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Sonographic Recognition of Gyral Infarction in Meningitis

Diane S. Babcock[1,2] and Bokyung K. Han[1,2]

Several authors have reported abnormal sonographic findings in infants with bacterial meningitis [1–4]: hydrocephalus, ventriculitis, prominent echogenic leptomeninges, abscess, subdural effusions, cerebral edema, and focal areas of increased brain parenchymal echogenicity. We report the observation of increased gyral echogenicity in two patients with bacterial meningitis and discuss its pathophysiology and prognostic significance.

Normal Gyral Anatomy

Using a high-frequency transducer (7.5 MHz) with a short focus, the interhemispheric fissure and gyri on the medial aspect of the cerebral hemispheres can be seen well (fig. 1). The hypoechoic gyri are outlined by the linear echogenic sulci. These sulcal echoes are produced by the interfaces of the brain and cerebrospinal fluid (CSF) and by vessels and meninges within the sulci. Within the central part of the gyrus itself, a slightly more echogenic area is identified that corresponds to the white matter. This may be more echogenic than the cortical gray matter because of increased interfaces from the axons.

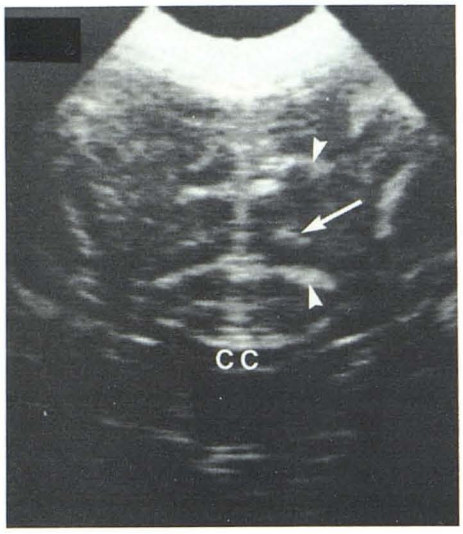

Fig. 1.—Normal gyral anatomy. Magnified sonogram of interhemispheric fissure and adjacent brain using 7.5 MHz short-focus transducer. Hypoechoic gyri outlined by linear echogenic sulci (*arrowheads*). Within central part of gyrus, slightly more echogenic area (*arrow*) corresponds to cerebral white matter. Cortical gray matter is anechoic. CC = corpus callosum.

Case Reports

Case 1

A 3½-month-old girl had sepsis, irritability, nuchal rigidity, and a bulging fontanelle. CSF was cloudy with a white blood cell (WBC) count of 740/mm^3 and red blood cells (RBCs) of 47/mm^3; culture revealed *Hemophilus influenzae* meningitis. Sonography (figs. 2A–2C), performed on day 9 because of persistent seizures, showed mildly enlarged ventricles and abnormal brain parenchymal echogenicity with increased gyral echoes. Computed tomography (CT) was performed on the same day (figs. 2D–2F). On follow-up examination at 8 months, the infant had severe developmental delay, cortical blindness, and recurrent seizures despite medication.

Case 2

A 4-month-old boy had 1 week of upper respiratory infection and 1-day of listlessness. On admission, physical examination showed increased tone, irritability, occasional apnea, a full fontanelle, and seizure activity. The CSF analysis showed 344 WBCs/mm^3 and 66 RBCs/mm^3; culture revealed pneumococcus. Sonography (figs. 3A and 3B) was performed on day 7 because of seizures and persistent fever. It showed a moderate amount of extraaxial fluid in the intrahemispheric fissure and over the convexities and abnormal parenchymal echogenicity with increased gyral echoes. CT was performed on day 9 (figs. 3C and 3D). After treatment, a follow-up examination 2 months later showed diffuse brain atrophy and abnormal brain density (figs. 3E and 3F). At 14 months of age, the infant had severe developmental delay, microcephaly, general hypertonicity with fisting bilaterally, hyperreflexia, and nystagmus.

Discussion

With the general availability of higher-frequency real-time transducers such as 7.5 MHz, increased resolution of the

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[1] Division of Radiology, Children's Hospital Medical Center, Cincinnati, OH 45229. Address reprint requests to D. S. Babcock.
[2] Departments of Radiology and Pediatrics, University of Cincinnati College of Medicine, Cincinnati, OH 45229.

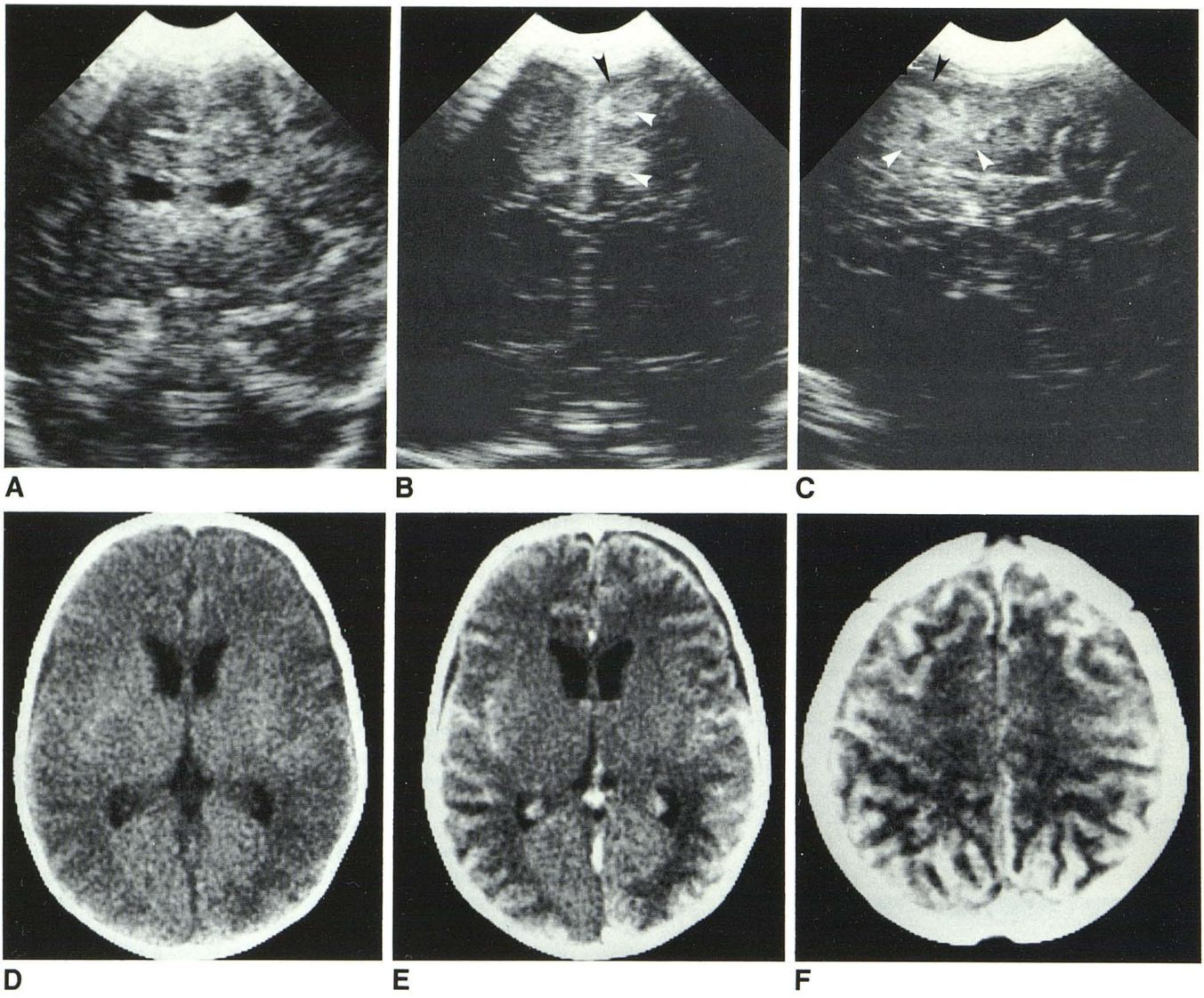

Fig. 2.—Case 1. **A**, Coronal sonogram with 5.0 MHz transducer. Mildly enlarged ventricles and abnormal brain parenchymal echogenicity. Magnified coronal (**B**) and sagittal (**C**) sonograms with 7.5 MHz transducer. Small amount of fluid over brain convexities (*black arrowheads*) and increased parenchymal echogenicity of cerebral gyri (*white arrowheads*) adjacent to interhemispheric fissure. **D**, CT scan on same day. Diffuse low density of brain, mild ventricular enlargement, and small extraaxial fluid collections. **E** and **F**, Contrast-enhanced CT scans. Gyral enhancement.

brain parenchyma is now possible, particularly in the near field of the transducer. Subtle abnormalities of brain anatomy and echogenicity can be better resolved with the higher-frequency transducers, as demonstrated in our two cases. Because sound waves penetrate the bony calvarium poorly, the peripheral part of the brain over the convexity is generally not seen as well as with cranial CT. The brain gyri and meninges can be well seen directly under the fontanelle, where there is no interference from overlying bone. Special attention should be paid to this area using a high-frequency transducer.

In our two patients, increased echogenicity was seen in the region of the cortical gray matter causing accentuation of the gray/white-matter inferface and reversal of the normal gray/white-matter relationship. This cortical echogenicity corresponded to areas of contrast enhancement on CT. While we did not have pathologic correlation in either of our patients, previous articles describing the CT findings have speculated that the parenchymal lesions are areas of cerebritis with cortical edema and congestion with accumulation of inflammatory cells. Cerebral arterial and venous vasculitis have been described previously in angiography in acute bacterial meningitis, and these areas of increased echogenicity could be areas of infarction and necrosis resulting from vascular thrombosis [5, 6].

Widening and increased echogenicity of the sulci (fig. 4) can be seen with meningitis, probably due to inflammatory exudate and/or increased CSF in the subarachnoid and subdural spaces, and has no clinical significance [7]. It should be differentiated from the gyral lesion. Both of our patients with

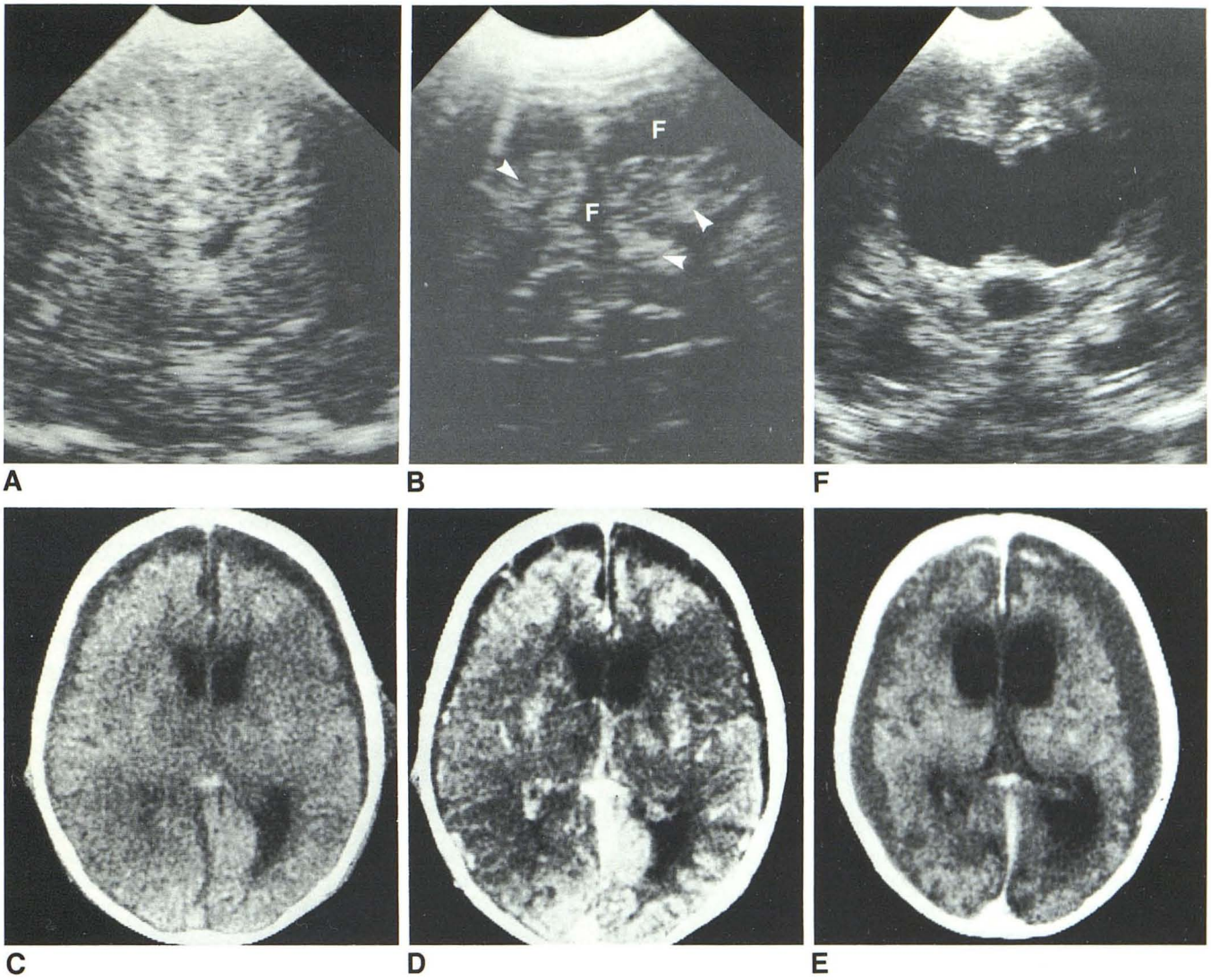

Fig. 3.—Case 2. **A**, Coronal sonogram with 5 MHz transducer. Abnormal brain parenchymal echogenicity. **B**, Magnified coronal sonogram with 7.5 MHz transducer. Moderate extraaxial fluid in interhemispheric fissure and over convexities (F) and increased gyral echoes (*arrowheads*). CT scans on day 9 without (**C**) and with (**D**) contrast enhancement. Mild ventriculomegaly, increased extraaxial fluid, diffuse areas of hypo- and hyperdensity, and extensive gyral enhancement. CT scan at 3 weeks (**E**) and sonogram at 2 months (**F**). Brain atrophy and diffuse abnormal parenchymal density and echogenicity.

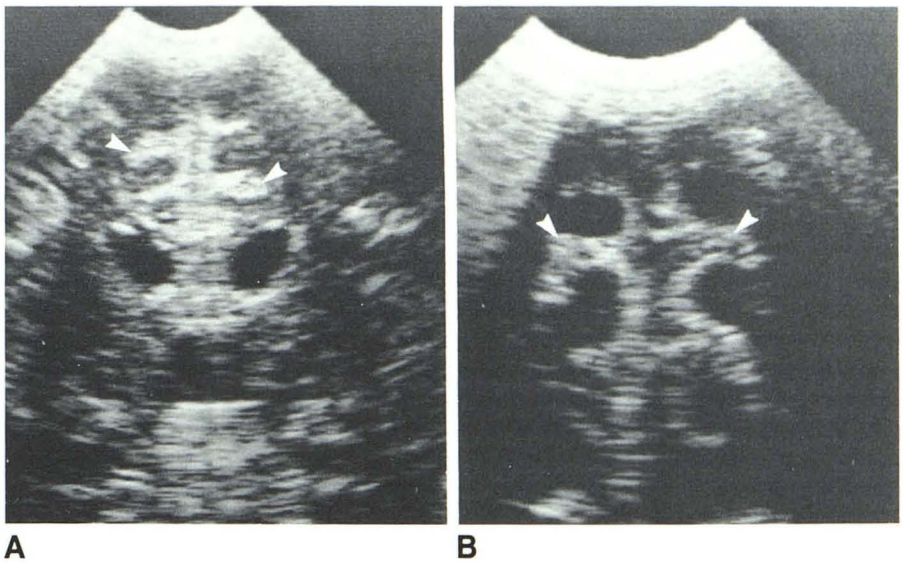

Fig. 4.—Echogenic sulci in 4-month-old infant with *Hemophilus influenzae* meningitis with persistent fever. Coronal sonogram with 5.0 (**A**) and magnified coronal sonogram with 7.5 (**B**) MHz transducer on day 18. Widened and echogenic interhemispheric fissure and sulci (*arrowheads*) from inflammatory exudate and/or increased CSF in subarachnoid space. Gyri are normal.

increased gyral echogenicity had severe neurologic abnormalities on follow-up. This abnormal gyral pattern is associated with parenchymal abnormalities elsewhere in the brain and can be part of a more diffuse process. In summary, increased gyral echoes should be sought in patients with meningitis. Their presence suggests gyral infarction.

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