest. We standardized the conditions under which babies were assessed, and we provided strict definitions, based on consensus, of bulging fontanel and split suture. Due to the limitations of mobility imparted by endotracheal intubation, a supine, relaxed position was chosen for assessment of the fontanel in all patients and a binary choice of bulging or not bulging was thought to provide the least room for subjectivity. The a priori consensus among the investigators was that at least 2 mm of space between the midparietal sagittal sutures was needed to determine true splitting with no abutment of the suture or overlap, but this distance was not measured directly by each observer. Our examiners were limited to pediatric neurosurgeons, pediatric neurosurgery fellows, or residents currently on the pediatric neurosurgery rotation since generally assessments by these individuals determine the need for surgical management. Under these study conditions, we found excellent reliability in the assessment of split su-

<p>| TABLE 1: Rater assessments of a bulging fontanel |
|---------------------|---------------------|---------------------|---------------------|</p>
<table>
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<th>Rater 2 Not Bulging</th>
<th>Total</th>
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<tr>
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<tr>
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<td>27</td>
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features. The reliability in assessing a bulging fontanel was lower, however, and this might be because it is a sign that is subject to more true variability and change based on conditions of assessment (ventilator status of the child, degree of irritability, and body position), despite our attempts to standardize these. Regardless, the reliability was still acceptably good.

Conclusions

Despite more than 25 years of outcomes literature on the topic, no consensus exists on a standardized surgical management strategy for premature infants with posthemorrhagic hydrocephalus. The ability for clinical decision makers to assess this patient population in a similar way is crucial for this process. Radiographic images of significant ventriculomegaly should be put into context with the physical examination findings of relative increased ICP. These 2 clinical examination findings, bulging fontanel and split sutures, appear to have good to excellent interrater reliability among our surgeons. This information will be useful as prospective studies move forward.

Disclosure

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Author contributions to the study and manuscript preparation include the following. Conception and design: Wellons, Riva-Cambrin, Whitehead, Kestle, Kulkarni. Acquisition of data: Wellons, Browd, Riva-Cambrin, Whitehead, Kestle, Kulkarni. Analysis and interpretation of data: Wellons, Holubkov, Riva-Cambrin, Kestle, Kulkarni. Drafting the article: Wellons, Kulkarni. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Wellons. Statistical analysis: Holubkov, Kulkarni. Administrative/technical/material support: Kestle. Study supervision: Wellons, Browd, Riva-Cambrin, Whitehead, Kestle, Kulkarni.

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References


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Address correspondence to: John C. Wellons III, M.D., Pediatric Neurosurgery, Vanderbilt University Medical Center, Nashville, Tennessee 37232. email: John.Wellons@vanderbilt.edu.

<table>
<thead>
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<th>Rater 2</th>
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