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Neonatal Brain: Sonography of Congenital Abnormalities

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Sonograms of the brain were obtained in six neonates with congenital intracranial abnormalities. Two of the six abnormalities were echogenic: a lipoma of the corpus callosum and calcific foci associated with toxoplasmosis. Four were anechoic (fluid) lesions including dilated ventricles in two patients, an aneurysm of the vein of Galen, and a Dandy-Walker cyst of the posterior fossa. In all but one patient (the patient with a lipoma of the corpus callosum), the ventricles were enlarged. Sonography has accurately detected and delineated the extent of the congenital intracranial abnormalities and it has been useful in monitoring the ventriculomegaly associated with these lesions.

Several authors have used sonography to study abnormalities of the neonatal brain including hydrocephalus [1–4] and large collections of blood [5–8]. Most have used either static B-scanners [4, 7] or linear array real-time units [7, 8] to obtain axial scans through the parietal bone. Babcock et al. [5] found that static scans obtained through the anterior fontanelle were the most useful. Others [2, 6] used an automated water delay scanner to obtain axial scans of the brain. We describe our experience with real-time and static sonograms obtained mainly through the anterior fontanelle in the delineation and diagnosis of congenital intracranial abnormalities, both echogenic and cystic.

Subjects and Methods

In a 6 month period, 100 neonates had sonograms of the brain. Although most patients were investigated for intracranial hemorrhage, several patients were examined for suspected congenital lesions. In most instances, the patient was well enough to be transported to the ultrasound department where scans were performed with a 90° sector real-time scanner (ATL, 5 MHz), a 105 ° sector real-time scanner (Diasonics, 3.5 MHz), or a conventional static B-scanner (Picker Echoview, system 80–L).

It is our experience that scans obtained through the anterior fontanelle give much better detail of the brain than axial scans through the parietal bone which markedly attenuates the sound beam. Therefore, real-time scans were performed through the anterior fontanelle in coronal and sagittal planes in all patients. When the lateral and/or posterior fontanelles were open, they were also used as scanning windows. In some patients, axial scans through the parietal bone were obtained in order to compare with the CT scans. All patients had CT scans, some performed on the EMI 1010 unit which has a scan time of 60 sec and slice thickness of 8 mm, and others on the GE 8800 which has a scan time of 9.6 sec and slice thickness of 10 mm.

Results

Six neonates had congenital abnormalities of the brain detected with sonography. Two had echogenic abnormalities and four had anechoic (fluid) lesions. Five of the six patients had associated ventriculomegaly.

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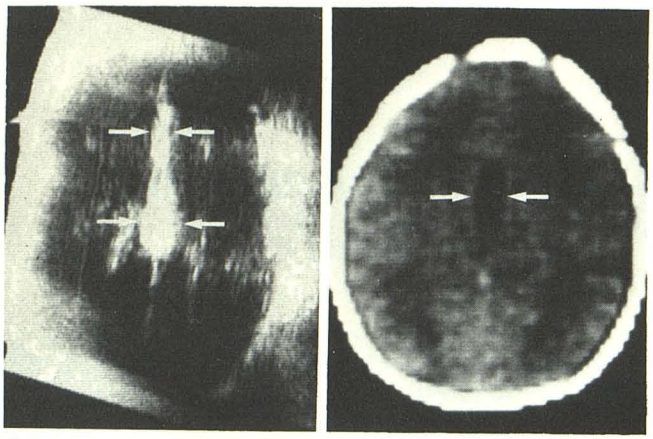


Fig. 1.—**A,** Axial sonogram through parietal bone in patient with lipoma of corpus callosum. Echogenic lipoma (*arrows*) in midline extends from frontal area to area of pineal gland. **B,** Axial CT scan. Lipoma of corpus callosum (*arrows*) extends from pineal gland toward frontal bone.

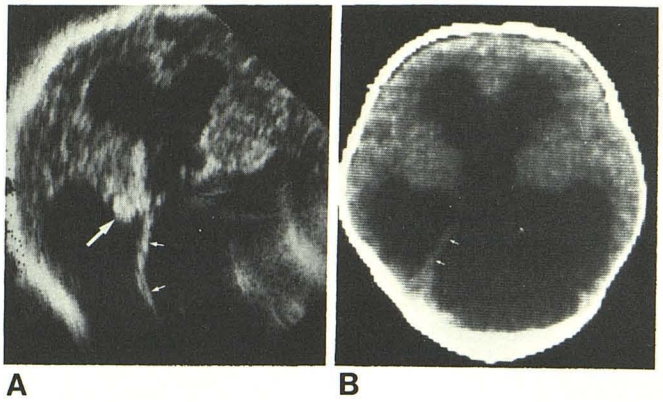
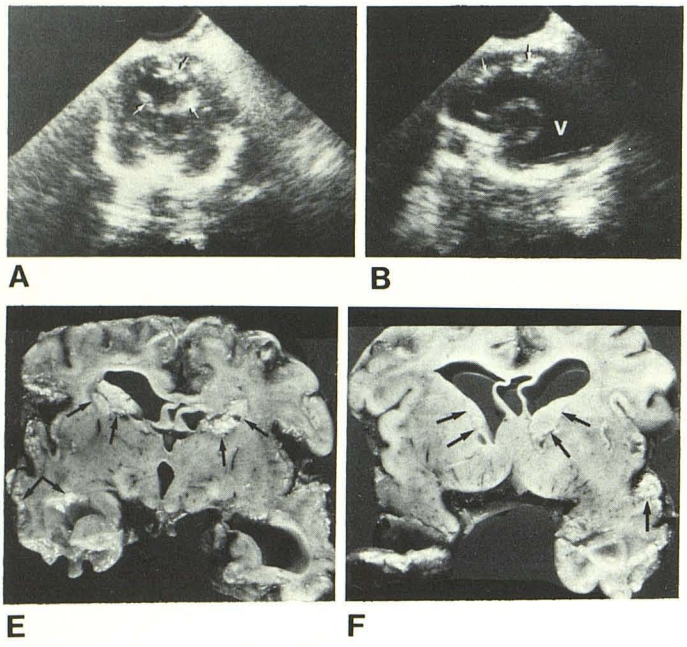


Fig. 3.—**A,** Axial sonogram through lateral fontanelle in patient with severe congenital "hydrocephalus." Left and right occipital horns are asymmetrically and grossly dilated. Membrane (*arrows*) separates left and right occipital horns. Left choroid plexus in trigone (*large arrow*). Anterior horns less markedly dilated than occipital horns. **B,** CT scan. Severe "hydrocephalus." Membrane (*arrows*) separates occipital horns of lateral ventricles.



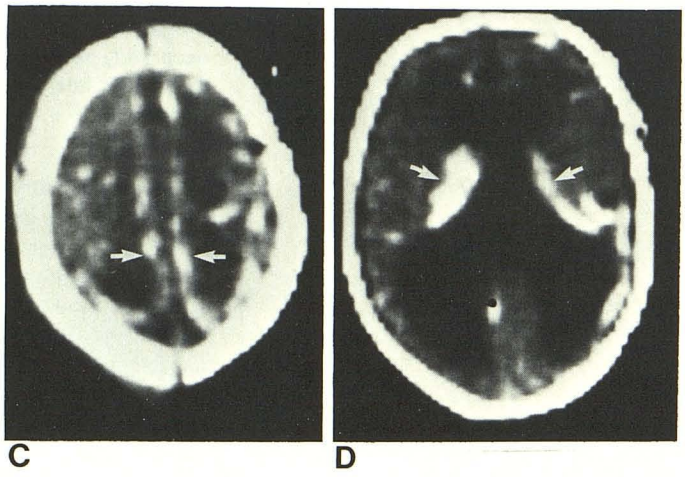


Fig. 2.—Coronal (**A**) and parasagittal (**B**) sonograms through anterior fontanelle. Echogenic foci of calcification (*arrows*) within brain substance and in periventricular distribution. Lateral ventricles (v) are dilated. **C** and **D,** CT scans. Curvilinear calcificatons (*arrows*) within brain substance and in periventricular distribution. Enlarged ventricles. **E** and **F,** Coronal pathologic specimen. Several foci of calcification (*arrows*) within periphery of brain substance and in periventricular distribution. **E** corresponds to **A.**

The sonogram of all six patients with congenital lesions differed markedly from the appearance in normal patients. Normally, the ventricles are small fluid-filled structures surrounded by brain tissue which usually appears as homogeneous medium-level echoes. Stronger echoes arise from structures such as the choroid plexus and interfaces such as the falx, the tentorium, and the cerebral sulci.

Echogenic Congenital Abnormalities

In two patients the sonograms demonstrated an obvious echogenic intracranial abnormality. One patient had a large cleft palate, ventricular septal defect, and patent ductus arteriosus. Sonography was requested to look for any associated intracranial abnormalities. Scans through the anterior fontanelle and through the parietal bone demonstrated a column of echogenic material extending in the midline from the frontal area to the area of the pineal gland (fig. 1A). CT (fig. 1B) confirmed that the midline defect had fat density and, hence, represented a lipoma of the corpus callosum. No other intracranial abnormality was seen in this patient.

The other patient was a premature neonate with jaundice and hepatosplenomegaly. The sonograms of the brain (figs. 2A and 2B) showed multiple echogenic foci in the brain substance and periventricular area associated with enlarged ventricles, despite the small head circumference. CT (figs.

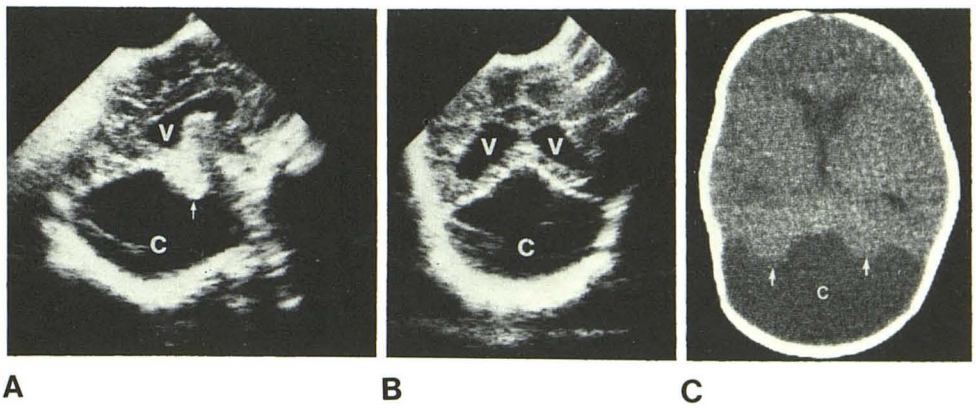


Fig. 4.—Parasagittal (**A**) and coronal (**B**) sonograms through anterior fontanelle in patient with Dandy-Walker cyst. Large cystic space (c) within posterior fossa. Small remnant of cerebellar tissue (*arrow*) within posterior fossa. Roof of cystic space formed by tentorium. Ventricles (v) only slightly dilated. **C,** Axial CT scan. Cyst (c) in posterior fossa. Remnants of cerebellar hemispheres (*arrows*) are seen anteriorly.

2C and 2D) also showed ventriculomegaly and foci of calcification in the same distribution. The patient died 1 week after birth; autopsy confirmed the multiple foci of necrosis and calcification due to toxoplasmosis (figs. 2E and 2F).

Anechoic Congenital Lesions

Four patients had anechoic congenital abnormalities and all four patients had enlarged ventricles. Two of these infants had a grossly enlarged head due to congenital "hydrocephalus" (fig. 3). In one patient (fig. 3) the ventriculomegaly was detected in utero at 37 weeks gestation. After elective cesarean delivery, a ventriculoperitoneal shunt was placed and the baby was soon discharged. The patient's ventricular enlargement was thought to be secondary to congenital aqueductal stenosis. The second patient was also diagnosed in utero and there was a history of consanguinity in the parents.

The third patient with an anechoic congenital abnormality developed congestive heart failure shortly after birth; heart catheterization revealed a double outlet right ventricle and coarctation of the aorta. In the second week of life, the head circumference increased rapidly. Sonography (figs. 4A and 4B) showed a large cyst in the posterior fossa associated with mild "hydrocephalus." Small nubbins of tissue were noted in the posterior fossa to either side of midline. This was interpreted as a Dandy-Walker cyst with small remnants of the cerebellar hemispheres. CT (fig. 4C) confirmed the Dandy-Walker cyst. The patient then had a posterior fossa cystoperitoneal shunt placed. However, the shunt became infected and the patient died.

The fourth patient with an anechoic abnormality was a second twin who was well up until age 3 months when his mother noticed a bulging anterior fontanelle. CT showed a large Galenic arteriovenous malformation, associated with enlarged ventricles. A vertebral angiogram (fig. 5A) demonstrated that the posterior cerebral arteries emptied into a huge "aneurysm" of the vein of Galen. A ventriculoperitoneal shunt was inserted and repeat CT was performed (fig. 5B). About 2 months later sonography showed the large aneurysm without any evidence of hydrocephalus (fig. 5C).

Discussion

Before the advent of CT scanning, the identification of neonatal intracranial abnormalities often required invasive diagnostic procedures, such as pneumoencephalography and carotid angiography. CT scanning has allowed the accurate diagnosis of intracranial abnormalities without the risks of the invasive techniques, although it still involves ionizing x-radiation. Sonography also has been useful in diagnosing abnormalities such as hydrocephalus [1–4], congenital anomalies such as arteriovenous malformations, encephaloceles, and Dandy-Walker cysts [5, 6], and even some instances of intraventricular hemorrhages [5–8]. Although reports have emphasized that sonograms obtained through the parietal bone are useful for detecting enlarged ventricles and cystic masses in the brain [1, 6], we have found that sonograms obtained through the anterior fontanelle are better at detecting anechoic (fluid) and echogenic intracranial abnormalities.

Aside from normal echogenic structures in the brain, such as the choroid plexus, falx, tentorium, and cerebral sulci, abnormal echogenic foci may arise from collections of blood, fat, or calcium. In premature neonates, hemorrhages characteristically occur in the subependymal growth plate of the lateral ventricles, and they may be associated with intraventricular extension of the bleed or hemorrhage into the periventricular white matter [9, 10]. The echogenicity of these hemorrhages is similar to the normal choroid plexus, but the distribution and asymmetry of the hematomas allow a specific diagnosis.

Although the echogenicity of fat and calcium (figs. 1 and 2) is similar to that of hematomas, the distribution makes a specific diagnosis possible. The lipoma of the corpus callosum is a midline structure extending from the frontal bone to the area of the pineal gland. Cerebral hematomas usually occur within the cerebral hemisphere and intraventricular hemorrhage throughout the ventricular system. The foci of calcification in the patient with toxoplasmosis could be mistaken for hemorrhages, but the periventricular distribution and the distribution within the brain substance were highly suggestive of calcifications associated with a congenital infection. Although foci of calcification usually cause

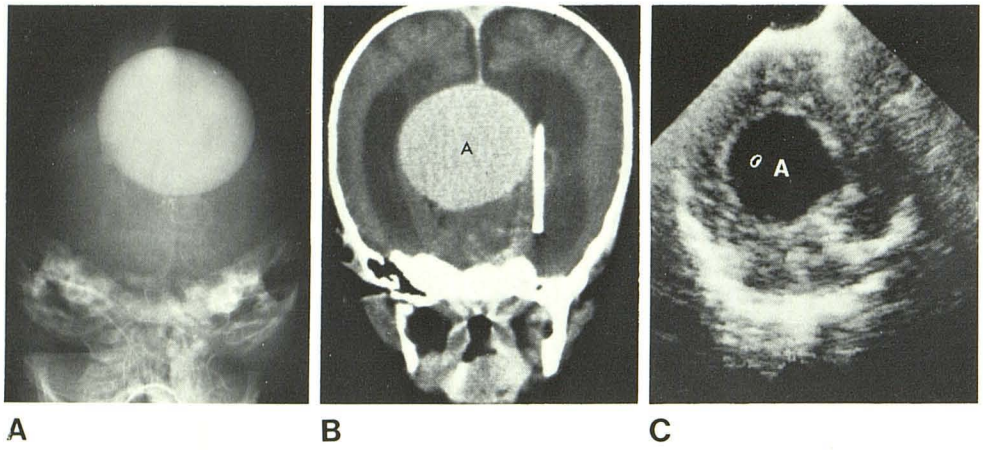


Fig. 5.—**A,** Frontal view, vertebral angiogram. Large aneurysm. **B,** Coronal CT scan after intravenous contrast enhancement. Large vein of Galen aneurysm (A) splaying apart enlarged lateral ventricles. Shunt tube in right lateral ventricle. **C,** Coronal sonogram through anterior fontanelle. Aneurysm (A) is seen as large cystic space within central part of brain. No evidence of hydrocephalus at this time.

distal shadowing in sonograms, we were unable to detect any such shadowing with the 3.5 MHz transducer. However, with the high frequency linear array (7 MHz) there was definite shadowing distal to the echogenic foci, thus, differentiating them from collections of blood which do not shadow.

In cases of cystic abnormalities, it is often possible to make a specific diagnosis by sonography. The posterior fossa cyst was diagnosed as a Dandy-Walker cyst because small cerebellar hemispheric remnants were detected. The ventricles were only slightly dilated, suggesting that there must be some flow of cerebrospinal fluid from the dilated fourth ventricle into the subarachnoid space.

In neonates with an enlarged head or with obvious congenital abnormalities, sonography should be the first imaging procedure to study the brain. If the sonogram is normal, further investigations may not be needed. If a specific abnormality can be diagnosed by sonography, the number of additional investigations may be diminished. The initial sonogram will also act as the baseline for follow-up scans to monitor the degree of ventriculomegaly which may accompany the primary congenital abnormality.

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