ULTRASONIC DIAGNOSIS OF INTRACRANIAL HEMORRHAGE IN HIGH RISK NEONATES

J.P. Soni
B.D. Gupta
M. Soni
M. Gupta
D.R. Dabi
K.R. Nemal

ABSTRACT

One hundred and eleven high risk neonates were subjected to cranial ultrasound (CR-USC). Cranial sonography was performed by 2D realtime scanner with 5 MHz transducer through anterior and posterior fontanelle and temporo—squamal suture. One quarter of these neonates developed intracranial hemorrhage (ICH) within 120 hours of birth. Of them, 42.8% neonates recovered completely, 21.4% developed ventriculomegaly, 21.4% neonates expired, 10.4% developed pseudo-porencephalic cyst and 3.5% developed aqueductal block. It is concluded that CR-USC is a useful technique for detection and monitoring of complications of ICH and at least one screening sonogram is essential in the first week of life of all high risk neonates.

Keywords: Cranial ultrasound, Intracranial hemorrhage, Neonate.

From the Department of Pediatrics, Regional Institute of Maternal and Child Health, Dr. S.N. Medical College, Jodhpur.
Reprint requests: Dr. J.P. Soni, Madhu Kunj, 23-G, Pokran House, Jodhpur 342 001.
Received for publication: May 4, 1994; Accepted: October 12, 1994

Spontaneous hemorrhage in and around the cerebral ventricle is a phenomenon that occurs in premature neonates(i) and is now being increasingly observed in high risk term neonates(2). It's incidence is approximately 40-45% in newborns weighing less than 1500 g or born before 35 weeks of gestational age. It is due to rupture of the fragile capillaries of the germinal matrix whereas hypoperfusion may cause infarction of the boundary zones between different arterial territories, within the periventricular white matter(3).

The incidence of subependymal intraventricular (SEH-IVH) and periventricular leukomalacia (PVL) is 30-55% in newborns weighing less than 1500 g and born before 35 weeks of gestational age(4). Real time ultrasound (RTU) was first used in Neonatal Intensive Care Unit (NTCU) in the year 1978 to detect IVH(5). The procedure has high sensitivity (96%) and specificity (94%) in diagnosing intracranial hemorrhage [ICH](6). Since then, it is emerging as an alternative modality of investigation of choice in all high risk neonates because of number of inherent advantages over CT, viz., noninvasive, inexpensive, easily repeatable, requires no sedation, less time consuming and can be performed in NICU's by trained neonatologists. We report our experience with high resolution, real time scanning in which the anterior fontanelle was used as a scanning window to detect the presence of ICH and the subsequent complications in them by serial sonography.

Material and Methods

One hundred and eleven inborn
newborns admitted in the Neonatal Division of Regional Institute of Maternal and Child Health Hospital, Jodhpur between December, 1992 to March, 1994 were studied prospectively.

Cranial ultrasonography [CR-USG] was done by real time 2D scanner SIM 3000 OTC Biomedier with a 5 MHz transducer. Images were obtained through the anterior fontanelle in both right and left para-sagittal, coronal, and axial planes. All the scans were performed by one author [JPS].

The first sonography examination was done in each newborn infant within 72 hours of delivery (mean 36 hours). CR—USG was repeated at 120 hours, 1st, 2nd, 3rd and 4th weeks of age, if required, or before discharge, whichever was earlier.

The hemorrhages were graded by the classification of Papile et al.(7): Grade I-hemorrhage confined to germinal layer matrix; Grade II-intraventricular hemorrhage without dilatation of ventricles; Grade III-IVH with dilatation; and Grade IV-intraparenchymal hemorrhage.

Gestational age was assessed using the modified Parkin's criteria in conjunction with the antenatal history(8). Severity of asphyxia was assessed by APGAR score at 1 and 5 minutes and modified Sarnat and Sarnat hypoxic ischemic encephalopathy [HIE] staging(9).

Their weight, occipito-frontal circumference, gestational age, mode of delivery, APGAR score and HIE staging, serial sonographic findings, CSF finding and final outcome were recorded.

Results

A total of 111 neonates were subjected to sequential sonography. Their male to female ratio was 1.39 :1.00. The overall incidence of SEH-IVH with or without parenchymal extension was 25% (Table I). Grades I (Fig. 7), II (Fig. 2), III and IV (Fig. 3) ICH was detected in 17, 1, 6 and 5 neonates on first sonography, respectively. The initial site of hemorrhage was subependymal in 22, brain parenchyma in four and choroid plexus in 2 neonates (Table I). Intracranial bleed was detected by CR USG within 120 hours of birth in all infants of ICH.

SEH-IVH was observed in 33.3, 23.8 and 23.8% neonates with gestational age ≤32, 33-<37 and 38 weeks in 33.3, 23.5, 18.7 and 25.3% neonates with weight of 1-1.5, 1.5-2, 2-2.5 and >2.5 Kg respectively (Table II).

As regards risk factors, all term neonates (n=72) had birth asphyxia. SEH IVH was observed in 44.4% (12/27), 11% (2/18) and 11% (3/27) neonates with APGAR SCORE of ≤2, 3 to 4 and 5-7 at one and five minutes, respectively. Their clinical assessment was also done by modified Sarnat and Sarnat HIE staging. SEH TVH was observed in 25%, 71% and 37.5%, term neonates with HIE Stages I, II and III, respectively. ICH was also observed in 6.8% neonates—who had birth asphyxia but were otherwise normal (Table III).

Sequential CR-USG revealed that 12 of the 17 neonates (70%) with Grade I and the only neonate with Grade II ICH improved over a period of 3 weeks, while 6 neonates with Grade I ICH had progression of anatomical lesions-3 developed Grade ITI and 2 Grade IV
### TABLE I—Follow-up Profile of Neonates with ICH

<table>
<thead>
<tr>
<th></th>
<th>Preterm (n = 29)</th>
<th>Term (n = 72)</th>
<th>Total (%) (n = 111)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ICH</strong></td>
<td>11</td>
<td>17</td>
<td>28 (25)</td>
</tr>
<tr>
<td><strong>Site of hemorrhage</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEH</td>
<td>11</td>
<td>11</td>
<td>22</td>
</tr>
<tr>
<td>Parenchyma</td>
<td>4</td>
<td>04</td>
<td></td>
</tr>
<tr>
<td>Choroid plexus</td>
<td>2</td>
<td>02</td>
<td></td>
</tr>
<tr>
<td><strong>Outcome (n = 28)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete recovery</td>
<td>6</td>
<td>6</td>
<td>12 (42.8)</td>
</tr>
<tr>
<td>Ventriculomegaly</td>
<td>2</td>
<td>4</td>
<td>6 (21.4)</td>
</tr>
<tr>
<td>Pseudo Porencephalic cyst</td>
<td>3</td>
<td>3</td>
<td>3 (10.7)</td>
</tr>
<tr>
<td>Aqueductal block hydrocephalus</td>
<td>1</td>
<td>1</td>
<td>1 (3.6)</td>
</tr>
<tr>
<td>Death</td>
<td>3</td>
<td>3</td>
<td>6 (21.9)</td>
</tr>
</tbody>
</table>

Fig. 1a

Fig. 1b

Fig. 1. Mid coronal (Fig. 1a) and right para-sagittal (Fig. 1b) scan showing Grade I hemorrhage.
hemorrhage (Table IV). Out of 9 neonates with Grade III hemorrhage, 3 expired and 6 had persistence of ventriculomegaly.

Out of seven neonates with Grade IV ICH, 3 expired, 1 developed acqueductal block and hydrocephalus, and three developed pseudo-porencephalic cyst (Table I).

Discussion

Intracranial hemorrhage is a significant problem in the low birth weight premature(1) and term neonates(2,10,11) and is also responsible for significant morbidity and mortality. SEH-IVH or their extension in to the brain parenchyma have previously been reported in 20-75% of preterm neonates(3,6,12,13) and few term neonates(2,10,11). In this study, it was observed in 33.3, 23.8 and 23.8% neonates with gestational ages ≤32, 33-<37 and ≥38 weeks.

Pevsner et al. observed SEH-IVH in >9,52, 20,14 and 3% neonates with birth weight of <1 Kg, >1-1.5 Kg, >1.5-2.0 Kg, >2.0-2.5 Kg and >2.5 Kg, respectively(14). Mack et al. reported ICH in 20% preterm neonates with birth weight of 810-2040 g(12). We observed SEH-IVH in 33.3, 23.8, 18.7 and 25.3% neonates with birth weight of 1.00-1.5 Kg, >1.5-2, >2.0-2.5 and 2.5 Kg, respectively.

Leech et al. had demonstrated that the source of FVH is the germinal matrix.
in more than 90% neonates(1). Papile et al. from their study concluded that IVH in preterms classically emanates from small vessels, principally-capillaries in the subependimal germinal matrix, which is a richly vascular structure and is more pronounced in the fetus of 6-8 months gestation(15). Now it is increasingly being reported in term neonates too(2,10).

In the present study, the site of hemorrhage was SEH in all preterm and 11 term neonates. In the remaining 6 term neonates, the site of hemorrhage was choroid plexus and brain parenchyma in 2 and 4 neonates, respectively.

Pevsner et al from their study, suggested that bleeding may begin in the germinal matrix even before birth as subependymal hematoma and the latent period between SEH and FVH is relatively short(14). Dolfin et al. also ob-
served that hemorrhage occurred within 62 hours of birth in all neonates(13).

Trounce et al. reported that ultrasonic evidence of hemorrhage was evident within first seven days of life in 78% neonates and second week in 15% neonates(16). Gupta et al. from their study reported that hemorrhage occurred in all neonates within 96 hours of birth(17). The hemorrhage occurred in all preterm and term neonates within 120 hours of the birth in the present study.

Besides, prematurity and birth weight of neonate, hypoxic-ischemic insult is a major contributor to IVH and PVH in premature neonates and full term neonates(3,10,18).

In the present study, ICH was observed in 44.4, 11 and 11% term neonates with APGAR score of less than <2, 3-4 and 5-7 at one and 5 minutes. The modified Sarnat and Sarnat HIE staging was used for clinical assessment, which revealed ICH in 37.5, 71 and 25% neonates with HIE States HI, II and I, respectively.

Sauerbrei et al. reported that 22 out of 26 preterm neonates of ICH developed complications like hydrocephalus and porencephalic cyst in 16% each, parenchymal and intraventricular hemorrhage in 23% each and ventricular septation in 5.5% neonates(6). Brustein et al. observed hydrocephalus in 35% and 30% neonates with Grades III and IV hemorrhage and death in 30, 40, 50 and 70% neonates with Grades I, II, III and IV hemorrhage, respectively. They concluded that trigonal dilatation appears to be the most sensitive indicator of ventricular enlargement 19). Trounce et al. reported periventricular leucomalacia, ventricular dilatation and death in 26, 10 and 21% preterm neonates with ICH(16).

Gupta et al. reported case fatality rate of 27%. The prognosis directly correlates to the severity of hemorrhage. The overall immediate neonatal mortality was 0, 50, 75 and 100% in neonates with ICH Grades I, II, III and IV, respectively. The 84% neonates with ICH Grade I, revealed complete recovery while neonates with Grades II and III ICH had ventricular dilatation with hydrocephalus in 50% preterm neonates(17).
In this study, complete recovery (ICH Grades I and II), ventriculomegaly, pseudo-porencephalic cyst, aqueductal block (Fig. 4) and hydrocephalus was seen in 42.8, 21.4, 10.7 and 3.6% neonates, while case fatality rate was 21.4%. One patient with aqueductal block and hydrocephalus was operated for ventriculo-peritoneal shunt, while patients with ventriculomegaly did not require any surgical intervention as their head size was within normal limit for age till discharge. We could not follow them later on.

In conclusion, cranial ultrasonography is a sensitive and specific technique for the detection of various types of ICH (SEH, IVH, PVL) and very useful for the detection and monitoring of complications of ICH (hydrocephalus, porencephalic cyst, periventricular leukomalacia, ventricular septation and clots, and block in CSV pathway) by serial sonographic evaluations. At least one screening sonogram is essential in the first week of life for all high risk preterm and term neonates. Once hemorrhage is picked up sonographically, further evaluation may be done at weekly intervals.

Acknowledgements

Authors acknowledge Pool officer scheme of Council of Scientific and Industrial research, Government of India for financial help. The authors are grateful to the Principal Dr. S.N. Medical College, Jodhpur, for granting permission to carry out this work. We are thankful to Mr. V. Sharma, L.K. Vyas and L. Sharma for typing this manuscript.

REFERENCES


