

Step by step in the brain US in children with meningitis

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Learning objectives

1. To analyze the main US brain findings in meningitis and its complications in pediatric patients.
2. To emphasize the relationship between imaging findings and underlying pathological changes.

Background

- INTRODUCTION:

Bacterial and viral meningitis is an uncommon but serious condition in the newborn and infant child.

Despite the recent advances in neonatal intensive care units and a wide range of potent antibiotics, neonatal meningitis remains an important cause of neurological disability worldwide.

- PATHOPHYSIOLOGY OF MENINGITIS:

Meningitis usually occurs as a result of bacteremia and sepsis, with initial seeding of the central nervous system via the choroid plexus.

The infection then spreads into the cerebrospinal fluid (CSF) and can cause inflammation of the ventricular system (ventriculitis).

Inflammation of the meninges typically follows; meningeal inflammation extends to the walls of the bridging and cortical veins to cause thrombophlebitis and vascular occlusion, which is associated with cortical infarct. [Fig. 1](#) on page 4

Later pathological findings include diffuse cerebral cortical and white matter atrophy, hydrocephalus, which can also be seen in the early phase, multicystic encephalomalacia, porencephaly and ventricular septations.

In the newborn infant, Streptococcus group B, Escherichia Coli and Listeria Monocytogenes are the most commonly isolated organisms in CSF.

Images for this section:

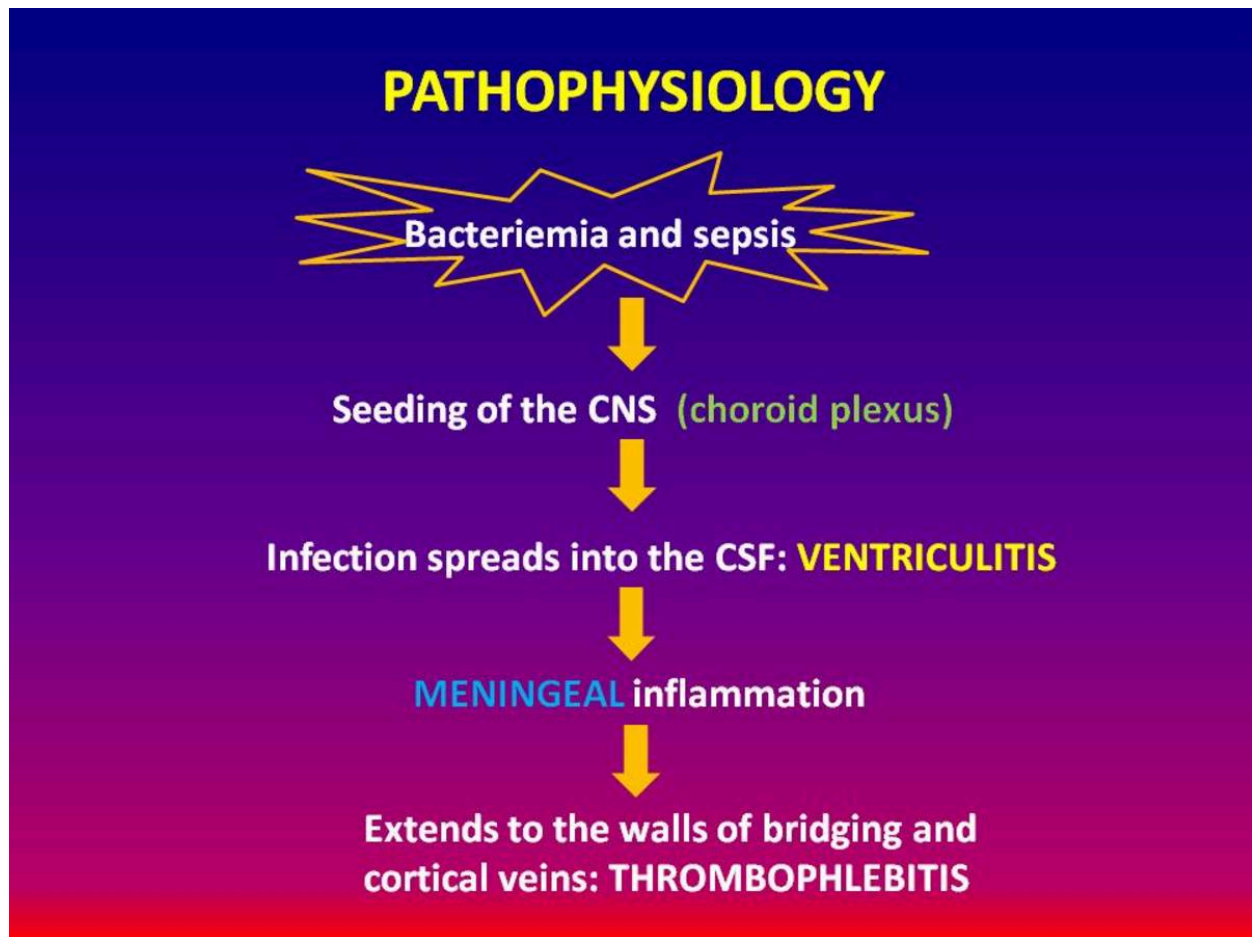


Fig. 1: Fig 1

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Findings and procedure details

SONOGRAPHIC FINDINGS IN MENINGITIS:

Ultrasound abnormalities are present in approximately 65% of infants with acute bacterial meningitis. However, the frequency of imaging abnormalities in patients with a clinical presentation complicated by persistent seizures, abnormal neurological findings and a deterioration of CSF examination within the first 48 hours can be as high as 100%.

Because the major advantage of sonography is its ability to be safely repeated, a second study should be performed if any clinical deterioration occurs, such as increasing head circumference, occurrence of new neurological findings and/or lack of response to therapy.

We divide the main ultrasound findings that we should look for in meningitis suspicion into 3 main groups, as follows: [Fig. 2](#) on page 8

1). EXTRA-AXIAL AND MENINGEAL FINDINGS: [Fig. 3](#) on page 8

- **Echogenic widening of brain sulci**, or meningeal thickening, is the most common and earliest sonographic sign of meningitis, seen in 26-83% of affected patients.

In healthy individuals, the pia-arachnoidal membrane is seen as an echogenic line on the surface of the brain. Normal thickness of the membrane measured from the surface of a frontal gyrus (single layer) and within a sulcus (double layer) should not exceed 1.3 mm and 2 mm, respectively.

This can be accompanied by prominent cortical vessels within the arachnoid on color Doppler sonography. These findings reflect the intense inflammatory exudate that accumulates in the depths of the fissures and sulci, especially around the pial and subarachnoid vessel.

- **Accumulation of extra-axial fluid** might be present in 8- 33% of infants with bacterial meningitis. Most commonly, these represent sterile, reactive subdural effusions that have no prognostic significance.

- On **sonography**, they appear as hypoechoic concave fluid spaces and sometimes may contain mobile echogenic debris.
- **Color Doppler** sonography can be very helpful in differentiating benign enlargement of subarachnoid spaces from subdural effusions. When subarachnoid fluid is present cortical vessels on the brain surface are surrounded by fluid, whereas fluid in the subdural space compresses the cortical vessels along the surface of the brain.

- **Venous thrombosis.** If meningeal inflammation extends to the walls of bridging and cortical veins it can lead to thrombophlebitis and sagittal venous thrombosis.

2). PARENCHYMAL FINDINGS: [Fig. 4 on page 9](#)

- **Areas of abnormal brain echogenicity** have been reported in 12% to 65% of infants with bacterial meningitis.

Lesions can be focal or diffuse and can represent parenchymal involvement by cerebritis, infarction, secondary hemorrhage or early abscess. The presence and size of parenchymal lesions are associated with significant neurological sequelae and are indicators of a poor prognosis.

- During the **initial stage** of cerebritis, sonography might only show a poorly marginated area of increased echogenicity with increased vascularity using color or power Doppler.
- In the **acute stage** of meningitis, both intra- and extracellular edema can occur. On sonography, there might be a diffuse or heterogeneous increase in the echogenicity of the brain with effacement of the sulci and gyri.

- **Elevated resistive index (RI)** on pulsed Doppler sonography due to increased intracranial pressure, which is associated with increased pulsatility of arterial flow.

Other causes of elevated pulsatility of flow include venous thrombosis, which may also show reversal of flow during the entire diastolic phase in duplex Doppler waveform of the anterior cerebral artery.

- **Diffuse cerebral atrophy, multicystic encephalopathy, and porencephaly** might be seen as the end-stage of complications of bacterial meningitis.

3). VENTRICULAR FINDINGS:

- **Irregular and echogenic ependyma**, and

- **Intraventricular debris and stranding** [Fig. 5 on page 10](#) , often associated with ventricular dilatation, are the most common sonographic signs of ventriculitis. Debris in the ventricles can be caused by any infecting organism; however, it is most frequently seen with E. Coli meningitis.

- **Hydrocephalus** (ventricular dilatation) [Fig. 6 on page 11](#) is present in 14-65% of infants with bacterial meningitis and can occur in either the acute or the chronic phase of the disease.

- The level of obstruction to CSF flow is usually outside the ventricular system but can occur within the narrowest portions of the ventricles as a result of ependymitis and secondary adhesion.
- Pulsed Doppler of the anterior cerebral artery before and after compression of the anterior fontanel can be a useful adjunct in the serial monitoring of infants with postinfectious hydrocephalus.
- Increasing response to fontanel compression as manifested by increasing changes in arterial RI can be an indication for shunt placement in infants with rapidly progressive hydrocephalus.

Images for this section:

- US abnormalities in 65% of newborns with meningitis → 100% if persistent seizures, abnormal neurological findings and CSF deterioration.



CHECKLIST:

1) EXTRA-AXIAL AND MENINGEAL FINDINGS:

- Echogenic widening of brain SULCI
- Extra-axial FLUID
- Venous THROMBOSIS

2) PARENCHYMAL FINDINGS:

- Focal/diffuse abnormal brain ECHOGENICITIES
- Elevated RI
- PORENCEPHALY areas

3) VENTRICULAR FINDINGS:

- Irregular echogenic EPENDYMA
- Intraventricular DEBRIS and stranding
- HYDROCEPHALUS

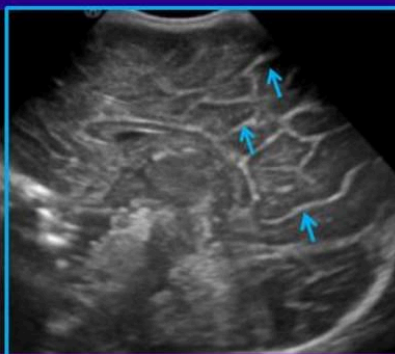
Fig. 2: Fig 2

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1. Meningeal and extra-axial findings



**Enlarging
complex
EXTRA-AXIAL
FLUID SPACE in
temporal lobes**



**ECHOGENIC
widening of the
brain SULCI**



**Dural venous
THROMBOSIS**

Fig. 3: Fig 3

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2. Parenchymal findings

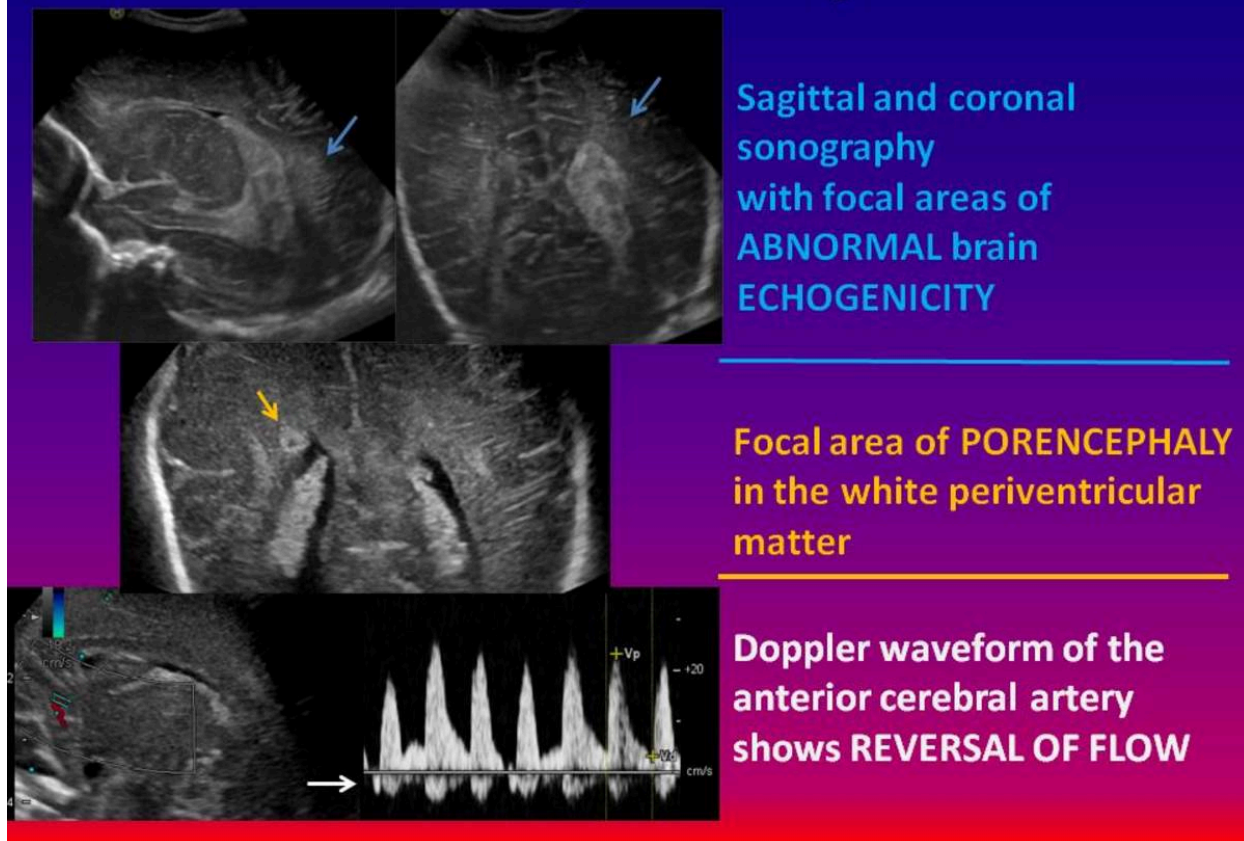
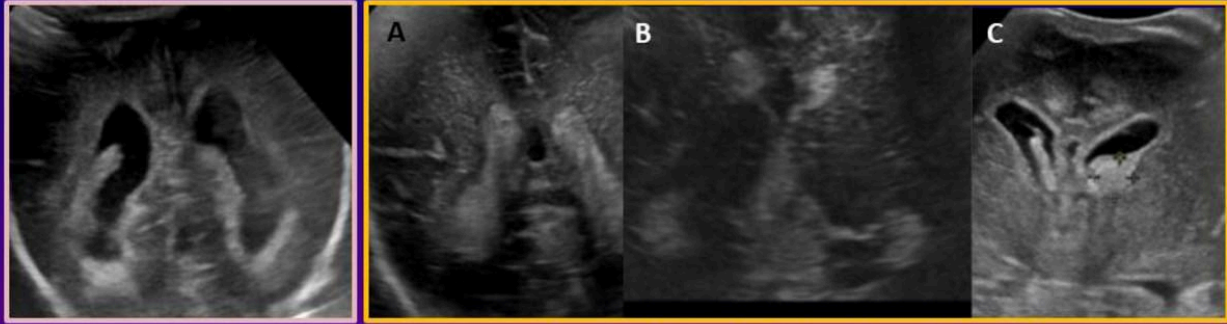


Fig. 4: Fig 4

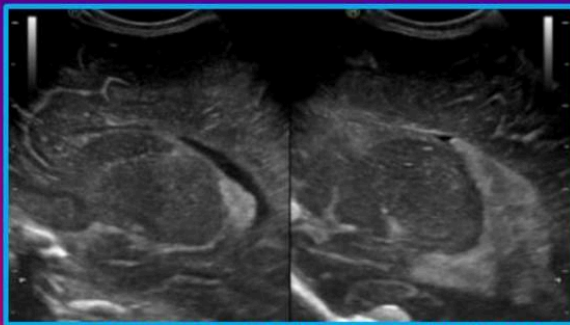
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3. Ventricular findings

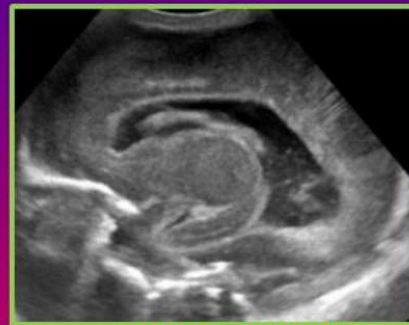


Irregular and echogenic
EPENDYMA

Intraventricular diffuse (A, B) and nodular (C)
HEMORRHAGE



Normal choroid plexus (left) and
hemorrhage (right)



Intraventricular
DEBRIS

Fig. 5: Fig 5

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3. Ventricular findings

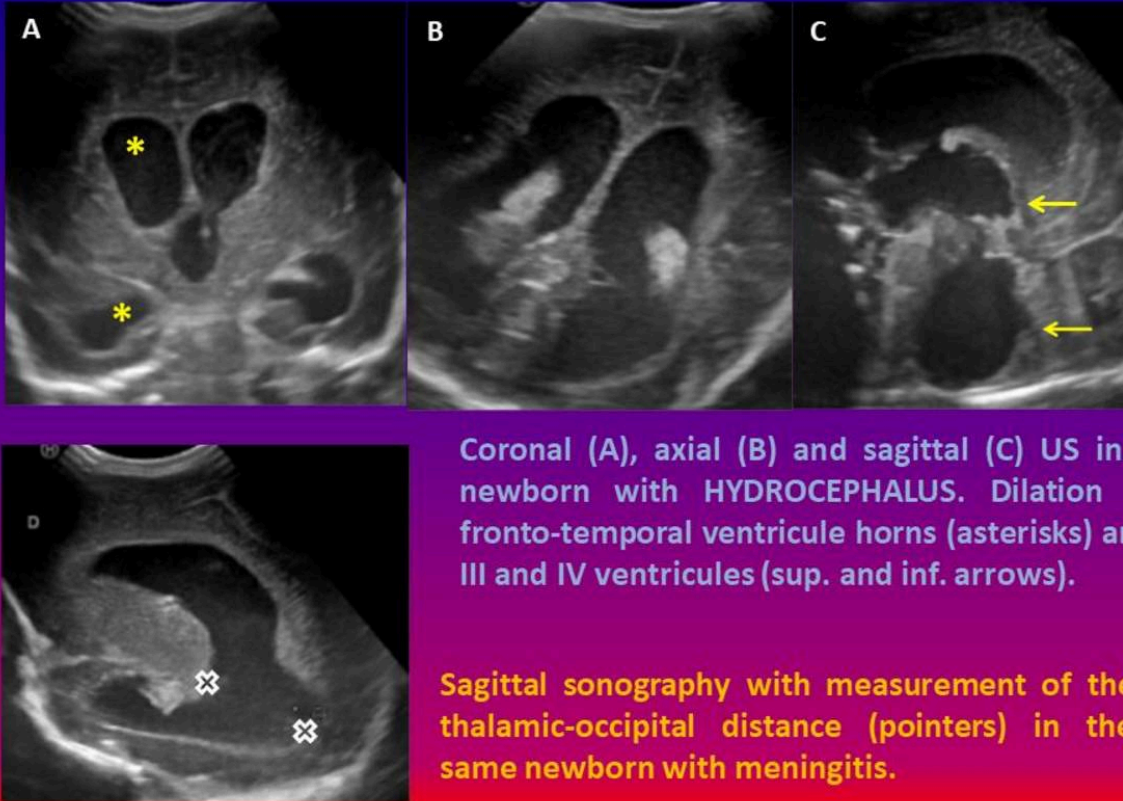


Fig. 6: Fig 6

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Conclusion

- Cranial sonography plays an important role in the initial evaluation of infants with suspected bacterial meningitis and in monitoring for complications of the disease.
- Its utility is enhanced by the use of alternative scanning approaches and Doppler techniques for identification of ventriculitis, extra-axial fluid collections, and hemodynamic alterations.
- Early diagnosis of the primary disease and its complications is essential for the prevention of neurodevelopmental sequelae.

Personal information

Thank you very much for your interest in our poster!.

Please do not hesitate to contact us should you have any questions in:
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References

- Ali Yikilmaz, George A. Taylor (2008) Sonographic findings in bacterial meningitis in neonates and young infants. *Pediatr Radiol* 38:129-137
- Daneman A, Epelman M, Blaser S et al (2006) Imaging of the brain in full-term neonates: does sonography still play a role? *Pediatr Radiol* 36:636-646
- Kastrup O, Wanke I, Maschke M (2005) Neuroimaging of infections. *NeuroRx* 2:324-332
- Syrogiannopoulos GA, Nelson JD, McCracken GH Jr (1986) Subdural collections of fluid in acute bacterial meningitis: a review of 136 cases. *Pediatr Infect Dis* 5:343-352
- Shen EY, Tsai CY, Wong TT (1998) Prospective neurosonographic study in infantile purulent meningitis. *Zhonghua Min Guo Xiao Er Ke Yi Xue Hui Za Zhi* 39:180-185
- Seibert JJ, Avva R, Hronas TN et al (1998) Use of power Doppler in pediatric neurosonography: a pictorial essay. *Radiographics* 18:879-890