

SONOGRAPHY IN PYOGENIC MENINGITIS

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ABSTRACT

In this prospective study to evaluate usefulness of ultrasonography for early diagnosis and monitoring of complications of acute pyomeningitis, we performed serial sonographic examinations of skull in 50 infants (with open fontanelle) with proven pyomeningitis. One or more abnormal sonographic findings were detected in 32 infants. These were echogenic sulci (26%), ventriculomegaly with some or other complication (26%), brain abscess (20%), ventriculitis (14%), subdural effusion (6%) and cerebral edema (10%), and were detected mostly after the first week of illness. Ultrasonographic findings were in complete agreement with CT scan diagnosis of ventriculomegaly, ventriculitis, solitary brain abscess and cerebral edema. However, sonography missed cases of subdural effusion (2 out of 5), multiple brain abscesses (1 out of 2), and cerebral infarction (all the four), which were detected on CT Scan. Serial sonographic findings were useful in documenting progressive increase in ventricular size in all the 13 infants with ventriculomegaly and monitoring response to anti-edema therapy in 5 infants with cerebral edema. Sonography is a useful tool for diagnosis of complications of pyomeningitis after the first week of illness, and for monitoring the progress of ventriculomegaly.

Key words: Brain abscess, Meningitis, Subdural effusion, Ventriculitis, Ultrasonography.

Acute bacterial meningitis in infancy is associated with a high mortality and morbidity, often leading to neurodevelopmental deficits in survivors. Early detection and management of complications could help in reducing the mortality and morbidity. Ultrasonography of the brain has been shown to be a simple, reliable, informative, relatively inexpensive, non-invasive and radiation free bedside procedure to evaluate and monitor infants with meningitis. Although, a number of studies have described sonographic findings in bacterial meningitis(1-4), most of them have not attempted evaluation of the clinical significance of ultrasonographic findings(5,6). This prospective study was undertaken to evaluate the usefulness of sonography in early diagnosis, monitoring and prognosticating the significance of complications of pyomeningitis.

Material and Methods

The study was carried out on 50 infants (38 boys and 12 girls) with proven pyogenic meningitis. These were admitted consecutively to Pediatrics Wards of Postgraduate Institute of Medical Education and Research, Chandigarh between January 1988 to August 1989. Infants upto 18 months of age with open anterior fontanelle were included. Criteria for diagnosis of acute pyogenic meningitis were: (i) Suggestive

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history and clinical findings; (ii) Cerebrospinal fluid (CSF) changes of hypoglycorrhacia (CSF/blood sugar ratio <50%), polymorphonuclear leukocytosis and raised proteins above normal for the age, together with (iii) Either (a) CSF culture positive for pyogenic organisms or (b) CSF counterimmunoelectrophoresis (CIEP) positive for pyogenic organism. In the absence of a or b, tubercular meningitis was excluded by negative results of Mantoux test, chest roentgenogram and acid fast bacillus stains and cultures of CSF for *Mycobacteria*. Bacterial etiological organisms could be identified in 23 infants; in 20 by CSF culture and in 3 by CIEP only (Table I).

Infants with pre-existing intracranial malformations and neurological deficits were excluded. The study was approved by the Institute Ethics Committee.

Details of history and clinical examination were recorded on a prestructured proforma. Cases were followed up carefully; their clinical progress, appearance of new neurological signs, and treatment administered (including surgical interventions) was recorded.

Sonographic examination of the skull was done in all the infants at the time of the diagnosis and between day 5 to 7 after hospitalization. Follow up scans were done if the infant showed deterioration in neurological status or persistence of signs of raised intracranial pressure. RT 3600 model ultrasound machine (General Electric Company), with 5 and 7 MHz sector transducers was used. The scans were obtained in transfontanelle, axial, coronal, saggital and parasagittal planes. The sonograms were assessed for the presence of echogenic

TABLE I—Bacteria Identified in 23 Infants with Pyogenic Meningitis

Organisms	Number of infants in various age groups			
	0-1 mo	1-6 mo	6-12 mo	All (%)
1. <i>Streptococcus pneumoniae</i>	-	3*	4	7 (30)
2. <i>Salmonella</i>	1	2	-	3 (13)
3. <i>Meningococcus</i>	-	-	2*	2 (9)
4. <i>Staph. aureas</i>	1	1	-	2 (9)
5. <i>Klebsiella</i>	1	2	-	3 (13)
6. <i>Esch. Coli</i>	1	-	1	2 (9)
7. <i>Acinetobacter</i>	-	-	1	1 (4)
8. β -hemolytic streptococcus	1	-	-	1 (4)
9. <i>Proteus mirabilis</i>	-	-	1	1 (4)
10. Anerobic organism	-	1	-	1 (4)

* One case each was identified by CIEP.

sulci, parenchymal echogenicity, ventricular size, ventriculitis, fluid collection, and any evidence of encephalomalacia or brain abscess.

Computerized axial tomographic (CT) scans were obtained if the ultrasound findings were inconclusive, doubtful or insufficient to explain the clinical status of the infant. The scans were done within 24 hours of the ultrasonography. A high resolution CT scanner (model SCT 2000, Shimadzu) was used.

The outcome was assessed in term of mortality directly related to meningitic illness and morbidity.

Results

One or more abnormal sonographic findings, mostly detected in the second week of the illness, were seen in 32 infants (*Table II*). Increased brightness level of sulcal echoes was seen in 26% cases. In some patients the sulci were not only echogenic but also abnormally widened probably due to accumulation of inflammatory exudate (*Fig. 1*).

The ratio of the width of the lateral ven-

tricles to the hemispheres measured at the same level-in coronal section was defined as ventriculo: hemispheric ratio (VHR). A VHR above 33% was regarded as an abnormal increase in ventricular size (ventriculomegaly), and was found in 13 cases. It was of communicating type in 10 and non-communicating type in 3. Of these 13 infants, 5 had ventriculitis, 4 had brain abscess, 2 had subdural effusions (SDE) and 1 had a porencephalic cyst. A ventriculo-peritoneal (VP) shunt was inserted in six infants.

Brain abscess was seen as a sharply circumscribed lesion with a rim of intense echogenicity surrounding a relatively hypoechoic centre on sonography (*Fig. 2*) and was detected in 10 patients; in 8 these were solitary. Multiple abscesses which were detected on CT scan only, were completely missed on sonography in one patient while in another one sonography could detect only one of the three abscess cavities. The abscesses were located either in the frontal (in six) or parietal region (in four).

Ventriculitis was diagnosed in 7 cases on ultrasonography. The sonographic fea-

TABLE II— Sonographic Findings and their Relation to the Onset of First Symptoms in Infants with Pyogenic Meningitis (n=50)

Findings	<48 h	48h-1 w	>1 w	Total (%)
1. Normal study	3	13	2	36
2. Echogenic sulci	1	4	8	26
3. Ventriculomegaly	-	3	10	26
4. Brain abscess	-	1	8	18
5. Ventriculitis	1	1	5	14
6. Subdural effusion	-	1	4	10
7. Cerebral edema	-	2	3	10
8. Porencephalic cyst	-	-	1	2

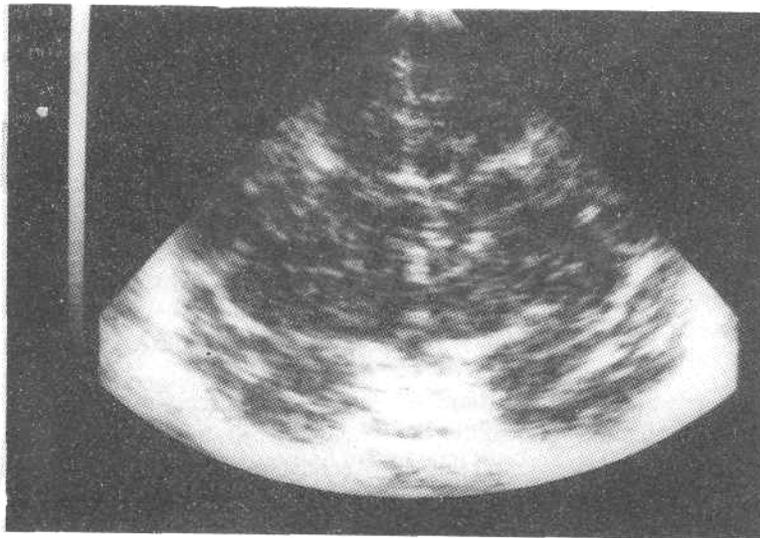


Fig. 1. Cranial ultrasound showing hyperechoic sulci, enhanced gyri and compression of lateral ventricles (Coronal section).

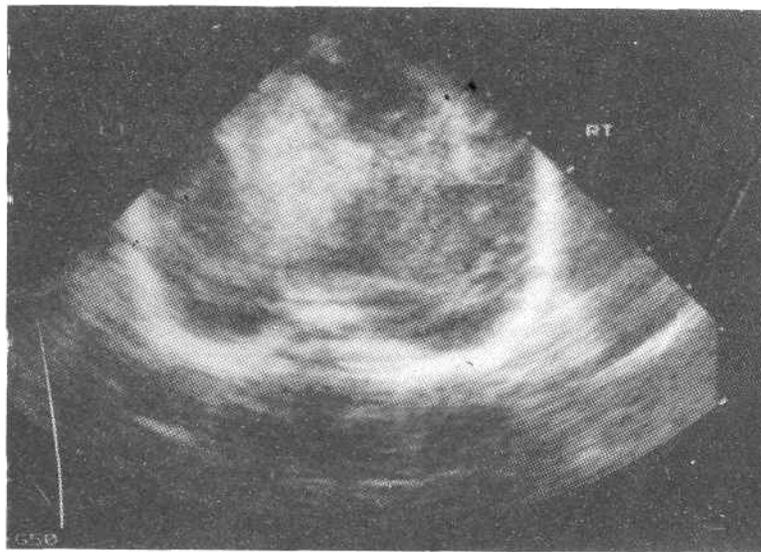


Fig. 2. Sonograph with features suggestive of brain abscess (sharply circumscribed echoes with a rim of intense echogenicity—coronal section).

tures of ventriculitis were: echogenic ependyma (all), echogenic choroid plexus (5) ventriculomegaly (4), echogenic debris

within ventricular cavity (3), and septation and compartmentalization (2) (Fig. 3). Contrary to popular belief, ventriculitis was not

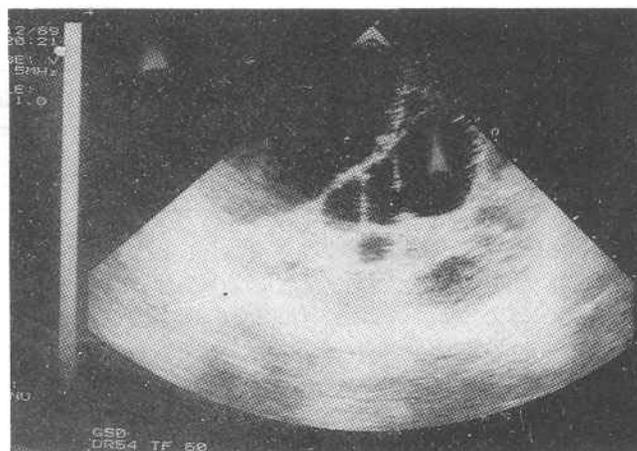


Fig. 3. Cranial ultrasound showing features of ventriculitis (septation and compartmentalization of ventricular cavity—parasagittal view).

confined to Gram-negative or neonatal meningitis. Three infants between 1 to 6 months of age, and two infants older than 6 months, one each with *Pneumococcal* and *Staphylococcal* meningitis, also showed findings of ventriculitis.

To increase the yield of detection of subdural fluid, angled projection through a fluid bag was used. However, sonography picked up only 3 out of 5 cases with subdural effusion (SDE); other two were detected on CT scan only. All the infants with SDE had sterile CSF cultures.

Cerebral edema with chink like ventricles was seen in five infants (Fig. 1). The findings disappeared on follow up examination after antiedema therapy.

Sonographic guided drainage was performed in 6 infants for drainage of ventricular fluid, subdural effusion and brain abscesses. It was successful in all.

CT Scans were done in 21 infants, 3 of

whom required multiple scans. As shown in Table III, the CT scan and sonographic findings were in very good agreement in diagnosing ventriculomegaly, ventriculitis, solitary brain abscess and cerebral edema. However, sonography failed to pick up two cases of bilateral SDE and brain abscess, and four cases of infarction detected on CT Scan. Most of the complications detected by CT Scan were visible in the third week of the illness (Table III).

All the 18 infants with normal ultrasounds had an uneventful recovery (Table IV). Of the 10 cases of brain abscess, 3 died and 6 were left with sequelae. The overall mortality was 16%, sequelae were seen in 18%.

Discussion

This study demonstrates a spectrum of sonographic findings in pyogenic meningitis which had good correlation with clinical outcome and CT Scan findings. Sonography

TABLE III—*Diagnostic Yield of Ultrasonography versus CT Scan in 50 Cases of Pyogenic meningitis, and Timing of Their Detection*

Findings	Length of the illness			Total No. detected by	
	1st week	2nd week	3rd week	CT Scan	Ultrasound
Of meningitis	-	1	-	1	1
Of ventriculitis	-	1	1	2	2
Brain abscess					
Solitary	1	2	5	8	8
Multiple	-	-	2	2	1
Unilateral SDE	-	-	1	1	1
Bilateral SDE	-	2	2	4	2
Cerebral edema	-	-	1	1	1
Infarction	1	1	2	4	-
Porencephalic cyst	-	-	1	1	1
Ventriculomegaly	1	3	7	11	11

Abbreviation : SDE = Subdural effusion

TABLE IV—*Outcome in Relation to Complications Detection on Ultrasonography*

	Morbidity	Mortality
1. Brain abscess	6/10	3/10
2. Ventriculitis	2/7	3/7
3. Ventriculomegaly	9/13	2/13

was particularly useful in early recognition of ventriculomegaly, ventriculitis, cerebral edema and solitary brain abscess. However, it was less sensitive in picking up cerebral infarction and subdural effusion. Infants with normal sonography had an uneventful recovery, while those with abnormal findings had significant morbidity and mortality.

Echogenic sulci which represent accumulation of inflammatory exudate in sulcal fissures, were seen in 26% of the patients in this study. This is in contrast to reported figures of 45-83%(2,5-7). These were not found to have any prognostic significance.

Ventriculomegaly was one of the most frequently seen abnormalities (26%). Some authors have reported a similar experience(6), while others have not found it to be very common(5). It is suggested that ventriculomegaly in the acute stage of meningitis may be a reversible finding(8); progression is likely if it is associated with parenchymal abnormality(5). In all the 13 of our cases with ventriculomegaly, it was associated with some other brain pathology, and 6 of them required a ventriculo-peritoneal shunt for decompression. High pressure

ventriculomegaly requiring a shunt has been considered very uncommon in some series(5).

Brain abscess was seen 10 infants. Only 3 of these had focal neurologic signs. Clinical evidence of raised intracranial tension was present in 8 infants. In two cases the abscesses were revealed in the absence of any suggestive clinical evidence. The incidence of brain abscess in this study (20%) is higher than most previous reports(5,7,9). Certain factors like a greater duration of illness, younger age of patients and infection with Gram negative organisms (5/10) could be responsible. In two infants, brain abscess was possibly the primary pathology, which had ruptured into the ventricles and led to meningitis. This was demonstrated in one case by sonography and CT Scan and in another at autopsy.

Sonography had an edge over CT Scan in demonstrating intraventricular septae in 7 cases of ventriculitis. Similar observations have been reported by other authors(6). Sonographic monitoring may thus help in early detection of ventriculitis and planning of therapy. Cerebral edema, sonographically identified by the effacement of sulci and gyri and presence of chink like ventricles, was seen in 5 cases. These findings were very helpful in the management of these cases. In all of them the findings disappeared after appropriate antiedema therapy. This is in contrast to the experience of Chowdhary *et al.* wherein all 4 infants with these findings died despite extensive medical therapy(6). Our data support the value of repeated ultrasound examination as a useful tool for follow up of cerebral edema.

Subdural effusions have been commonly reported in children with pyogenic meningitis[^]). However, inspite of using laterally

angled projections through the fluid bag between the transducer and the anterior fontanelle, SDE was missed in two out of 5 cases, which were picked up on CT Scan. Apparently sonography was not as good as CT Scan for detection of SDE.

Sonography was successfully used for therapeutic drainage of brain abscesses, ventricular fluid, and subdural effusions in this study. It can also be used for guiding the placement of ventriculoperitoneal shunts, and follow up of shunt surgery.

In conclusion, our study indicates that sonography is a useful initial imaging modality in the evaluation of complications of pyogenic meningitis after 48 hours of illness in infants with open fontanelle. It is particularly useful for monitoring ventriculomegaly. When there are doubtful or unexplained findings on sonography, CT Scan may be required for better delineation.

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