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). Caranial 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 (1CH) 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 leukcomalacia (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 than, 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 sonographic 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 T-hemorrhage confined to germi-, nal layer matrix; Grade II-intraventricular hemorrhage without dilatation of ventricles; Grade III-IVH with dilatation; and Grade TV-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 S38 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 regarfls 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*

	Preterm (n = 29)	%	Term (n = 72)	Total (%) (n = 111)
ICH	11	38	17	28 (25)
Site of hemorrhage				
SEH	11		11	22
Parenchyma			4	04
Choroid plexus			2	02
Out come (n = 28)				
Complete recovery	6		6	12 (42.8)
Ventriculomegaly	2		4	6 (21.4)
Pseudo Porencephalic cyst			3	3 (10.7)
Aqueductal block hydrocephalus			1	1 (3.6)
Death	3		3	6 (21.9)

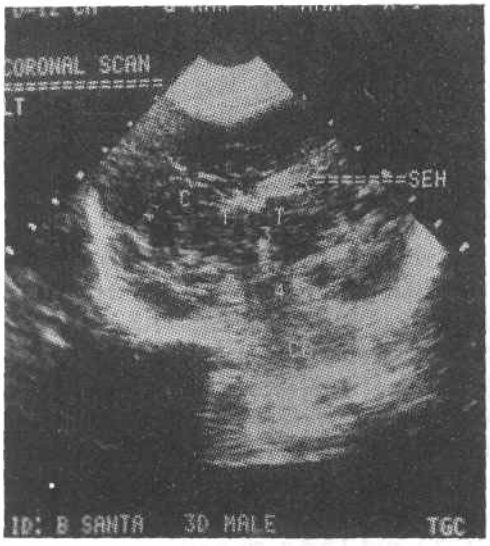

Fig. 1a

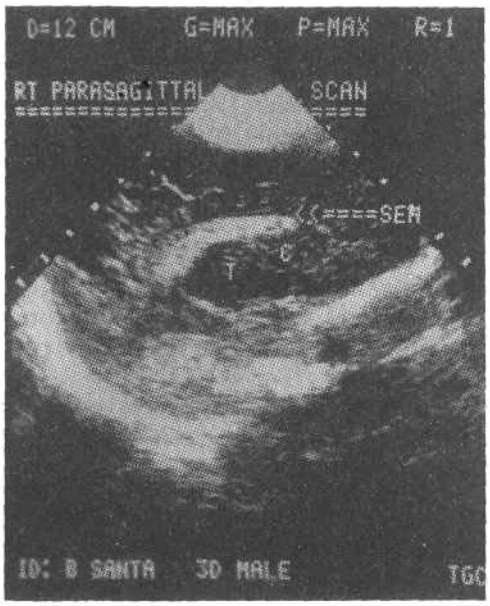

Fig. 1b

Fig. 1. Mid coronal (Fig. 1a) and right para-sagittal (Fig. 1b) scan showing Grade I hemorrhage.

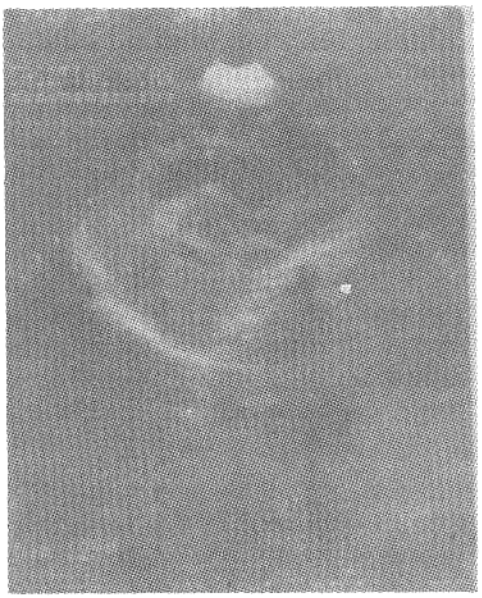

Fig. 2. Para-sagittal scan shows dilated lateral ventricle—Grade III hemorrhage.

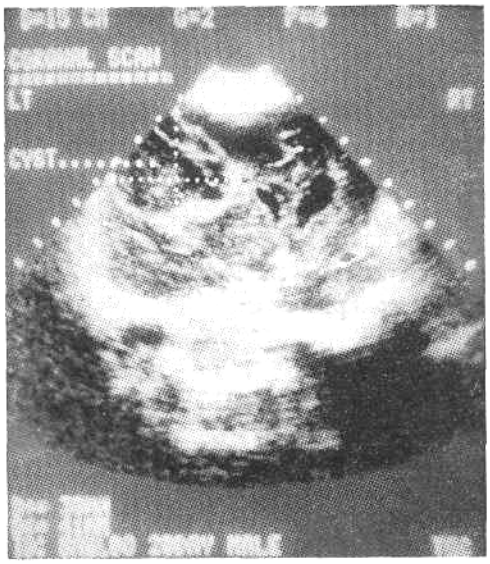

Fig. 3. Mid coronal scan shows intraparenchymal hemorrhage (Grade IV) in left hemisphere with shift of falx and ventricle to opposite side.

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 acqueducrtal 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,ll) and is also responsible for significant morbidity and mortality. SEH-IVH or their extension in to the brain parenchyma have previously been eported in 20-75% of preterm neoiates(3,6,12,l3) and few term neoiates(2,10,ll). In ttys study, it was observed in 33.3, 23.8 and 23.8% neonates vith 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, >2.00-2.5 Kg and >2.5 Kg, respectivey(14). Mack *et al* reported ICH in 20% jreterm neonates with birth weight of 810-2040 g(12). We observed SEH-IVH n 33.3, 23.8, 18.7 and 25.3% neonates vith birth weight of 1.00-1.5 Kg, >1.5-2, >2.00-2.5 and 2.5 Kg, respectively.

Leech *et al.* had demonstrated that he source of FVH is the germinal matrix

TABLE II—*Distribution of Cases of SEH-IVH According to their Gestational Age and Birth Weight*

ICH	Gestational age (weeks)			Birth weight (kg)				Total
Grading	≤32	33-≤37	≥38	1-1.5	>1.5-2	≥2-2.5	>2.5	
No.	18	21	72	15	17	16	63	111
I	4	2	5	2	3	1	5	11
II	-	-	1	-	-	-	1	1
III	1	2	6	2	-	1	6	9
IV	1	1	5	1	1	1	4	7
Total	6	5	17	5	4	3	16	28
%	33.3	23.8	23.8	33.5	23.5	18.7	25.3	25

TABLE III—*Incidence of SEH—IVH in Neonates with Birth Asphyxia*

ICH	*APGAR score			HIE staging			
Grading	<2	3-4	5-7	I (>4#)	II (3.5#)	III (2#)	n. (6)
No.	27	18	27	4	14	8	46
I	5	1	-	-	4	1	1
II	-	-	1	-	1	-	-
III	5	-	1	1	3	1	1
IV	2	1	1	-	2	1	1
Total	12	2	3	1	10	3	3
%	(44)	(11)	(11)	(25)	(71)	(37.5)	(6.8)

* APGAR score at 1 minute and 5 minutes.
# Mean APGAR score of group.

in more than 90% neonates(l). Papile *et al.* from their study concluded that IVH in preterms classically emanates from small vessels, principally-capillaries in the subependymal 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-

TABLE IV—*Sonographic Follow up of Neonates of SEH–IVH (n =28)*

Grade of ICH	Day of sonography					
	<5	7	14	21	28	CSF
I	17	12	decreased	disappear	-	clear
II	1	1	decreased	disappear	-	blood
III	6	9	6 + 3*	6**	6**	blood
IV	5	7	4 + 3*	3 + 1***	3 + 1***	blood

* Expired.
** Ventriculormegaly without abnormal increase in head circumference.
*** Acqueductal block, hydrocephalus.

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 1VH 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 nepnates with Grades II and III ICH had ventricular dilatation with hydrocephalus in 50% preterm neonates(17).

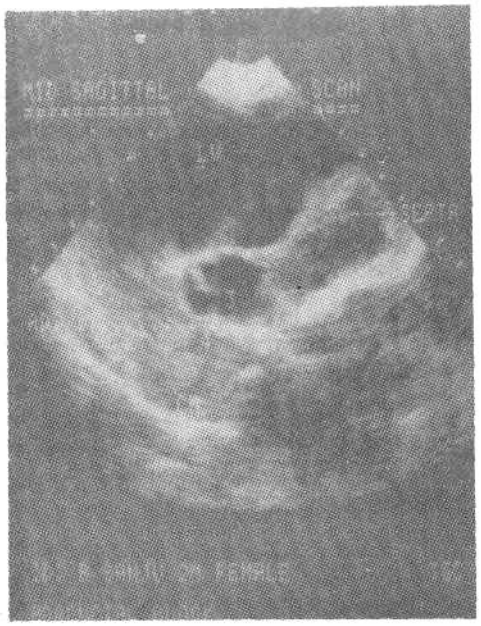

Fig. 4. Mid sagittal scan shows aqueductal block, dilated 3rd ventricle and lateral ventricle with septa in the patient with Grade III ICH.

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 leucomalacia, ventricular septation and clots, and block in *CSV* pathyway) 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

1. Leech RW, Kohnen P. Subependymal and intraventricular hemorrhages in the newborn. Am J Pathol 1974, *77:* 465-476.
2. Palma PA, Miner ME, Morris FH Jr, Adcock EW, Densen SE. Intraventricular hemorrhage in the neonate born at term. Am J Dis Child 1979, 133: 941-944.
3. Walter AC, Rividlo JJ. Parenchymal ischemic lesions in term and preterm infants. Pediatr Clin North Am 1992, 39: 621-643.
4. Bowerman RA, Donn SM, Silver TM, Jaffe MN. Natural history of neonatal periventricular/intraventricular hemorrhage and its complications: Sonographic observation. Am J Radiol 1984,143:1041-1052.

5. Heimburger R, Fry F, Patrick JT, *et al.* Ultrasound brain tomography for in fants and young children. Perinatal Neonatoll978, 2:27-31.

6. Sauerbrei EE, Digney M, Harrison PB, *et al.* Ultrasonic evaluation of neonatal intracranial hemorrhage and its complications. Radiology, 139: 677-685.

7. Papile LA, Burstein J, Burstein R, *et al.* Incidence and evolution of subependymal and intraventricular hemorrhage. A study of infants with birth weight less than 1500 grams. J Pediatr 1978, 92: 529-534.

8. Parkin JM, Hey EN, Clowes JS. Rapid assessment of gestational age at birth. Arch Dis Child 1976, 57:,259.

9. Sarnat HB, Sarnat MS. Neonatal encephalopathy following fetal distress. A clinical and electroencephalographic study. Arch Neurol 1976, 33: 696-705.

10. Bergman I, Baver RE, Barmada MA *et al.* Intracerebral hemorrhage in the full term neonates. Pediatrics 1985, 75: 488-496.

11. Chadha V, Mathur NB, Khanijo CM, Khalil A, Gulati P, Chowdhury V. Periventricular hemorrhage in term newborn originating from germinal matrix. Indian Pediatr 1991, 28: 401-405.

12. Mack LA, Wright K, Hirsch JH, *et al* Intracranial hemorrhage in premature infants: Accuracy of sonographic evaluation. Am J Radiol 1981, 137: 245-250.

13. Dolfin T, Skidmore MB, Fong KW, Hoskins EM, Shennan AT. Incidence, severity and timing of SEH-IVH in preterm infants born in a perinatal unit as detected by serial realtime ultrasound. Pediatrics 1983, 71: 541-546.

14. Pevsner PH, Bunvel RG, Leeds M, Finkel Stein M. Subependymal and IVH in neonates. Radiology 1976, 119: 111-114.

15. Friede RL. Developmenal Neuropathology. New York, Springer Verlog, 1976, pp 1-37.

16. Trounce JQ, Rutter M, Lenene MI. Periventricular leucomalacia and in traventricular hemorrhage in the preterm neonate. Arch Dis Child 1986, 61:1196-1202.

17. Gupta. *AK,* Anand NK, Lamba IMS. Ultrasonic evaluation of neonatal subependymal-intraventricular hemorrhage and its complications. Indian J Pediatr 1993, 60:11-18.

18. Svenningsen NW, Blennow G, Lindrath M, Coddin PO, Ahlstrom H. Brain oriented intensive care treatment in severe neonatal asphyxia. Arch Dis Child 1982, 57:176-183.

19. Brustein J, Papile LA, Brustein R. In traventricular hemorrhage and hydrocephalous in premature newborn—A prospective study with CT. Am J Radioll 979,132:631-635.