Diagn Interv Radiol 2007; 13:61-63

The value of power Doppler ultrasonography in the differential diagnosis of intracranial extraaxial fluid collections

Mehmet Noyan Zenger, Serdar Kabataş, Seda Zenger, Handan Çakmakçı

PURPOSE
The aim of this study was to determine the value of power Doppler ultrasonography in the differential diagnosis of intracranial extraaxial fluid collections in enlarged subarachnoid spaces.

MATERIALS AND METHODS
The study included 11 patients referred to our hospital's radiology department between April 2001 and February 2002 who were determined to have intracranial extraaxial effusion based on the results of cranial ultrasonography (US), computed tomography (CT), and magnetic resonance imaging (MRI). Transfontanel examinations of the enlarged subarachnoid spaces, including cortical vascular structures, with a 4–7 MHz linear probe were used to make differential diagnoses of extracerebral fluid collections.

RESULTS
In 8 of the 11 patients, the diagnosis was an enlarged benign extraaxial subarachnoid space. In one case, the differentiation of mirror artifacts of an epidural hematoma from a cephalhematoma was constructed by the cortical vascular structure with power Doppler US. In 2 cases, subdural hematomas were seen.

CONCLUSION
Power Doppler US is a safe and complementary method to cranial US that is useful in the differential diagnosis of extraaxial intracranial fluid.

Key words: • *intracranial collections* • *power Doppler ultrasonography* • *subarachnoid space*

Pericerebral fluid collections are relatively common in infants and might present as benign enlargement of the subarachnoid space, or enlargement of the subarachnoid space due to parenchymal atrophy, subdural hygroma, subdural effusion, or subdural hematoma (1–6). Magnetic resonance imaging (MRI) is generally adequate for differential diagnosis with various pulse sequences, contrast media enhancement, and the cortical vein sign, which is the visualization of cortical veins in the intracranial extraaxial space. Visualization of these veins in the fluid collection proves that the extraaxial fluid collection is secondary to subarachnoid space enlargement and points to the non-existence of subdural pathology. Power Doppler ultrasound (US) might demonstrate cortical veins in the fluid collection among the superficial gyri and sulci (7–12). The aim of this study was to detect the availability of the cortical vein sign of MRI with power Doppler US.

Materials and methods

We prospectively evaluated 11 infants (5 females and 6 males; mean age, 7 months; age range, 3–18 months) in the radiology department of our hospital between April 2001 and February 2002.

Pericerebral fluid collections detected with computed tomography (CT), MRI, and gray-scale transcranial US were evaluated with power Doppler US. We looked for the cortical vein sign with power Doppler US during transcranial sonography. Images were acquired with gray-scale and power Doppler US (HDI 5000, Philips, ATL Ultrasound, Bothell, WA, USA) using a 4–7 MHz linear probe. A water pad was not used. Infants were evaluated in the supine position without sedation. Images were acquired from the anterior fontanel, and the frontoparietal pericerebral space in parasagittal and coronal planes. One of the patients was also examined using posterior fontanel and transtemporal approach to visualize the frontoparietal fluid collection that was seen on MRI.

Results

Positive cortical vein signs were detected in 8 of 11 (72%) infants who were diagnosed with benign extraaxial subarachnoid space enlargement (Fig. 1). There was an epidural hemorrhage-mimicking image due to mirror artifacts secondary to a cephalhematoma in one of the 3 (28%) cases in which the cortical vein sign was not detected. Displaced cortical veins were detected in both of the 2 cases with subdural effusion demonstrated in MRI (Fig. 2).

Discussion

Abnormal pericerebral fluid collections are generally detected in 2 spaces in infants: the potential subdural space and the subarachnoid space. Cortical veins are stretched or displaced secondary to the enlarge-

From the Department of Radiology (M.N.Z. ✉ *mnoyanz@hotmail.com*), Nakiboğlu Bilgi Hospital, Konya, Turkey; the Department of Neurosurgery (S.K.), Batı Bahat Hospital, İstanbul, Turkey; the Department of Radiology (S.Z.), Meram Research and Training Hospital, Konya, Turkey; and the Department of Radiology (H.Ç.), Dokuz Eylül University School of Medicine, İzmir, Turkey.

Received 15 February 2007; accepted 27 April 2007.

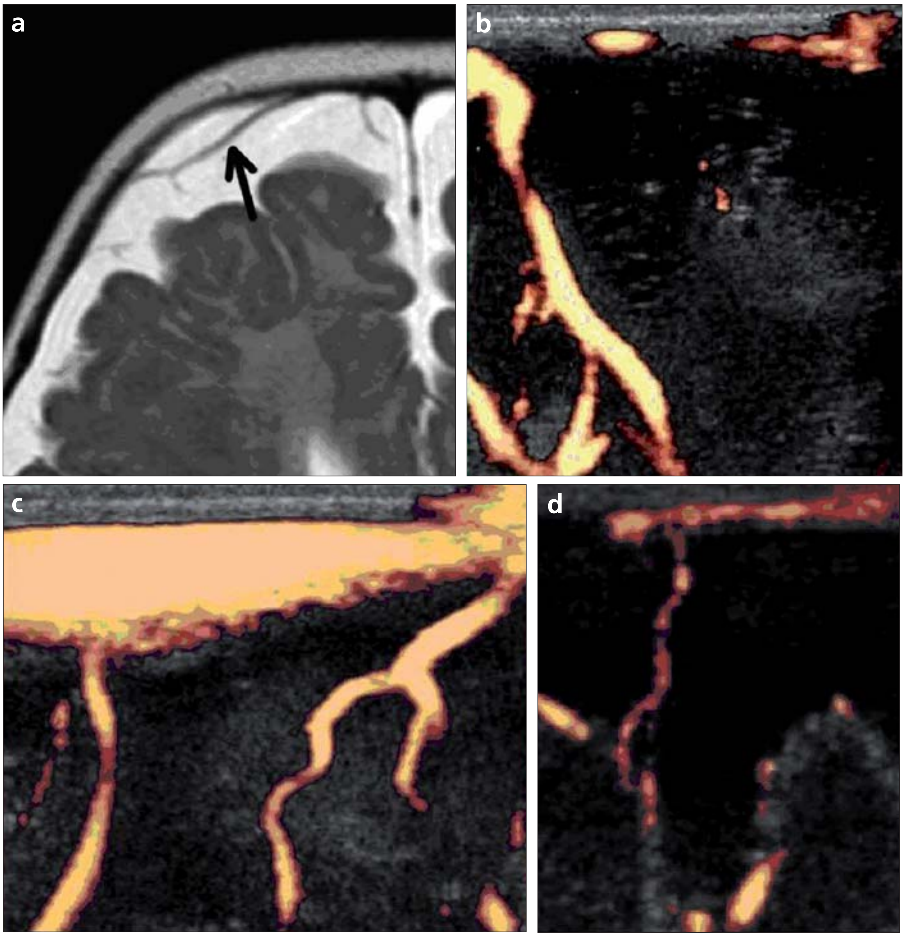

Figure 1. a–d. Positive cortical vein sign on axial T2-weighted MR image **(a)** and cortical veins visualized with power Doppler US **(b–d)** in the subarachnoid space in a case of benign subarachnoid space enlargement.

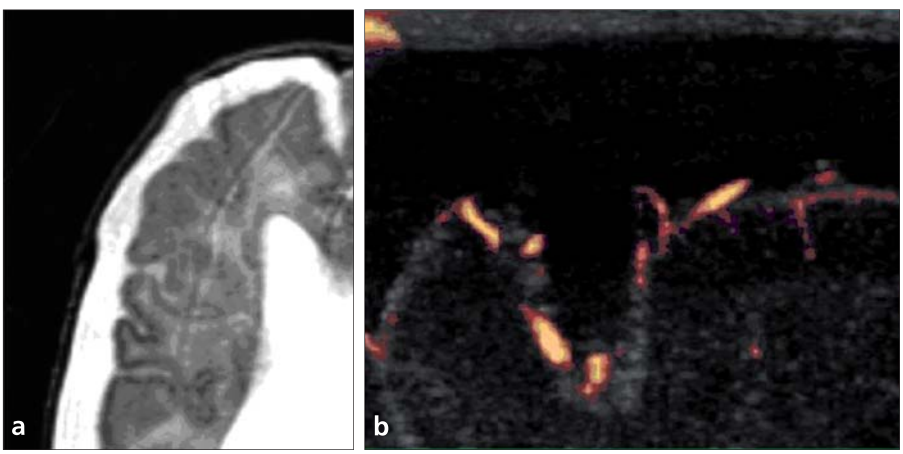

Figure 2. a, b. A case of subdural hematoma in which cortical veins were not visualized on axial T2-weighted MR image **(a)**. Cortical veins are visualized as displaced toward the parenchyma on power Doppler US examination of the same case **(b)**.

ment of these spaces. The cortical vein sign is actually used for discrimination of enlargement in the subarachnoid space secondary to atrophy due to subdural hygroma. Cortical veins are visualized as displaced toward the brain parenchymal surface as a result of internal shifting of the arachnoid membrane in subdural hygroma. Displaced cortical veins medial to the hygroma drain into the superior sagittal sinus by piercing the neighboring dura (13,14).

The cortical vein sign was adapted to power Doppler US in this study. Displacement of superficial cortical veins due to different localizations of pathologic conditions was detected. An echogenic neomembrane (arachnoid membrane) neighboring displaced veins in gray-scale and negative cortical vein sign in subdural collections have been described in the literature (7, 9). This membrane was not visualized in any of the two cases with subdural collections in our study. Additional findings described in gray-scale were gyral and sulcal displacement, ventricular enlargement, and a thick-echogenic pia-arachnoid membrane. Previous gray-scale findings detected in benign subarachnoid enlargement were sulcal dilatation, normal gyrus configuration, and normal ventricular system (9–12, 15, 16).

Cranial gray-scale US and power Doppler US examinations might be performed before closure of fontanels and both are quite effective methods for demonstrating neonatal intracranial pathologies. The advantages of US are that it is a non-invasive and easy-to-perform technique that does not require sedation like other imaging techniques (e.g., CT, MRI). Power Doppler US is complementary to cranial gray-scale US and we think it is a reliable technique for the differential diagnosis of intracranial extraaxial fluid collections.

References

1. Zouros A, Bhargava R, Hoskinson M, Aronyk KE. Further characterization of traumatic subdural collections of infancy. Report of five cases. J Neurosurg 2004; 100 (5 Suppl Pediatrics):512–518.
2. Loh JK, Lin CL, Kwan AL, Howng SL. Acute subdural hematoma in infancy. Surg Neurol 2002; 58:218–224.
3. Korinth MC, Lippitz B, Mayfrank L, Gilsbach JM. Subdural-atrial and subdural-peritoneal shunting in infants with chronic subdural fluid collections. J Pediatr Surg 2000; 35:1339–1343.
4. Wells RG, Sty JR. Traumatic low attenuation subdural fluid collections in children younger than 3 years. Arch Pediatr Adolesc Med 2003; 157:1005–1010.
5. Cohen JE, Rajz G, Itshayek E, Umansky F. Bilateral acute epidural hematoma after evacuation of acute subdural hematoma: brain shift and the dynamics of extraaxial collections. Neurol Res 2004; 26:763–766.
6. Miranda P, Lobato RD, Rivas JJ, Alen JF, Lagares A. Postraumatic subdural collections: case report and review of the literature. Neurocirugia (Astur) 2004; 15:67–71.

7. Wilms G, Vanderschueren G, Demaerel PH, et.al. CT and MR in infants with pericerebral collections and macrocephaly: benign enlargement of the subarachnoid spaces versus subdural collections. AJNR Am J Neuroradiol 1993; 14:855–860.
8. Ozturk MH, Aydingoz U. Comparison of MR signal intensities of cerebral perivascular (Virchow-Robin) and subarachnoid spaces. J Comput Assist Tomogr 2002; 26:902–904.
9. Seibert JJ, Avva R, Hronas TN, et al. Use of power Doppler in pediatric neurosonography: a pictorial essay. Radiographics 1998; 18:879–890.
10. Hamper UM, DeJong MR, Caskey CI, Sheth S. Power Doppler imaging: clinical experience and correlation with color Doppler US and other imaging modalities. Radiographics 1997; 17:499–513.
11. Riccabona M, Resch B, Eder HG, Ebner F. Clinical value of amplitude-coded colour Doppler sonography in paediatric neurosonography. Childs Nerv Syst 2002; 18:663–669.
12. Couture A, Veyrac C, Baud C, Saguintaah M, Ferran JL. Advanced cranial ultrasound: transfontanellar Doppler imaging in neonates. Eur Radiol 2001; 11:2399–2410.
13. Dean LM, Taylor GA. The intracranial venous system in infants normal and abnormal findings on duplex and color Doppler US. AJR Am J Roentgenol 1995; 164:151–156.
14. McCluney KW, Yeakley JW, Fenstermacher MJ, Baird SH, Bonmati CM. Subdural hygroma versus atrophy on MR brain scans: “the cortical vein sign”. AJNR Am J Neuroradiol 1992; 13:1335–1339.
15. Robertson WC Jr, Chun RW, Orrison WW, Sackett JF. Benign subdural collections of infancy. J Pediatr 1979; 94:382–386.
16. Chen CY, Chou TY, Zimmerman RA, Lee CC, Chen FH, Faro SH. Pericerebral fluid collection: differentiation of enlarged subarachnoid spaces from subdural collections with color Doppler US. Radiology 1996; 201:389–392.