

PYOGENIC MENINGITIS: SONOGRAPHIC EVALUATION

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ABSTRACT

Forty infants with proven pyogenic meningitis were evaluated by real time cranial sonography. A spectrum of sonographic abnormalities was observed which included echogenic sulci, focal or diffuse increase in parenchymal echoes, ventriculitis, ventriculomegaly with or without aqueductal block, subdural collection, parenchymal infarcts, abscess and subdural empyema. There were two infants with normal sonogram while encephalomalacia was seen in another two patients. An excellent correlation was observed between clinical profile, cerebrospinal fluid biochemistry and sonographic findings.

Key words: Cranial sonography, Infant, Pyogenic Meningitis, Sonography.

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Meningoencephalitis of pyogenic origin remains one of the principle cause of mortality and morbidity even in the present antibiotic era. A significant number of survivors are often left with varying degrees of neuro developmental deficits. The early diagnosis, medical management and timely surgical intervention of the complications followed by proper sequential examinations can reduce the morbidity and mortality to a considerable extent. The detailed neurological assessment of the infants is limited and often impossible, so a reliable non-invasive imaging modality is needed which can demonstrate early structural changes and be suitable for follow up. The present study was carried out to evaluate the role of cranial sonography in infants of pyogenic meningitis.

Material and Methods

A prospective study was carried out in 40 infants of bacterial meningitis. Of these 27 were males and 13 females with 37 patients being less than one year of age. The criteria of diagnosis of pyogenic meningitis was (a) History and clinical examination; and (b) Cerebrospinal fluid showing presence of polymorphonuclear leukocytes, raised proteins and low sugar content. Cerebrospinal fluid was also examined microbiologically by Gram staining, culture sensitivity and latex agglutination test to detect the infective organism.

All infants with proven meningitis were subjected to sonography and sequential studies were performed if (a) initial study showed any abnormality, (b) new symptoms appeared, (c) cerebrospinal fluid did not clear with antibiotic therapy, or (d) sudden deterioration in the infant condition.

The scans were performed on Phillips

SDU 3000 real time sector scanner with a 5 MHz short focus transducer. Images were recorded on a multiformat camera. Transfontanelle coronal, sagittal and parasagittal scans were obtained in all the cases. The sonograms were assessed for presence of echogenic sulci, any abnormal increase or decrease in parenchymal echogenicity, ventricular size, ventriculitis, fluid collection and for any evidence of abscess or encephalomalacia.

Cranial computed tomographic scans were performed in twenty of these infants within 48 hours of the sonographic examination.

Results

A wide spectrum of sonographic abnormalities was observed in the present series of 40 infants of pyogenic meningitis. Only two infants had a normal sonogram despite clinical and biochemical profile of pyogenic meningitis (Table I).

TABLE 1-Sonographic Spectrum in Pyogenic Meningitis (n = 40)

Findings	Number	Percentage
Echogenic sulci	33	82.5
Parenchymal opacities	26	65.0
Ventriculitis:		
Ependymitis	21	5.3
C. Plexitis	8	2.0
V. exudates	1	0.3
Septae	4	1.0
Obliterated ventricles	4	1.0
Ventriculomegaly		
Aqueductal block	12	3.0
No block	3	0.8
Abscess	3	0.8
Infarcts	2	0.5
Subdural effusion	3	0.8
Encephalomalacia	2	0.5

The qualitative increase in brightness level of sulcal echoes and some degree of widening was the commonest sonographic finding seen in 33 cases (Table I).

Normal brain parenchyma exhibits low and medium level echoes throughout the white and grey matter which are typically relatively uniform and less prominent than the echoes from the cortical sulci. In parenchymal inflammation the echogenicity of brain parenchyma is increased which may be focal or generalized. There were twenty two cases having focal areas of increased echogenicity with varying severity, of these three showed only this abnormality which regressed to normal with specific antibiotic therapy.

Obliterated ventricular system with generalized increase in parenchymal echoes indicating cerebral edema was observed in four cases. All these cases were in Grade III coma at the time of admission and subsequently died.

Ventriculitis seen in the form of echogenic irregular ependyma, irregular hyperechoic choroid plexus, ventricular exudates or septae was another common finding seen in thirty four patients. Septae causing compartmentalization of lateral ventricle were seen in four infants (Fig. 1.) All the four infants had history of more than ten days of illness.

Ventriculomegaly observed in fifteen cases was due to aqueductal block in twelve. This block was due to intraductal or periaqueductal exudates.

The commonest complication detected sonographically was abscess seen as a sharply circumscribed lesion with a thick rim of intense echogenicity surrounding the hypoechoic centre (Fig. 2). One infant had multiple abscesses while two showed a solitary lesion. Infarct was seen as an area of altered parenchymal echogenicity in the

territorial distribution of a vessel with effacement of nearby sulci and absence of diminished pulsation of affected vessel. Infarcts were seen in two cases, in one as an area of increased echogenicity in the left caudate nucleus suggestive of hemorrhagic infarct (Fig. 3) and in another as a hypoechoic area in territory of middle cerebral artery representing an ischemic infarct.

A solitary case developed progressive bilateral subdural empyema with gross cerebral atrophy (Fig. 4). Two infants developed encephalomalacia as a sequelae of pyogenic meningitis.

In all the four infants having neurological motor deficit, causative lesion could be shown sonographically—abscess in two and infarct in the other two.

The study revealed a good correlation between cerebrospinal fluid cell count, protein level and the sonographic findings. Sugar levels did not show any significant correlation with sonograms (Table II). An increase in cell count and protein level was associated with an increase in severity and magnitude of sonographic abnormalities. All four infants having sonographic fea-

tures of cerebral edema had a cell count of more than 3000/cu mm and proteins of more than 100 mg/dl.

The sonographic findings in relation to duration of illness were as shown in Table III. Subdural empyema, parenchymal infarcts and abscesses were seen after a minimum of 10 days of illness.

In twenty infants sonographic findings were also compared with CT. Both modalities were equally effective in evaluation of normal, enlarged or compressed ventricles with mass effect. Ultrasound failed to demonstrate a small infarct in one case and a small subdural effusion in another which were picked up on CT.

Ventriculitis and intraventricular septae were better demonstrated on sonography. Aqueductal blocks were also diagnosed with greater confidence on sonography as it was possible to scan in saggital plane directly by ultrasound while direct saggital scanning is not possible on CT.

In this study 10 of the 40 infants expired. Four of these had sonographic features of gross cerebral edema, 5 had ventriculitis and one infant of cerebral abscess died in the post operative period.

TABLE II—Sonographic Features: CSF Biochemistry

Cerebrospinal fluid	Sonographic features				
			Obli. vent (C. edema)	Aqueductal block	Absc/Infarct/ SDE
Cell count (mm ³)	<1000	(20)	0	3	4
	1000-3000	(15)	0	4	2
	>3000	(5)	4	5	2
Proteins (mg/dl)	>40	(5)	0	0	0
	40-60	(15)	0	3	3
	>60	(20)	4	9	5

Obli = Obliterated; C. edema = Cerebral edema; Absc = Abscess, Vent = Ventricle.

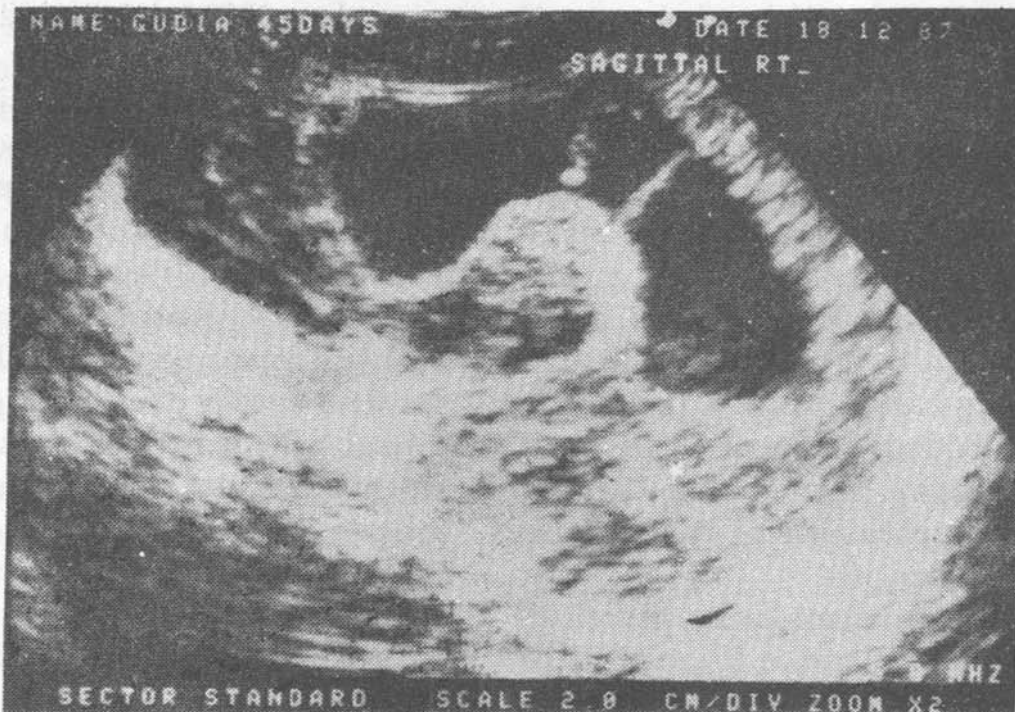


Fig. 1. Parasagittal scan showing dilated ventricles with ventricular septae.

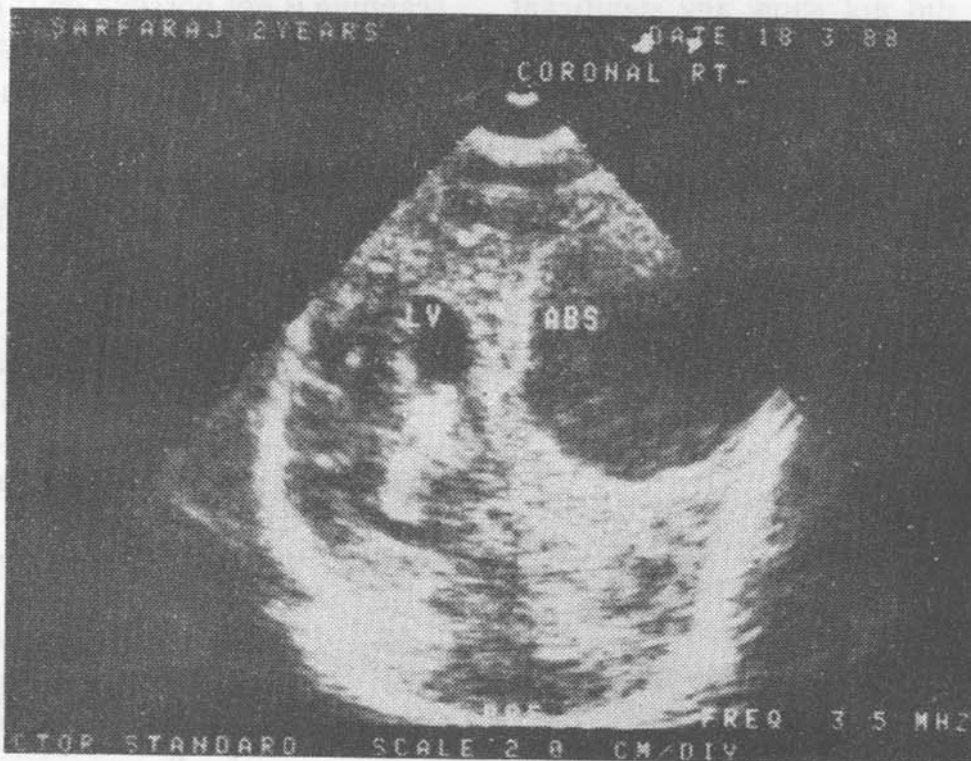


Fig. 2. Coronal scan showing a right parietal abscess.

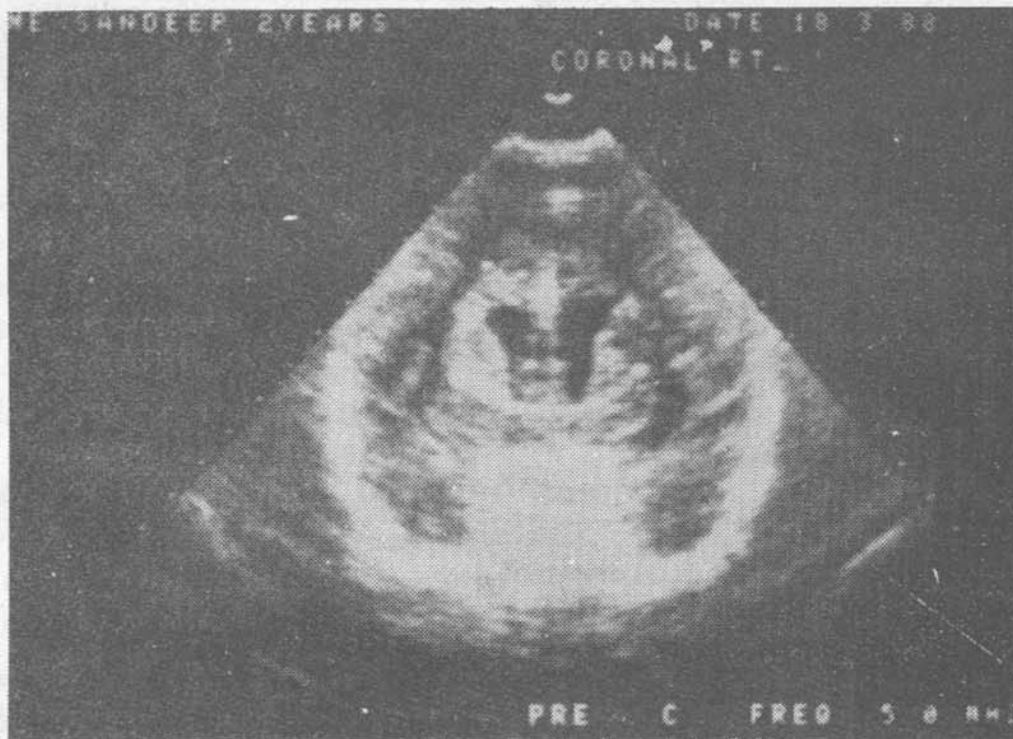


Fig. 3. Hemorrhagic infarct in left caudate nucleus seen in coronal scan.

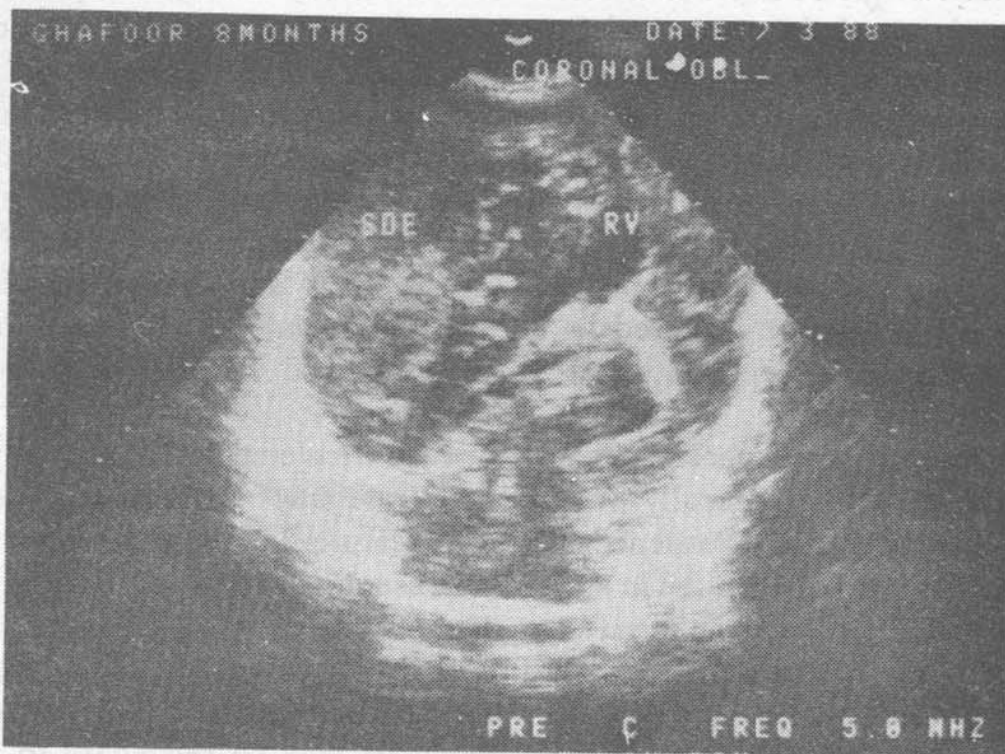


Fig. 4. Scan showing subdural fluid collection with lot of internal echoes—Empyema.

TABLE III—Sonographic Findings in Relation to Duration of Illness

Duration (days)	Ventriculitis (%)	Aq. block (%)	Parenchymal		Echo. sulci (%)	Others (%)
			Echoes (%)	Inf./Abs (%)		
1- 2	50.0	14.2	64.2	—	85.7	14.2*
3- 4	55.5	44.4	77.7	—	77.7	11.1*
5- 6	75.0	25.0	100.0	—	100.0	25.0*
7- 9	100.0	—	100.0	—	100.0	—
10-15	60.0	40.0	20.0	60.0	80.0	—
16-30	100.0	100.0	—	100.0	100.0	—
>30	—	—	100.0	—	100.0	100.0**

* Obliterated ventricles

** Subdural empyema

Discussion

Pyogenic meningitis is a common cause of mortality and morbidity in the pediatric age group. Mortality is high during the acute stage while sequelae like behavioral changes, mental retardation, motor deficits, hydrocephalus, cranial nerve palsies and convulsive disorders are often seen in survivors. An early recognition of structural changes is imperative for timely medical and/or surgical intervention. Although sonography as well as computed tomography can provide the required information the former has definite established edge over the latter.

The ventricular and parenchymal changes observed sonographically vary with the duration of illness and virulence of the infective organism. The increase in sulcal echogenicity and some degree of sulcal widening reflects an intense inflammatory exudate which accumulates in the depths of the fissures and sulci particularly around the pial and subarachnoid vessels(1). It was the earliest and commonest abnormal sonographic finding in our study as well as the previous studies(2).

An alteration in the parenchymal echo-pattern—diffuse, patchy or localised was the other common finding. The generalized increase in echogenicity represents diffuse cerebritis, while focal areas may reflect focal cerebritis, infarction or possibly hemorrhage(3). Focal cerebritis was commoner than diffuse in the present series.

Part of the infectious process manifests as gross generalized cerebral edema seen sonographically as compressed, obliterated ventricles with diffusely effaced sulci and gyri(4). This is a poor prognostic sign. All the four infants having these sonographic features died despite extensive medical therapy.

Ventriculomegaly, commonly mild to moderate may be an early or late sonographic feature. In the acute stage it probably represents a form of normal pressure hydrocephalus which may be associated with prominent, echogenic sulci and is usually reversible. The obstructive hydrocephalus may be secondary to accumulation of purulent exudate (acute) or due to gliosis (chronic). The frequency and severity of ventriculomegaly, however, varies widely in the different reported

series(2,3,5,6). We had fifteen cases with hydrocephalus, of which twelve were due to aqueductal block.

Sonography has a definite edge over computed tomography in demonstrating intraventricular septae. The intraventricular septae, seen in four infants of the present series, have a definite important therapeutic implication as they result in compartmentalization which may complicate medical as well as surgical management(7).

Sonogram revealed subdural effusion in only two infants, in contrast to previously reported studies(2,6) who have shown it to be a commoner finding. The subdural collection in these cases is usually sterile and ventricular tap is not required. In one infant sonogram revealed subdural fluid having lot of internal echoes suggestive of empyema, computed tomography and subdural tap corroborated the sonographic finding.

Abscess formation is an uncommon feature of neonatal and infantile pyogenic meningitis. It is usually caused by virulent Gram negative organisms. Abscess was seen in three infants. The precise sonographic appearance of an abscess depends upon its stage of formation, degree of cavitation and lignification. The abscess is usually found in an area that previously exhibited increased echogenicity and poor margination, representing a focus of cerebritis, vasculitis or parenchymal infarction that became infected(8).

The study clearly shows cranial real time sonography is a reliable, informative, inexpensive, less time consuming imaging modality for evaluation and follow up of the infants of pyogenic meningitis.

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