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Role of Spinal Ultrasound in Diagnosis of Meningitis in Infants Younger than 6 months

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Abstract
Aims: *The study was undertaken with the objective to assess accuracy of spinal ultrasound in diagnosis of meningitis in infants younger than 6 months.*
Material and Methods: *our study is hospital based prospective diagnostic accuracy study, done over a period of 12 months, The nature and purpose of procedure was explained to parents / guardians and written informed consent from parents/guardians was taken in all cases. Infants more than 6 months of age, Infants having open spinal defects, Infants who had a prior lumbar puncture and parents of infant denying lumbar puncture were excluded from study.100 infants with clinical suspicion of meningitis and age less than 6 months were recruited for the study. Detailed history was taken from parents/guardians, and complete examination was done in all subjects. After base line investigations all the patients were subjected to spinal ultrasound.*
Standard sagittal and axial sonography of thora-columbar spine was performed in all the 100 patients suspected of meningitis on the basis of history and clinical examination. Images were analysed for presence of echogenic debris or trabeculations in the posterior subarachnoid space within the thoraco-lumbar spine. Colour Doppler was used to differentiate subarachnoid vessels from echogenic debris. Presence or absence of spinal cord and nerve root pulsation in cine mode was also recorded. USG findings were analyzed as: 1.Echogenicity or trabeculations in subarachnoid space: present/absent.2.Pulsations of the spinal cord and nerve roots: present/reduced or absent. Following spinal USG all the infants were subjected to lumbar puncture for CSF analysis and confirmation of meningitis. Infants with echogenic debris/ trabeculations or abnormal pulsation of the spinal cord and nerve root were compared with those with echo-free subarachnoid space and normal pulsation of spinal cord and nerve roots with respect to their findings of CSF examination.
Statistical Analysis: *Continuous variables were summarized as mean and standard deviation, categorical variables were summarized as frequency and percentage. Differences in the distribution of categorical variables among those with and without meningitis were analysed using chi-square test. McNemar chi-square was used to analyze the relationship between ultrasound findings and meningitis. The validity of ultrasound findings in the diagnosis of meningitis was reported as sensitivity, specificity, positive predictive*

value, negative predictive value and diagnostic accuracy along with their 95% confidence intervals. Data was analyzed using Microsoft Excel and Open Epi. A p value of <0.05 was taken as significant.

Result: *Among 60 CSF positive patients USG spine findings (Echogenicity / Trabeculations or Reduced / Absent spinal cord and nerve root pulsations) were present in 32 cases whereas 28 patients had normal USG spine findings and only 4 patients out of 40 CSF negative patients had positive USG spine findings (Present Echogenicity / Trabeculation). Based on these findings the sensitivity , specificity , positive predictive value , negative predictive value , after combining both the sonographic findings of spinal USG in meningitis patients was 53.33% , 90% , 88.89% , 56.25% respectively with a diagnostic accuracy of 68%. These results were statistically significant with p value <0.001.*

Conclusion: *Our study demonstrates that the presence of echogenicity / trabeculations in posterior subarachnoid space on ultrasound spine or abnormal spinal cord and nerve root pulsations are significantly associated with meningitis with a high specificity and positive predictive value in its diagnosis. So spinal ultrasound can be used as a simple, inexpensive, non-invasive, rapid and fairly specific radiation free imaging modality to help in diagnosing meningitis.*

Keywords: *Meningitis, Spinal cord, USG, Nerve root pulsations and trabeculations.*

Introduction

Meningitis refers to inflammation of the leptonmeninges. Meningitis can be caused by bacteria, viruses, parasites and fungi as well as by non-infectious conditions including inflammatory disorders (e.g., systemic lupus erythematosis or Kawasaki disease) and neoplasia (e.g., leukemic meningitis)[1]. Meningitis is one of the most potentially serious infections occurring in infants and older children. The infection is associated with a higher rate of acute complications and risk of long term morbidity. The etiology of bacterial meningitis and its treatment during the neonatal period (0-28 days) are generally distinct from those in older infants and children[2]. Most common causes of neonatal meningitis in US are group B Streptococci (50%), E.coli (20%) and Listeria monocytogenes (5-10%). In developing countries gram negative bacilli specifically Klebsiella and E.coli more commonly cause neonatal meningitis[3,4].

In children older than one month of age, most common organisms causing bacterial meningitis are streptococcus pneumonia, Neisseria meningitidis and Hemophilus influenza type B. Alterations of host defense resulting from anatomic defects or immune deficits also increase the risk of meningitis from less common pathogens such as Pseudomonas aeruginosa, Staphylococcus aureus, coagulase negative Staphylococci, Salmonella spp., anaerobes and Listeria monocytogenes. The incidence of meningitis is sufficiently high in febrile infants that it should be included in the differential diagnosis of those with altered mental status and other evidence of neurologic dysfunction[2].

Regardless of etiology, most patients with acute CNS infection have similar clinical manifestations. Common symptoms include headache, nausea, vomiting, anorexia, restlessness, altered state of consciousness and irritability. Common symptoms found in infants are fever, poor appetite, bulging fontanel, seizures, jitteriness, apnea, irritability, vomiting, neck rigidity. Common signs of CNS infection in addition to fever, include photophobia, neck pain and rigidity, obtundation, stupor, coma, seizures, and focal neurologic deficits [5].

Meningitis is a serious, potentially life-threatening condition that can rapidly progress to permanent brain damage, neurologic problems, and even death despite the availability of new antibiotics and good preventive care. Though meningitis is common in different parts of the world, its incidence varies from place to place. Baruah et al. found the incidence of meningitis higher in 5–12 month age group (60%). Apart from this age group, the next highest incidence was found in age group of 2–4 months (21.9%) followed by less than 1 month (17.1%)[6]. Over one million cases of meningococcal disease occur every year, with more than 80% cases of bacterial meningitis in children under the age of two years[7,8]. The mortality rate is up to 15–20% in neonates[9]. Hence, early diagnosis and detection of complications is necessary for timely management and intervention.

A definitive diagnosis of meningitis is made by lumbar puncture (LP); however CSF findings are characteristic in only 90% of the cases[10-13].

Cranial ultrasound is often used in initial evaluation of critically ill infants with suspected meningitis[12]. Thus, familiarity with sonographic findings is important for the radiologists and neonatologists. The spectrum of abnormalities includes echogenic sulci, sulcal separation, abnormal parenchymal echogenicity, hydrocephalus, ventriculitis, abscess, subdural empyema and hemorrhagic infarct.

Contrast enhanced computed tomography (CT) of brain may show meningeal enhancement, which becomes more accentuated in later stages. Brain CT scan is often performed before the LP, with signs or symptoms of increased intracranial pressure, however, overuse of CT as a diagnostic modality only to confirm meningitis is not justified because of its low diagnostic yield. Also, the radiation exposure to the pediatric population from CT scans is a well known hazard.

Spinal ultrasound was first proposed in the early 1980s but it has taken some time to enter routine clinical practice[14,15]. The examination is performed using a 7.5–10 MHz linear probe in both the sagittal and axial plane along the entire spine. The examination can be performed in the Ultrasound Department or on the ward with a portable machine. No sedation is necessary. Spinal ultrasound is possible in the neonate owing to a lack of ossification of the predominantly cartilaginous posterior arch of the spine[16,17]. The quality of ultrasound assessment decreases after the first 3-4 months of life as posterior spinous elements ossify, and in most children spinal ultrasound is not possible beyond 6 months of age. However, the persisting acoustic window in children with posterior spinal defects of spinal dysraphism enables ultrasound to be performed at any age[16,17]. The normal neonatal spinal cord is displayed on ultrasound as a tubular hypoechoic structure with hyperechoic walls. The central canal is hyperechoic, the so-called central echo complex[18]. The subarachnoid space surrounding the cord is hypoechoic.

Sonographic examination of the pediatric spinal canal is accomplished by scanning through the normally incompletely ossified posterior elements. Therefore, it is most successful in the newborn period and in early infancy. In infants older than 6 months, the examination can be very limited, although the level of termination of the cord can often be identified. In experienced hands, ultrasound imaging of the infant spine has been shown to be an accurate and cost-effective examination that is comparable to magnetic resonance imaging (MRI) for evaluating congenital or acquired abnormalities in the neonate and young infant. The advantages of Spinal ultrasound are not only a diagnostic sensitivity equal to MRI[19] but that, unlike MRI, SUS can be performed portably, without the need for sedation or general anesthesia. In addition, MRI is highly dependent on factors affecting resolution, including patient movement, physiological motion from cerebrospinal fluid (CSF) pulsation and vascular flow, factors that do not affect SUS[20]. Because of the clinical ease of examination and lack of need for sedation, ultrasound is generally considered the first-line tool for diagnosis, with MRI often reserved for cases in which ultrasound is inadequate or insufficient for diagnosis or exclusion of abnormalities.

Specifications of the Examination: The examination is usually performed with the infant lying in the prone position, although the study can also be done with the patient lying on his or her side. A small bolster may be placed under the lower abdomen/pelvis to mildly flex the back, which may improve imaging. The knees are flexed to the abdomen to allow adequate separation of the spinous processes and visualization of the spinal canal contents.

Avoiding overzealous and excessive flexing that could impede respiration[21]. The spinal cord is assessed in longitudinal and transverse planes, with right and left labeled on transverse images. Longitudinal images are ideally obtained in the midline sagittal plane, although in larger/older babies (with greater spine ossification), it may be necessary to obtain images in a slightly off-midline parasagittal plane that is parallel to the spinous processes. The thoraco- lumbar region of spinal canal is included in the examination.

Few studies[22-24] have discussed the utility of spinal USG in evaluation of echogenicity and pulsation of spinal cord and nerve roots. Referring to the available literature, till date there has been very limited published data about the prospective accuracy of spinal USG in meningitis[25]. As subarachnoid space is continuous along the spinal canal, echogenic debris is expected to be found in subarachnoid space at the spinal level[6]. Echogenic debris in spinal subarachnoid space is a marker of arachnoiditis[23]. Due to inflammation of endothelial lining of brain capillaries, permeability increases allowing penetration of serum proteins of low molecular weight into CSF. Large number of leukocytes enter subarachnoid space and release toxic substances. So inflammatory cells, RBCs and proteins are found in subarachnoid space of spinal canal. These inflammatory mediators increase the echogenicity of subarachnoid space. CSF flow is seen as a pulse[26] on spinal USG. Pulse is reduced or absent in areas where arachnoiditis obliterates the subarachnoid space[27], in cases of impaired CSF flow due to altered neuraxial flow dynamics[28] and hardened dural membrane due to pachymeningitis. Formation of septations and echogenic debris also reduce the spinal cord and nerve root pulsations. Thus, spinal cord and nerve root pulsations are expected to reduce in cases of meningitis.

This forms the basis of our study, that spinal USG can detect changes in CSF echogenicity and decreased spinal cord and nerve root pulsation which can reflect the inflammatory changes in meningitis.

Materials and Methods

Our study was a Hospital based prospective diagnostic accuracy study. This study was done for a period of 12 months, conducted from 1st April 2015 to 31st March 2016. The study was conducted at Post Graduate Department of Pediatrics, G.B. Pant Hospital Srinagar, An associated Hospital of Government Medical College Srinagar. The nature and purpose of procedure was explained to parents/guardians and written informed consent from parents/guardians was taken in all cases. Infants less than 6 months of age with clinical suspicion of meningitis.

Methodology

One hundred consecutive patients with clinical suspicion of meningitis and age less than 6 months were recruited for the study. Detailed history was taken from parents/guardians, and complete examination was done in all subjects. After base line investigations all the patients were subjected to spinal ultrasound.

The individual spinal ultrasound studies were performed using 7.5 MHZ linear transducer on SIEMENS ACUSON X300 ultrasonography machine, installed in the pediatric radiology section of G.B Pant Hospital G.M.C Srinagar. The examination was performed with the infant lying in the prone position, a small bolster was placed under the lower abdomen to mildly flex the back.

Standard sagittal and axial sonography of thora-columbar spine was performed in all the 100 patients suspected of meningitis on the basis of history and clinical examination. Images were analysed for presence of echogenic debris or trabeculations in the posterior subarachnoid space within the thoraco-lumbar spine. Colour Doppler was used to differentiate subarachnoid vessels from echogenic debris. Presence or absence of spinal cord and nerve root pulsation in cine mode was also recorded.

USG findings were analyzed as

Echogenicity or trabeculations in subarachnoid space: present/absent.

Pulsations of the spinal cord and nerve roots: present/reduced or absent.

Following spinal USG all the infants were subjected to lumbar puncture for CSF analysis and confirmation of meningitis.

Infants with echogenic debris/ trabeculations or abnormal pulsation of the spinal cord and nerve root were compared with those with echo-free subarachnoid space and normal pulsation of spinal cord and nerve roots with respect to their findings of CSF examination.

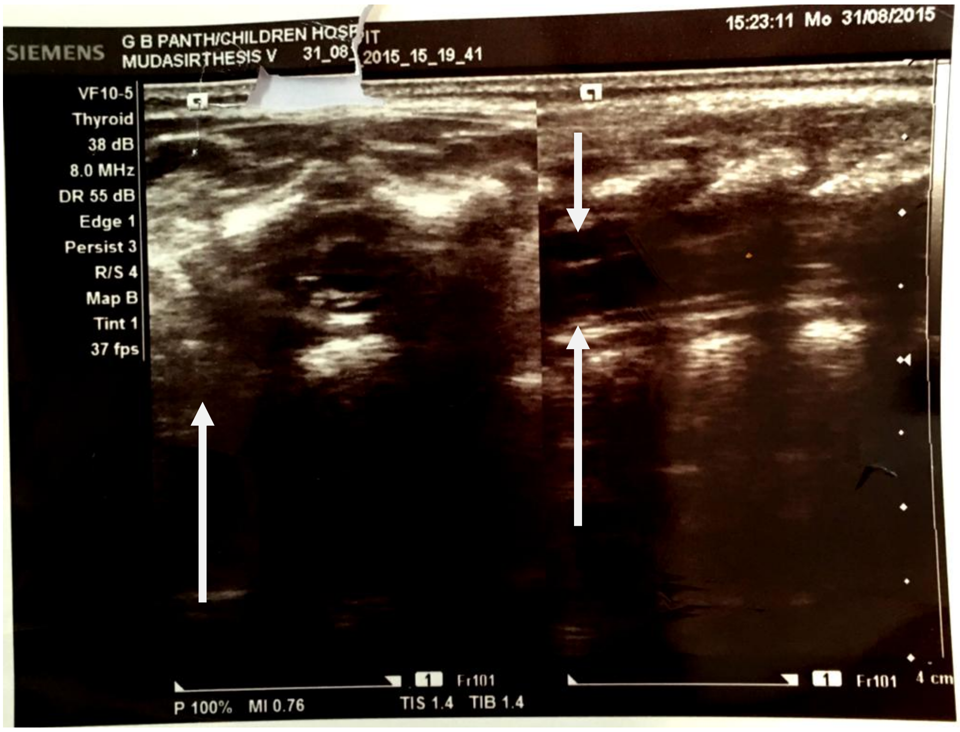
Observation and Results

Study was conducted in 100 patients who were suspected of meningitis based on their clinical presentation. We had male preponderance in our study. Out Of 100 patients studied 67% were males and 33% were females. Majority of patients were up to 60 days old with 41% patients of less than 30 days of age and 36% were between 31-60 days old .13% patients were in the age group of 61-90 day, 6% in 91-120 days and 4% in 121-150 days. Amongst males 35.8% were in each age group of ≤ 30 days and 31-60days. In females ≤ 30 days were 51.5% and 31-60 days were 36.4 %. 3%, 6.1% and 3% were in age group of 61-90 days, 91-120 days and 121-150 days respectively in females. In males 17.9%, 6%, 4.5% were in age group of 61-90 days, 91-120 days and 121-150 days respectively. Most frequent clinical feature was lethargy and poor cry (72), followed by Fever (60), Focal seizures (45),Vomiting (40), Altered sensorium (13), Raised temperature (56), Poor motor tone(52), Neck rigidity (33), Normal physical examination(30), Focal neurological deficit (12) and Bulging fontanel (8).

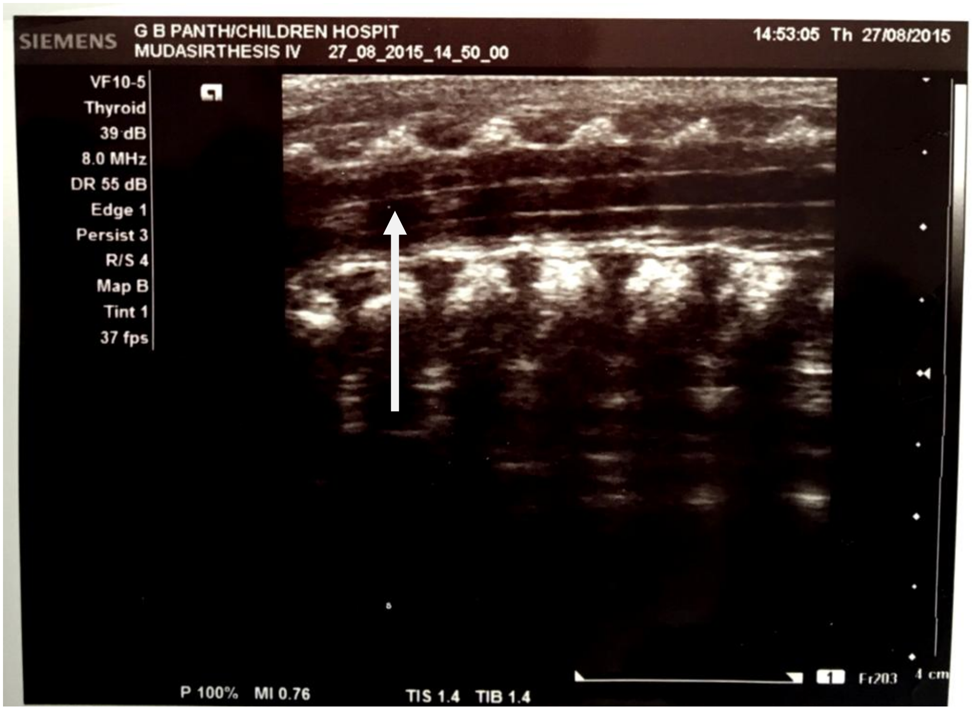
Out of 100 studied patients 34% had echogenicity and/or trabeculations in posterior subarachnoid space on ultrasound spine and 66% patients were having no echogenicity or trabeculations on ultrasound spine. Out of 100 studied patients, in 68% spinal cord and nerve root pulsations were present on ultrasound spine and in 32% spinal cord and nerve root pulsations were reduced or absent. 60% patients were diagnosed with meningitis on the basis of CSF examination out of 100 studied patients and 40% had normal CSF cytology. In meningitis group 50% had echogenicity and/or trabeculations present whereas 4 (10%) patients in non- meningitis group had echogenicity or trabeculations on spinal ultrasonography. This difference was statistically significant with p-value of <0.001. Spinal cord and nerve root pulsations were reduced/absent in 53.33% of patients in meningitis group where as none of the patients in non- meingitis group had reduced /absent spinal cord and nerve root pulsations on ultrasonography. These results were statistically significant with p value of <0.001

Out of 60 CSF cytology positive patients, majority of the patients were in the age group of ≤ 30 days and 31-60 days with 26 patients ≤ 30 days of age and 24 patients 31-60 days of age. 7 patients were 61-90 days of age, 2 patients were 91-120 days of age and 1 patient was 121-150 days of age. Out of 60 CSF cytology positive patients we had a male preponderance. 37 patients were CSF cytology positive and 23 females were CSF cytology positive.

Among 60 CSF positive patients USG spine findings (Echogenicity / Trabeculations or Reduced/Absent spinal cord and nerve root pulsations) were present in 32 cases whereas 28 patients had normal USG spine findings and only 4 patients out of 40 CSF negative patients had positive USG spine findings (Present Echogenicity/Trabeculation). Based on these findings the sensitivity , specificity, positive predictive value, negative predictive value, after combining both the sonographic findings of spinal USG in meningitis patients was 53.33%, 90%, 88.89%, 56.25% respectively with a diagnostic accuracy of 68%. These results were statistically significant with p value <0.001.



Spinal ultrasound of a 20 days female child presented with fever and lethargy for 5 days. No neurological symptoms were present. Axial and Sagittal images show normal subarachnoid space



Spinal ultrasound of a 30 days male child presented with fever for 20 days and seizure for 1 day. Sagittal image shows presence of increased echogenicity in the subarachnoid space. Absent cord and nerve root pulsations were seen on real time. CSF examination revealed TLC of 200 with 90% neutrophils

Discussion

Meningitis is a life threatening condition that despite the availability of new antibiotics and good preventive care can rapidly progress to permanent brain damage, neurologic deficits and even death. To reduce meningitis related morbidity and mortality prompt diagnosis and aggressive management is required. Diagnosing meningitis in uncomplicated stage offers advantage of reducing both mortality and neurologic sequelae.[29,30]

However as early clinical manifestations of meningitis are very subtle and non-specific and therefore, may be recognized in retrospect only. The diagnosis of meningitis is a dilemma. Thomas et al[31] did a retrospect review in 169,849 infants born during a 5 year study period to study the role of LP in evaluation of early neonatal sepsis. The study showed that 37% cases of meningitis would have been missed if only judged clinically. Thus it is very difficult to recognize meningitis clinically at an early stage.

The diagnosis of meningitis is confirmed by lumbar puncture and CSF cytology analysis. However, cranial ultrasound is often used in initial evaluation of critically ill infants with suspected meningitis[12]. Thus, familiarity with sonographic findings of meningitis is important for the radiologists and neonatologists. The spectrum of abnormalities includes echogenic sulci, sulcal separation, abnormal parenchymal echogenicity, hydrocephalus, ventriculitis, abscess, subdural empyema and hemorrhagic infarct.

As subarachnoid space is continuous along the spinal canal, echogenic debris is expected to be found in subarachnoid space at the spinal level[6]. Echogenic debris in spinal subarachnoid space is a marker of arachnoiditis[23]. Pulsation of the spinal cord and nerve root is reduced or absent in areas where arachnoiditis obliterates the subarachnoid space[27]. Formation of septations and echogenic debris also reduce the spinal cord and nerve root pulsations. Thus, spinal cord and nerve root pulsations are expected to be reduced in cases of meningitis. So spinal USG can detect changes in CSF echogenicity and decreased spinal cord and nerve root pulsation which can reflect the inflammatory changes in meningitis.

Spinal ultrasound is possible in the neonate owing to a lack of ossification of the predominantly cartilaginous posterior arch of the spine[16,17]. The quality of ultrasound assessment decreases after the first 3–4 months of life as posterior spinous elements ossify, and in most children spinal ultrasound is not possible beyond 6 months of age. So, ultrasound spine can help in diagnosing meningitis in infants younger than six months. Very limited data[25] is available with respect to role of spinal USG in diagnosis of meningitis. We selected this study to assess the accuracy of USG spine in diagnosis of meningitis in infants younger than six months of age.

100 consecutive patients were included in the study on the basis of clinical suspicion of meningitis. All the 100 patients were subjected to USG spine to look for:

1. Presence or absence of echogenicity / trabeculations in subarachnoid space.
2. Spinal cord and nerve root pulsations.

After USG spine all 100 patients were subjected to lumbar puncture and CSF analysis for confirmation of diagnosis.

In our study out of 100 clinically suspected meningitis cases, 67(67%) cases were males and 23(23%) were females. All the patients were subjected to lumbar puncture and CSF analysis. After LP 60 patients were confirmed as meningitis cases. Out of 60 meningitis cases 37 were males and 23 were females. So meningitis was more common in males than in females in our study. But this difference in incidence of meningitis in males and females is not statistically significant with p value of 0.165.

In our study majority of patients were up to 60 days of age with 41% in age group of less than 30 days and 36% between 31-60 days .13% patients were in the age group of 61-90 days, 6% in 91-120 days and 4% in 121-150 days. Minimum and maximum age of studied patients was 3 and 150 days respectively, mean age of studied subjects was 45.84 days with standard deviation of 33.54.

Out of 60 CSF cytology positive patients, majority of the patients were in the age group of ≤ 30 days and 31-60 days with 26patients ≤ 30 days of age and 24 patients 31-60 days of age. 7 patients were 61-90 days of age, 2 patients were 91-120 days of age and 1 patient was 121-150 days of age.

Most frequent presenting complaints in our study were Lethargy and poor cry in 72% patients, followed by Fever in 60%, Focal seizures in 45%, vomiting in 40% and Altered sensorium in 13%. Clinically Raised temperature was observed in 56% patients, Poor motor tone in 52%, Neck rigidity in 33%, Focal neurological deficit in 12% and Bulging fontanel in 8%. 30% patients had normal physical examination.

Incidence of clinical symptoms and signs in our study were similar to study by Nepal et al[25] where lethargy and fever were most presenting complaints and raised temperature and poor motor tone were most frequent signs.

In our study out of 100 studied patients 34% had echogenicity and/or trabeculations in posterior subarachnoid space on ultrasound spine and 66% patients were having no echogenicity or trabeculations. Out of 100 studied patients, in 68% spinal cord and nerve root pulsations were present on ultrasound spine and in 32% patients spinal cord and nerve root pulsations were reduced or absent.

The comparison of meningitis and non-meningitis patients with respect to presence and absence of echogenicity/trabeculations and presence or absence of spinal cord and nerve root pulsations on spinal ultrasound in our study was as follows

- In meningitis group 30(50%) patients had echogenicity and/or trabeculations present whereas 4(10%) patients in non-meningitis group had echogenicity or trabeculations on spinal ultrasonography. This difference in presence and absence of echogenicity and trabeculations in meningitis and non meningitis group was statistically significant with p-value of <0.001.
- Spinal cord and nerve root pulsations were reduced/absent in 32(53.33%) patients in meningitis group where as none of the patients in non- meingitis group had reduced /absent spinal cord and nerve root pulsations on ultrasonography. These results were statistically significant with p- value <0.001.
- Only 4 patients in non-meningitis group were having Echogenicity/ Trabeculations in posterior subarachnoid space on ultrasound spine. These patients were diagnosed as cases of Extreme prematurity with low birth weight with IVH.

These results in our study were consistent with studies by Nepal et al[25], Rudas G et al[22] and Rudas G et al[24].

In study by Nepal et al[25] ecchogenicity / trabeculations on spinal USG were present in 20 out of 34 cases of meningitis and none of the 26 non-meningitis cases. These results were statistically significant with p value of < 0.05. In their study they found reduced spinal cord and nerve root pulsations in 25 out of 34 meningitis cases where as only 4 patient had reduced spinal cord and nerve root pulsations among 26 non-meningitis cases. These values were also statistically significant with p value <0.05.

Rudas G et al [22] in their study found echogenic debris in thoraco-lumbar subarachnoid space on USG spine in 11 out of 15 neonates with intra cranial hemorrhage or meningitis compared to none in 16 control neonates (p value < 0.001).

Rudas G et al[24] found on USG spine that all premature babies with major ICH in their study had developed increased echogenicity of cervical and thoracic spinal subarachnoid space. SSS remained echo free in all the control infants.

In our study amongst 60 CSF proven meningitis patients 30 had echogenicity or trabeculations on ultrasound spine where as 32 patients had reduced or absent spinal cord and nerve root pulsations. All the 30 patients who were having echogenicity or trabeculations on ultra sound spine were having reduced spinal cord and nerve root pulsations. Only 2 patients were having reduced / absent spinal cord and nerve root pulsations but with no echogenicity or trabecualtions.

After combining both the sonographic parameters of USG spine (echogenicity or trabeculations / pulsations of spinal cord and nerve root) the sensitivity , specificity , positive predictive value , negative predictive value of spinal USG in diagnosing meningitis was 53.33%, 90%, 88.89%, 56.25% respectively with a diagnostic accuracy of 68%. These results were statistically significant with p value <0.001.

The results of our study were consistent with the study done by Nepal et al[25]. 34/60 cases in their study had CSF findings suggestive of meningitis. Among 34 meningitis cases, echogenicity or trabeculations were present in 20 cases and absent in 14 cases where as all the non- meningitis cases had no echogenicity or trabeculations. Spinal cord and nerve root pulsations in meningitis cases were reduced or absent in 25 cases where as were present in 9 cases. Among non-meningitis patients 22 had present pulsations whereas only 4 had reduced pulsations. The sensitivity, specificity, positive predictive value and negative predictive value of their study were 67.16%, 92.3%, 93.1% and 74.64% respectively.

Conclusion

In our study amongst 60 CSF proven meningitis patients 30 had echogenicity or trabeculations on ultrasound spine where as 32 patients had reduced or absent spinal cord and nerve root pulsations. All the 30 patients who were having echogenicity or trabeculations on ultra sound spine were having reduced spinal cord and nerve root pulsations. Only 2 patients were having reduced / absent spinal cord and nerve root pulsations but with no echogenicity or trabeculations.4 patients among non-meningitis group with echogenic debris on USG spine had ICH. Based on these findings after combining both the above mentioned sonographic findings of USG spine the sensitivity , specificity , positive predictive value , negative predictive value of spinal USG in diagnosing meningitis was 53.33% , 90% , 88.89% , 56.25% respectively with a diagnostic accuracy of 68%. These results were statistically significant with p value <0.001.

Our study demonstrates that the presence of echogenicity/trabeculations in posterior subarachnoid space on ultrasound spine or abnormal spinal cord and nerve root pulsations are significantly associated with meningitis with a high specificity and positive predictive value in its diagnosis. So spinal ultrasound can be used as a simple, inexpensive, non-invasive, rapid and fairly specific radiation free imaging modality to help in diagnosing meningitis. For above reason ultrasound spine should find a place in diagnosis of meningitis but further studies need to be done to test reproducibility.

Conflict of interest: None

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