

# Cranial Ultrasonography in Evaluation of Meningitis in Neonates and Infants

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## A B S T R A C T

**Introduction:** Cranial ultrasonography plays an important role in the initial evaluation of infants with suspected meningitis and in evaluation of complications of the disease. Meningitis is a serious infection and commonly affects newborns, infants and children with grave consequences. There are many recent advances in diagnosis and treatment of meningitis. However, still there is residual neurological disability and morbidity. Study aimed to establish role of ultrasonography in evaluation of meningitis & its complication in neonates & infants.

**Material and methods:** 26 Patients with suspected case of meningitis with clinical findings of meningitis and/ or laboratory findings were performed cranial ultrasonography (Logiq P9 GE & Logiq P5 GE) with linear probe (7 to 11 MHz) and Curvilinear probe (3 to 5 MHz).

**Results:** A study was performed on 26 patients (newborn to one year old) of suspected meningitis. Sonograms were obtained within 72 hours of birth, and repeated on 7th, 14th or at an early date, if required. 5 patients were normal on sonography. The spectrum of sonographic abnormalities includes echogenic sulci (53.8%) and parenchyma (30.7%), ventriculomegaly (46%), ventriculitis (23%), cerebral infarction (3.8%), subdural fluid collection/ Subdural empyema (7.6%), extradural fluid collection (3.8%), encephalomalacia (3.8%) and cerebral abscess (7.6%) in patients.

**Conclusion:** Cranial ultrasonography continues as an excellent first line imaging investigation in suspected meningitis cases of infants for initial diagnosis, complications and monitoring the course of the disease. It is a reliable modality and provides useful information for diagnosis and treatment of meningitis and its complications.

**Keywords:** Meningitis, Ultrasonography, Doppler, Central Nervous System Infections, Neonates.

## INTRODUCTION

Even with recent advances in antibiotic and supportive treatment, meningitis is still an important cause of newborn and infant mortality and morbidity. Early diagnosis and timely appropriate treatment of the complications can reduce the morbidity and mortality to a considerable extent.<sup>1</sup>

The most common cause of neonatal meningitis is bacterial infection. The most commonly isolated causative organisms in CSF of infants with meningitis are Group B streptococci, *Escherichia coli* and *Listeria monocytogenes*. Less common gram-negative enteric organisms include *Klebsiella* species and *Citrobacter* species. Delayed detection and treatment of neonatal meningitis may cause cerebral palsy, seizure disorder and learning deficiencies.<sup>2</sup>

The use of sonography to examine these neonates & infants has rapidly increased in the last few years and the relative simplicity of the procedure, makes it an ideal method for early detection of complications and follow-up of these patients. Cranial sonography is mostly an initial imaging investigation for the evaluation of suspected meningitis in

new borns and infants. With the help of Doppler ultrasound, one can differentiate benign enlargement of subarachnoid spaces from subdural effusions.<sup>3</sup>

Sonography is extremely beneficial in evaluating intraventricular contents, especially debris and intraventricular septations.<sup>4</sup>

The objectives of study were early diagnosis of meningitis by cranial USG, early detection of complications of meningitis & early therapeutic intervention, establish the relationship between imaging findings and underlying pathological changes and establishment of cranial USG as 1<sup>st</sup> line imaging modality of choice.

## MATERIAL AND METHODS

The study was performed in the department of Radiodiagnosis, Dhiraj Hospital, S.B.K.S. Medical Institute and Research Centre, Pipariya, Vadodara. The study is Observational, Descriptive Hospital Based Study. Only those patients who were willing to participate in study were included. Patients who were suspected clinically and pathologically for meningitis were included in this study.

Sample size of the study is 26 patients, out of which 5 patients were normal on imaging study.

The age of the patients in this study is newborn and infants up to 1 year. Out of 26 patients, 14 patients were male and 12 were female. Sonograms were obtained in newborn within 72 hours of birth, and repeated on 7th, 14th or at an early date, if required.

Cranial ultrasonography was performed on Logiq P9 GE and Logiq P5 GE sonography machines. Patients were examined with both the probes: Linear probe (7 to 11 MHz) and Curvilinear probe (3 to 5 MHz). Trans-fontanelle coronal, axial and sagittal images were taken. Sedative agents were used when needed e.g. in case of excessive crying. All aseptic precautions were taken to reduce any chances of infection to neonates and infants. Brain parenchyma, ventricular system, brain stem, cerebellar hemispheres, outline and content of ventricles, CSF space and extra-axial spaces were carefully examined. After cranial ultrasonography, clino-radiopathological correlation was done and patients were treated according to severity of the disease.

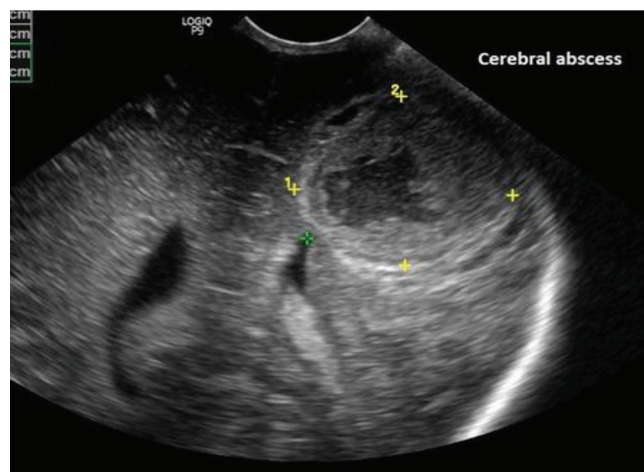
The patients were evaluated for presence of echogenic sulci, parenchymal echogenicity whether increased or decreased, size of the ventricles, presence of ventriculitis (echogenic ependyma, ventricular strands and echoes within the ventricles), any extraaxial fluid collection (e.g. subdural empyema) and for any evidence of abscess, infarcts or encephalomalacia.

### RESULTS

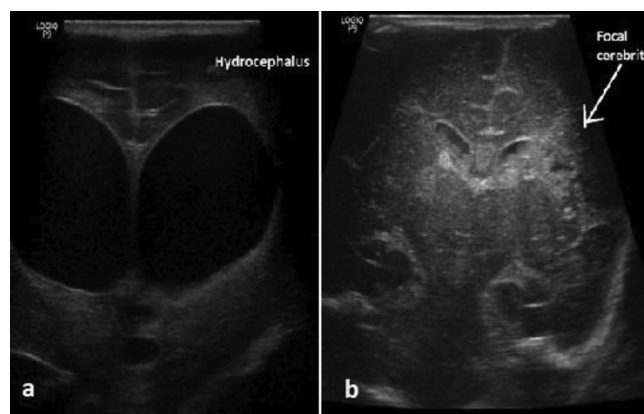
26 patients of suspected meningitis were evaluated with cranial ultrasonography. Out of these 26 patients, 5 (19.33%) patients were normal on ultrasonography despite clinical and biochemical profile of meningitis. 21(80.67%) patients were having imaging findings of meningitis. Out of 26 patients 14 (53.84%) were male and 12 (46.16%) were female, out of

them 3 (11.53%) males and 2 (7.69%) females are normal on imaging study. (Table 1)

The most common imaging finding is echogenic sulci and widening of sulci. It was seen in 14 (53.8%) patients. There were 8 (30.7%) patients having focal areas of increased echogenicity of brain parenchyma and out these patients,



**Figure-1:** Sonographic image of neonatal brain shows well defined round lesion with smooth margins and heterogeneous content suggestive of cerebral abscess.



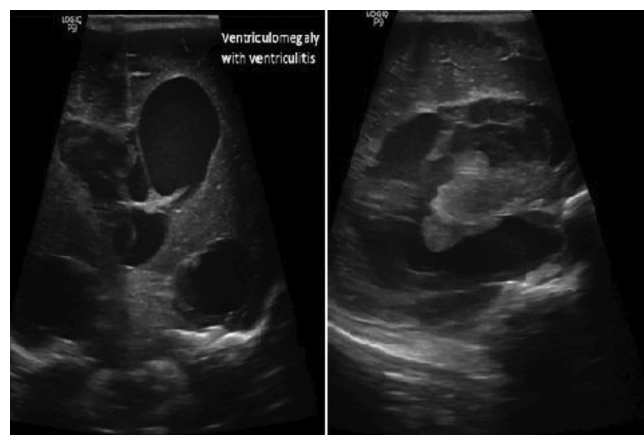
**Figure-2:** Transcranial ultrasonography in a patient shows (a) ventriculomegaly involving bilateral frontal horn & (b) changes of focal cerebritis in periventricular region.

Diagnosis	Male	Female	Total
Normal study	3	2	5
Abnormal imaging findings	11	10	21
Total	14	12	26

**Table-1:** Radiological findings according to gender distribution.

Findings	Number	Percentage (%)
Normal	5	19.2
Echogenic & widened sulci	14	53.8
Focal parenchymal opacities	8	30.7
Ventriculomegaly	12	46
Ventriculitis (Ependymitis, Choroid plexitis, Septa formation, Ventricular exudates)	6	23
Subdural empyema, Subdural effusion	2	7.6
Epidural effusion	1	3.8
Abscess formation	2	7.6
Encephalomalcia	1	3.8
Communicating Hydrocephalus	8	30.7
Haemorrhagic infarcts	1	3.8

**Table-2:** Sonographic spectrum in cases of meningitis (N=26)



**Figure-3:** Axial and sagittal images show ventriculomegaly with exudates, debris with septations & thickening of ependyma suggestive of ventriculitis.

Follow up Day	Echogenic sulci and widening (Out of 5 patients)	Parenchymal opacities (Out of 4 pts)	Ventriculomegaly and abscess formation (Out of 7 pts)
7 <sup>th</sup> day	2	2	7
14 <sup>th</sup> day	1	2	7
On date of discharge	1	1	7

**Table-3:** Follow up Imaging findings

2 (7.6%) patients developed cerebral abscess formation in subsequent scans. The sonographic appearance of Abscess was well-circumscribed, complex cystic mass with highly echogenic walls and marked peripheral hyperaemia. (Figure 1)

Ventriculomegaly was observed in 12 patients (46%); out of them 6 patients (23%) have imaging findings of ventriculitis. Ventriculitis was seen in form of echogenic irregular ependyma, choroid plexitis, septae and ventricular exudates. 8 patients (30.7%) were found having communicating hydrocephalus. (Figure 2 and Figure 3)

Subdural empyema, epidural and subdural effusions were observed in 3 patients (11.4%). Haemorrhagic infarcts were found in 1 patient (3.8%) and 1 patient (3.8%) was found having imaging findings of encephalomalacia on follow up images. (Table 2)

Out of 26 patients, 16 patients (61.53%) were followed up; it was observed that out of these 16 patients who were diagnosed on initial features of meningitis (Sulcal hyperechogenicity and widening) and were given timely antibiotic treatment, there was remarkable improvement in imaging. The patients who developed ventriculomegaly and other complications were found having same imaging findings on subsequent sonograms (Table 3).

## DISCUSSION

In the pediatric age group, infective meningitis is an important and common cause of mortality and long term morbidity. There is a high mortality in acute stages and serious neurological sequelae in the survivors. An early identification of macroscopic pathological changes is important for timely diagnosis and treatment.

In the early stages, first, there is widening and increased echogenicity of sulci on cranial ultrasonography due to intense inflammatory exudate accumulating in the fissures and sulci, particularly around pia and subarachnoid vessels. In our study it was observed in 53.8% neonates and infants where as Han et al. reported it 82% cases.<sup>5</sup> J.P. Soni did a study and found that echogenic sulci as the earliest finding in case of meningitis.<sup>6</sup>

Abnormal parenchymal echoes, diffuse or localized represents cerebritis or infarction, common in complicated meningitis carrying poor prognosis as reported earlier. Increased parenchymal echogenicity with thickened, small size ventricles suggested cerebral oedema and this required prolonged decongestive therapy. In our study it was found in 30.7% patients. Our study is consistent with Chowdhary *et al.* reported this in 65%.<sup>7</sup>

Ventriculomegaly can be an early or late finding on sonography. An early ventriculomegaly represents non-obstructive normal pressure hydrocephalus and is usually reversible. However, late ventriculomegaly is because of obstruction secondary to accumulation of purulent exudates (acute) or secondary to chronic inflammatory changes within ventricles or in the subarachnoid space. In our study it was found in 46% patients. D Baruah et al. found ventriculomegaly in 28.6% patients.<sup>8</sup> This finding is consistent with other studies.<sup>9</sup>

Ventriculitis usually arises from the choroid plexus. On sonography, there is echogenic irregular ependyma with irregular hyperechoic choroid plexus and ventricular exudates. If the disease progresses, after 2-3 weeks sonography shows formation of septations and compartments in the ventricles. In the present study, ventriculitis was observed in 23% cases in the form of ependymitis, choroid plexitis, ventricular exudate and septae.

Abscess is seen as sharply circumscribed lesion with thick rim of intense echogenicity surrounding the hypoechoic centre. The abscess is usually found in an area that previously exhibit increased echogenicity and poor margination, representing a focus of cerebritis, vasculitis or parenchymal infarction that becomes infected. In our study it was reported in 7.6% patients. Subdural and extradural effusion and subdural empyema were reported as complication of meningitis.<sup>10</sup>

## CONCLUSION

Cranial ultrasonography in newborns and infants is a rapid, safe and effective method for initial diagnosis, to identify complications and plan treatment of meningitis, even when signs and symptoms are vague or nonspecific. Ultrasound gives information regarding early and late changes seen in meningitis. Therefore, appropriate medical treatment can be timely initiated and monitored by sequential sonography and appropriate surgical intervention can be done when indicated.

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