Ultrasound for periventricular-intraventricular hemorrhage

In the past three decades, cerebral ultrasound (CUS) has become a trusted technique to study the neonatal brain. It is a relatively cheap, non-invasive, bedside neuroimaging method available in nearly every hospital. Traditionally, CUS was used to detect major abnormalities, such as intraventricular hemorrhage (IVH), periventricular hemorrhagic infarction, post-hemorrhagic ventricular dilatation, and (cystic) periventricular leukomalacia (cPVL). The use of different acoustic windows, such as the mastoid and posterior fontanel, and ongoing technological developments, allows for recognizing other lesion patterns (e.g., cerebellar hemorrhage, perforator stroke, developmental venous anomaly). The CUS technique is still being improved with the use of higher transducer frequencies (7.5-18 MHz), 3D applications, advances in vascular imaging (e.g. ultrafast plane-wave imaging), and improved B-mode image processing. Nevertheless, the helpfulness of CUS still highly depends on observer skills, knowledge, and experience [1].

Performed through the open fontanelles [2]. Accuracy ≈ 88% (91% sensitivity, 85% specificity) [3].

U/S is invaluable because:

1. it demonstrates the size of the ventricles, the location and size of the hematoma, and the thickness of the cortical mantle

2. it may be brought to the infant’s bedside (obviating transportation)

3. it is non-invasive

4. it is not adversely affected by occasional infant movements (eliminating the need for sedation)

5. there is no exposure to ionizing radiation (radiation from diagnostic imaging in children has long-term risks for cancer [4] and damage to the lens)

6. it may be followed serially with relative ease

Clinically, monitoring is performed using 2D ultrasound (US); however, its clinical utility in dilation is limited because it cannot provide accurate measurements of irregular volumes such as those of the ventricles, and this might delay treatment until the patient's condition deteriorates severely.

Kishimoto et al developed a 3-D US system to image the lateral ventricles of neonates within the confines of incubators. They describe an in vivo ventricle volume validation study in two parts: (i) comparisons between ventricle volumes derived from 3-D US and magnetic resonance images obtained within 24 h; and (ii) the difference between 3-D US ventricle volumes before and after clinically necessary interventions (ventricle taps), which remove cerebral spinal fluid. Magnetic resonance imaging ventricle volumes were found to be 13% greater than 3-D US ventricle volumes; however, they observed high correlations ($R(2) = 0.99$) when comparing the two modalities. Differences in ventricle volume pre- and post-intervention compared with the reported volume of cerebrospinal fluid removed also were highly correlated ($R(2) = 0.93$); the slope was not found to be statistically significantly different from 1 ($p < 0.05$), and the y-intercept was not found to be

statistically different from 0 ($p < 0.05$). Comparison between 3-D US images can detect the volume change after neonatal intraventricular hemorrhage. This could be used to determine which patients will have progressive ventricle dilation and allow for more timely surgical interventions. However, 3-D US ventricle volumes should not be directly compared with magnetic resonance imaging ventricle volumes [5].

Transfontanellar ultrasound

Transfontanellar ultrasound

References

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