ISSN : 1001-1781
Journal of Clinical Otorhinolaryngology, Head, and Neck Surgery

CRANIAL ULTRASONOGRAPHY IN EVALUATION OF MENINGITIS IN NEONATES AND INFANTS

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Introduction:
A crucial part of diagnosing possible meningitis in babies and assessing the consequences of the illness is cranial ultrasonography. Meningitis is a dangerous infection that frequently affects newborns, babies, and kids and can have life-threatening effects. The diagnosis and treatment of meningitis have advanced significantly in recent years. Still, there is morbidity and lingering neurological impairment. The purpose of the study was to determine the function of ultrasound in the assessment of meningitis and its complications in newborns and infants.

Materials and procedures: 26 Patients with clinical signs of meningitis and/or laboratory results who were suspected of having meningitis underwent cranial ultrasonography (Logiq P9 GE & Logiq P5 GE) using linear (7 to 11 MHz) and curvilinear (3 to 5 MHz) probes.

Results: A study of 26 patients with probable meningitis, ranging in age from newborn to one year, was conducted. Sonograms were taken within 72 hours of the baby's birth, and they were repeated on the seventh, fourteenth, or earlier if necessary. Five patients' sonography results were normal. Echogenic sulci (53.8%) and parenchyma (30.7%), ventriculomegaly (46%), ventriculitis (23%), cerebral infarction (3.8%), extradural fluid collection (3.8%), subdural fluid collection/subdural empyema (7.6%), encephalomalacia (3.8%), and cerebral abscess (7.6%) are among the range of sonographic abnormalities in patients.
In conclusion, cranial ultrasonography remains a valuable initial imaging examination for the diagnosis, management of complications, and tracking the progression of infants suspected of having meningitis. It is a dependable method that offers helpful information for meningitis diagnosis, treatment, and consequences.
Keywords: neonates, Doppler, ultrasonography, meningitis, and infections of the central nervous system.

Introduction:

Meningitis continues to be a major cause of newborn and infant mortality and morbidity despite recent advancements in antibiotic and supportive treatment. Morbidity and mortality

can be significantly decreased with early diagnosis and prompt, effective treatment of the consequences.

The most frequent cause of meningitis in newborns is infection with bacteria. In babies with meningitis, Escherichia coli, Listeria monocytogenes, and Group B streptococci are the most frequently isolated causal pathogens found in the CSF. The gram-negative bacteria Klebsiella and Citrobacter are less prevalent intestinal pathogens. Learning deficits, seizures, and cerebral palsy can result from treating newborn meningitis after it has been detected and treated too late.

Sonography has become increasingly popular in recent years as a means of examining neonates and babies. Its relative simplicity makes it a great tool for monitoring these patients and identifying issues early on. When a newborn or infant is suspected of having meningitis, cranial sonography is typically the first imaging test performed to assess the situation. Doppler ultrasonography can be used to distinguish between subdural effusions and benign expansion of the subarachnoid spaces.

When assessing intraventricular contents, particularly debris and intraventricular septations, sonography is incredibly helpful.

The study aimed to determine the relationship between imaging findings and underlying pathological changes, establish cranial USG as the preferred first line imaging modality, and diagnose meningitis early through early detection of complications and early therapeutic intervention.

Resources & Techniques:

The research was conducted in the radio-diagnosis department of the Dhiraj Hospital, S.B.K.S. Medical Institute and Research Centre, located in Pipariya, Vadodara. This is a descriptive, observational study conducted at a hospital. Patients were only included in the trial if they agreed to take part. This study covered patients who had a clinical and pathological suspicion of meningitis.

There are 26 patients in the study's sample, 5 of whom had normal imaging results.

The participants in this study range in age from newborns to infants who are one year old. There were 26 patients total; 12 were female and 14 were male. Sonograms were taken of the newborn within 72 hours after birth, and they were repeated on the 7th and 14th, or earlier if necessary.

On sonography devices Logiq P9 GE and Logiq P5 GE, cranial ultrasonography was carried out. Both the linear probe (7 to 11 MHz) and the curvilinear probe (3 to 5 MHz) were used to assess the patients. Coronal, axial, and sagittal trans-fontanelle images were obtained. Administered sedatives when necessary, such as in instances of profuse sobbing. Every aseptic measure was implemented to minimise the potential for infection among newborns and babies. A thorough examination was conducted of the brain parenchyma, ventricular system, brain stem, cerebellar hemispheres, ventricle shape and contents, CSF space, and extra-axial spaces. Following cranial ultrasonography, patients were treated based on the severity of their condition once clino-radio-pathological correlation was completed.

Echogenic sulci, parenchymal echogenecity (whether increased or decreased), ventricle size, ventriculitis (echogenic ependyma, ventricular strands and echoes within the ventricles), any

extra-axial fluid collection (e.g., subdural ependyma), and any signs of abscess, infarcts, or encephalomalacia were all assessed in the patients.

Results:

A total of twenty-six patients with probable meningitis underwent cranial ultrasound evaluation. Of these 26 individuals, 5 (19.33%) had normal ultrasonography results while having meningitis in their clinical and biochemical profiles. Meningitis was detected on imaging in 21 patients (80.67%). Of the 26 patients, 12 (46.16%) were female and 14 (53.84%) were male.

On imaging study, two (7.69%) girls and three (11.53%) males are normal. (Table 1).

Sulci that are echogenic and/or expanding are the most often observed imaging findings. Of the patients, 14 (53.8%) had it. Eight patients (30.7%) had localised regions with elevated brain parenchymal heterogeneity. Of these patients,

on subsequent scans, 2 individuals (7.6%) had the formation of a brain abscess. A well-circumscribed, complicated cystic mass with strongly echogenic walls and noticeable peripheral hyperaemia was what the abscess appeared like on sonography. (Fig. 1)

Of the patients, 6 (23%) had imaging evidence of ventriculitis; 12 patients (46%), had ventriculomegaly.

Ventriculosis manifested as sepate, choroid plexus, and ventricular exudates.

It was discovered that 8 patients (30.7%) had communicative hydrocephalus.(Figures 2 through 3).

Three patients (11.4%) had subdural effusions, epidurals, and subdural empyema. One patient (3.8%) was found to have hemorrhagic infarcts, and another patient (3.8%) had encephalomalcia on follow-up imaging. (Refer to Table 2)

Sixteen patients (61.53%) out of the 26 patients were followed up. It was noted that the imaging of these 16 patients showed a notable improvement after they received prompt antibiotic therapy and were diagnosed with meningitis based on the early symptoms (sulcal hyperechogenecity and widening). On later sonograms, the individuals who experienced ventriculomegaly and other problems were found to have the same imaging abnormalities (Table 3).

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)

Follow up Day	Echogenic sulci and widening (Out of 5 patients)	Parenchymal opacities (Out of 4 pts)	Ventriculomeg-aly and abscess formation (Out of 7 pts)
7^{th} day	2	2	7
14^{th} day	1	2	7
On date of discharge	1	1	7

Table-3: Follow up Imaging findings

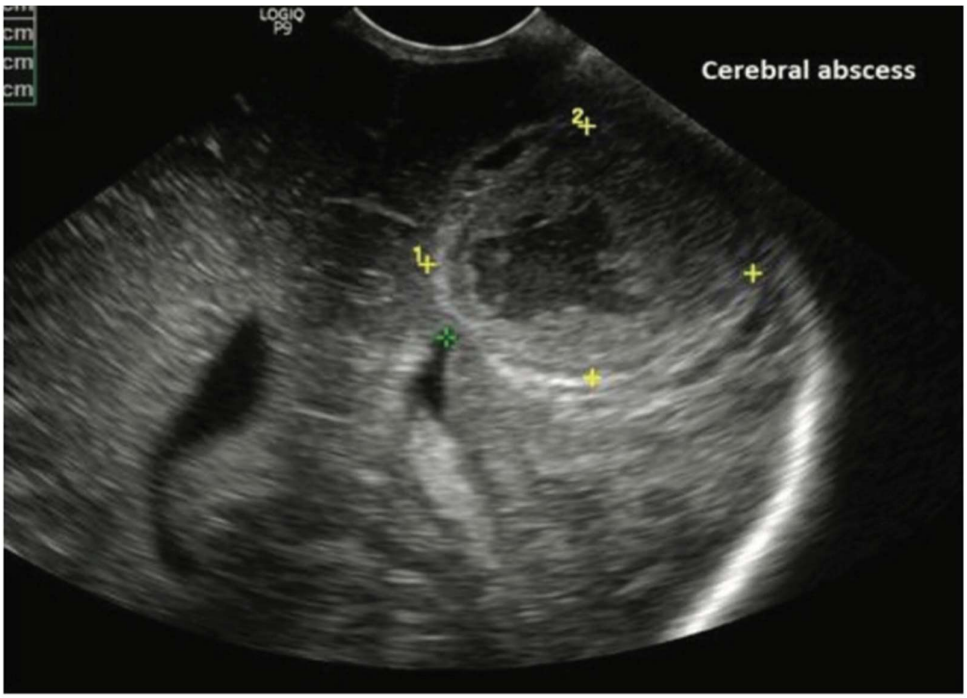

Figure-1: Sonographic image of neonatal brain shows well defined round lesion with smooth margins and heterogeneous content suggestive of cerebral abscess.

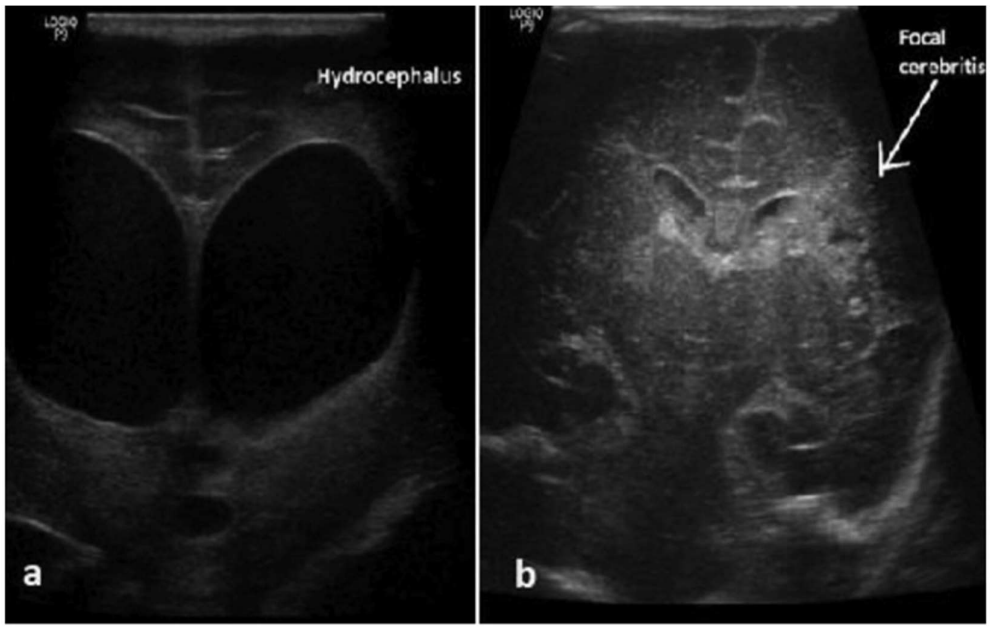

Figure-2: Transcranial ultrasonography in a patient shows (a) ventriculomegaly involving bilateral frontal horn &(b) changes of focal cerebritis in periventricular region.

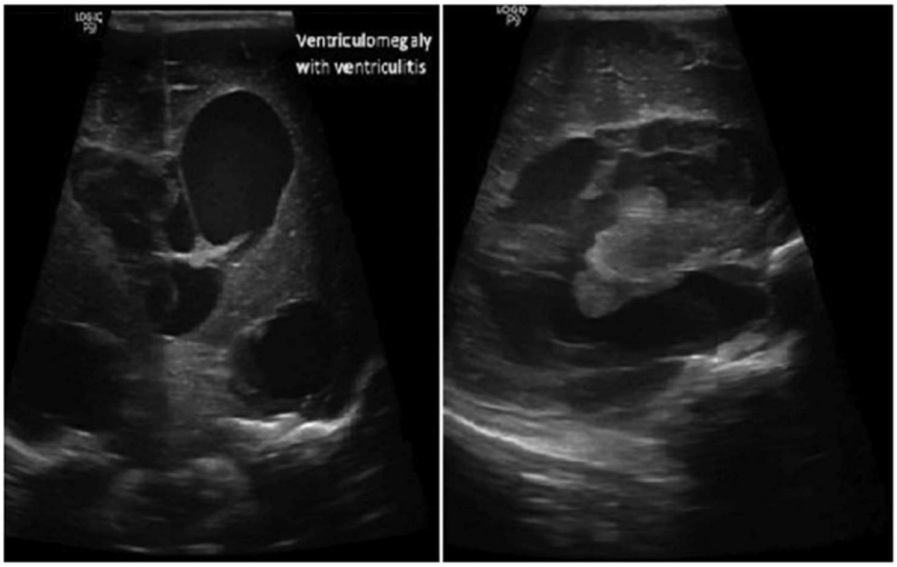

Figure-3: Axial and sagittal images show ventriculomegaly with exudates, debris with septations & thickening of ependyma suggestive of ventriculitis.

Discussion:

Infectious meningitis is a significant and frequent cause of death and long-term illness in the paediatric age range. In acute stages, there is a high death rate, and those who survive have significant neurological aftereffects. For prompt diagnosis and therapy, it is critical to identify macroscopic pathogenic alterations as soon as possible.

First, severe inflammatory exudate builds up in the fissures and sulci, especially around the pia and subarachnoid arteries, causing sulci to expand and become more echogenic on cranial ultrasonography.

53.8% of newborns and babies in our research had it, compared to 82% of instances reported by Han et al.5. According to a study by J.P. Soni, the first indication of meningitis is an echogenic sulci.

As previously stated, diffuse or localized abnormal parenchymal echoes are indicative of cerebritis or infarction, which is frequent in severe meningitis and has a bad prognosis.

Long-term decongestive therapy was necessary due to the suggestion of cerebral oedema caused by increased parenchymal echogenicity and tiny ventricles. In our investigation, 30.7% of the patients had it. Our research agrees with Chowdhary et al.'s 65% assessment on this.

Ventriculomegaly may present on sonography as an early or late finding.

Early ventriculomegaly, which is typically reversible, is a representation of non-obstructive normal pressure hydrocephalus. On the other hand, persistent inflammatory alterations within ventricles or in the subarachnoid space, or accumulation of purulent exudates as an acute source of blockage, are the causes of late ventriculomegaly. In our study, 46% of the patients had it. According to D Baruah et al., 28.6% of patients had ventriculomegaly. This result is in line with previous research.

The choroid plexus is typically the source of ventriculitis. Echogenic irregular ependyma with irregular hyperechoic choroid plexus and ventricular exudates are seen on sonography.

If the illness worsens, sonography will reveal the establishment of ventricular compartments and septations after two to three weeks.

In the current investigation, ependymitis, choroid plexitis, ventricular exudate, and septae were the forms of ventriculitis that were seen in 23 percent of the cases.

An abscess is observed as a narrowly defined lesion with a thick, highly echogenic rim encircling the hypoechoic center.

The abscess is typically located in a location that had previously shown poor margination and elevated echogenicity; this area may be an infected center of cerebritis, vasculitis, or parenchymal infarction. It was noted in 7.6% of the patients in our study. As a result of meningitis, subdural and extradural effusions as well as subdural empyema have been documented.

Outcome:

Even in cases where signs and symptoms are hazy or nonspecific, cranial ultrasonography is a quick, safe, and efficient way to make an initial diagnosis, spot complications, and schedule meningitis treatment. The early and late alterations in meningitis can be identified with ultrasound. As a result, when necessary, appropriate surgical intervention can be carried out, and sequential sonography can be used to monitor and promptly commence medical treatment.

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