



Get Clarity On Generics

Cost-Effective CT & MRI Contrast Agents



FRESENIUS
KABI

WATCH VIDEO

AJNR

Gadolinium-enhanced MR of chronic dural sinus thrombosis.

D Dormont, K Sag, A Biondi, B Wechsler and C Marsault

AJNR Am J Neuroradiol 1995, 16 (6) 1347-1352

<http://www.ajnr.org/content/16/6/1347>

This information is current as
of August 21, 2025.

Gadolinium-Enhanced MR of Chronic Dural Sinus Thrombosis

Didier Dormont, Kemal Sag, Alessandra Biondi, Bertrand Wechsler, and Claude Marsault

Summary: Gadopentetate dimeglumine-enhanced MR imaging was performed in four patients with chronic dural sinus thrombosis. After injection, intense enhancement of the chronic thrombus was observed in all cases. On three-dimensional time-of-flight MR angiography, performed in one case, the occluded part of the superior sagittal sinus was not distinguishable from a normal sinus because of thrombus enhancement mimicking blood flow. Enhancement of the clot is best explained by organization of the thrombus, which is converted into vascularized connective tissue. It could lead to false-negative results in patients with chronic dural sinus thrombosis studied with contrast-enhanced MR or contrast-enhanced time-of-flight MR angiography techniques.

Index terms: Dural sinuses; Thrombosis, dural sinus

Magnetic resonance (MR) imaging is considered the best noninvasive imaging modality to detect dural sinus thrombosis (1–5). In dural sinus thrombosis, postcontrast appearance rarely has been described (6). More recently, in patients with dural sinus thrombosis, the use of MR angiography has been proposed (7–12) and the use of paramagnetic contrast agents has been advocated to increase the sensitivity of MR angiography (13–15). In four patients in whom unenhanced MR studies demonstrated chronic dural sinus thrombosis, gadopentetate dimeglumine was injected to evaluate whether contrast administration improved visibility of the dural sinus thrombosis. One patient also was studied with contrast enhanced three-dimensional time-of-flight MR angiography.

Materials and Methods

Among 14 MR cases of chronic dural sinus thrombosis, the last 4 patients were studied with injection of gadopentetate dimeglumine. There were 2 men and 2 women,

ranging in age from 23 to 46 years (mean age, 32 years). Two patients had Behçet disease, according to the criteria of the International Study Group for Behçet disease (16). At the time of MR study, neurologic examination revealed intracranial hypertension with bilateral papillary edema in all cases. MR was performed 6 months (case 1), 7 months (case 3), 1 year (case 4), and 2 years (case 2) after the presumed onset of dural sinus thrombosis.

MR study was performed on a 1.5-T unit in 3 patients (cases 1, 2, and 4). For these patients, the following sequences were obtained before injection of gadopentetate dimeglumine: sagittal spin-echo T1-weighted images 600/11/2 (repetition time/echo time/excitations), coronal spin-echo T2-weighted images 2500-2800/60 (first echo), 120 (second echo)/1, coronal flow-sensitive gradient-echo images (gradient recalled acquisition in a steady state [GRASS] 50/14/2, 60° flip angle, or multiplanar gradient-echo 100/14/2, 90° flip angle) axial spin-echo T2-weighted images 2500/33/1 with 90° flip angle, axial spin-echo T1-weighted images 420/11/2, and axial flow-sensitive gradient-echo images (GRASS, 50/14/2, 60°-90° flip angle, or multiplanar gradient-echo 100/14/4, 90° flip angle). Section thickness was 5 mm in the sagittal, 6 mm in the axial, and 8 mm in the coronal planes and matrix size was 256 × 192. All the gradient-echo flow-sensitive sequences were obtained with first-order gradient moment nulling. After injection of gadopentetate dimeglumine, axial spin-echo T1-weighted images (420/11/2) were obtained.

One patient (case 4) also was studied with 3-D time of flight MR angiography after injection of gadopentetate dimeglumine. Parameters of the 3-D acquisition were 40/6.9/1, 25° flip angle; 64 1.5-mm axial sections were obtained with a 256 × 256 matrix and first-order gradient moment nulling.

One patient (case 3) was studied in another institution on a 0.5-T unit. Sagittal spin-echo T1-weighted images (440/20/2), axial spin-echo T2-weighted images (2600/30/90), and coronal spin-echo T1-weighted images (500/20/2) were obtained before contrast injection. After injection of gadopentetate dimeglumine, coronal spin-echo T1-weighted images were obtained. Angiography also was available in this case, performed 5 days after MR.

Received December 3, 1993; accepted after revision March 31, 1994.

From the Departments of Neuroradiology (D.D., K.S., A.B., C.M.) and Internal Medicine, Hôpital de la Pitié-Salpêtrière, Paris, France.

Address reprint requests to D. Dormont, Department of Neuroradiology, Hôpital de la Pitié, 83 Boulevard de l'Hôpital, 75651 Paris Cedex 13, France.

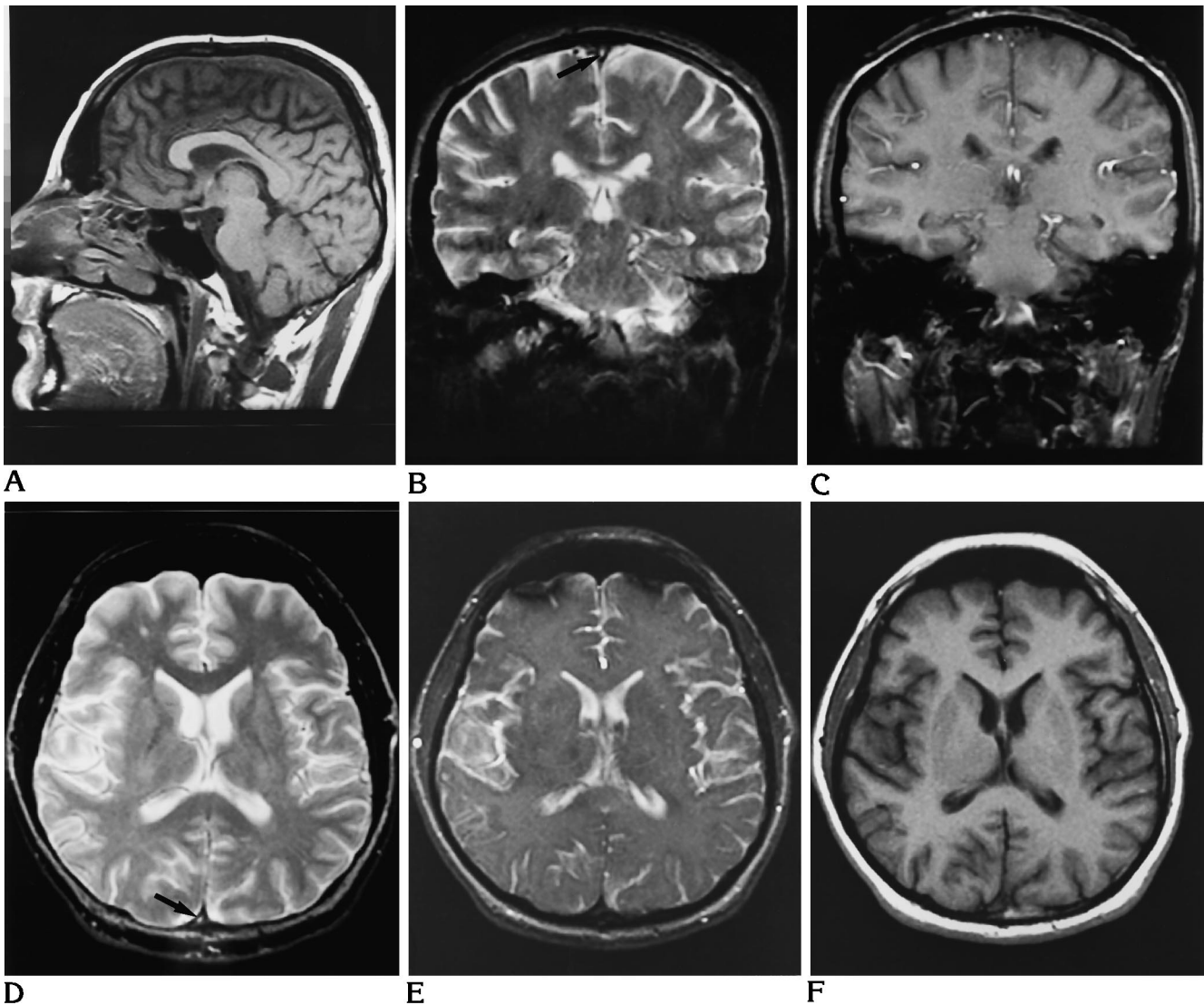


Fig 1. Case 1. 24-year-old man with Behçet disease. Thrombosis in the late stage of middle and posterior thirds of the superior sagittal sinus.

A, Sagittal spin-echo T1-weighted image (600/11/2) shows isointense signal of the middle portion of the superior sagittal sinus.

B, Coronal spin-echo T2-weighted image (2800/120/1) shows abnormal hyperintense signal in the superior sagittal sinus (*arrow*).

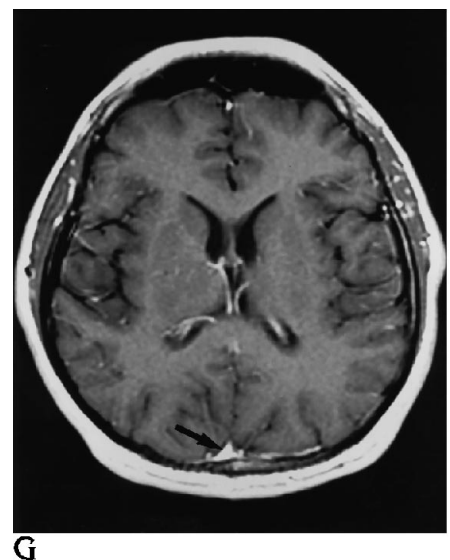
C, Coronal flow-sensitive multiplanar gradient-echo image (100/14/4, 90° flip angle) shows absence of the normal hyperintense signal at the same level, confirming superior sagittal sinus occlusion.

D, Axial spin-echo T2-weighted image (2500/90/1) shows abnormal hyperintense signal in the superior sagittal sinus (*arrow*) at a more posterior level than in B.

E, Axial flow-sensitive gradient-echo image (GRASS 50/14/2, 60° flip angle) shows absence of hyperintense signal at the same level, confirming superior sagittal sinus occlusion.

F, Axial spin-echo T1-weighted image (420/11/2) shows isointense signal in the superior sagittal sinus.

G, Axial spin-echo T1-weighted image (420/11/2) after injection of gadopentetate dimeglumine shows intense enhancement of the clot (*arrow*).



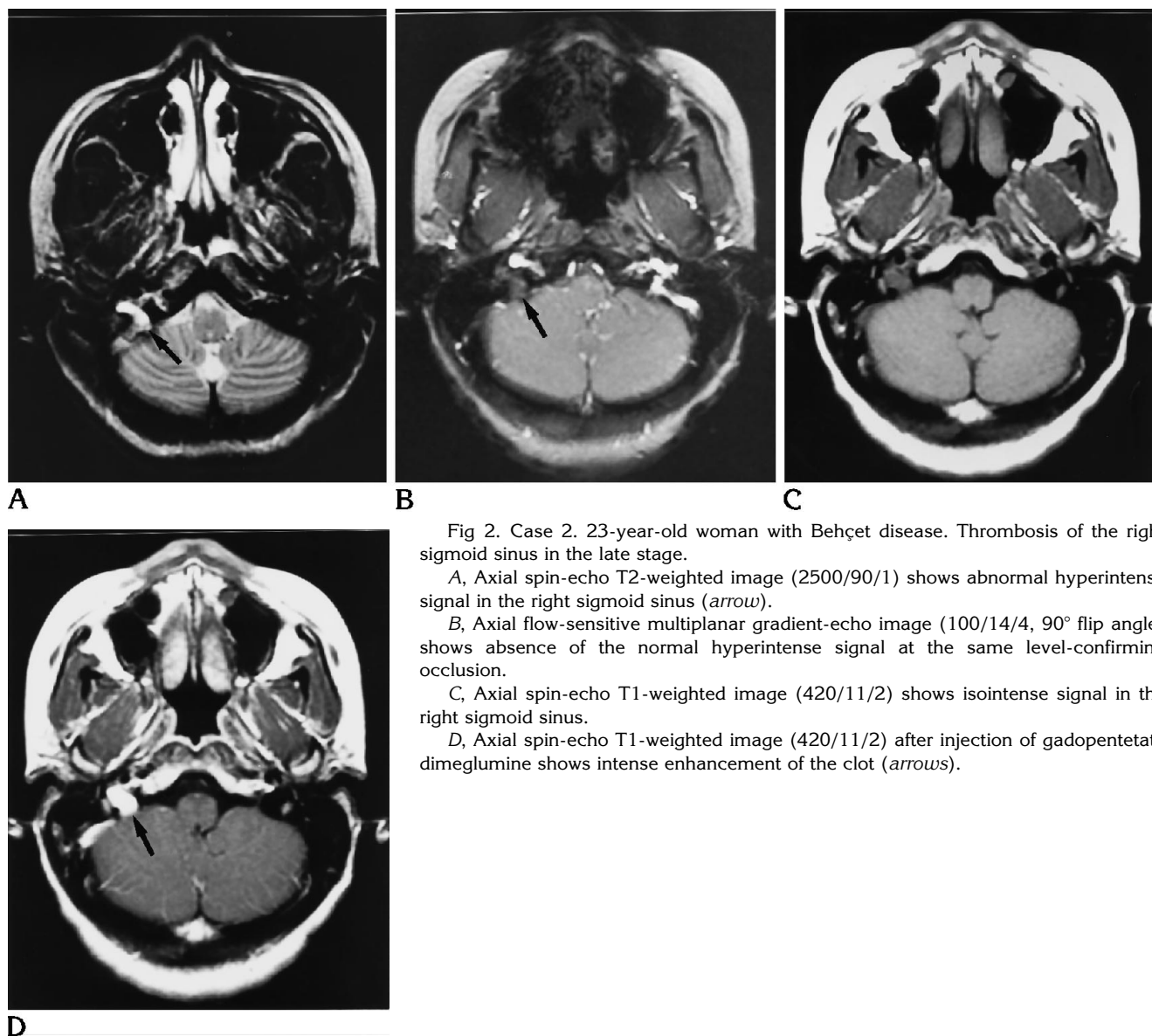


Fig 2. Case 2. 23-year-old woman with Behçet disease. Thrombosis of the right sigmoid sinus in the late stage.

A, Axial spin-echo T2-weighted image (2500/90/1) shows abnormal hyperintense signal in the right sigmoid sinus (*arrow*).

B, Axial flow-sensitive multiplanar gradient-echo image (100/14/4, 90° flip angle) shows absence of the normal hyperintense signal at the same level—confirming occlusion.

C, Axial spin-echo T1-weighted image (420/11/2) shows isointense signal in the right sigmoid sinus.

D, Axial spin-echo T1-weighted image (420/11/2) after injection of gadopentetate dimeglumine shows intense enhancement of the clot (*arrows*).

Computed tomography (CT) scan, performed before MR examination, was available in one patient (case 1).

Results

In all four patients, MR demonstrated dural sinus thrombosis in the late stage with presence of a chronic thrombus (cases 1 and 3, middle and posterior thirds of the superior sagittal sinus; case 2, right sigmoid sinus; case 4, posterior third of the superior sagittal sinus).

Normal dural sinuses presented flow void on spin-echo T1- and T2-weighted images and hyperintense signal on gradient-echo flow-sensitive images. After gadopentetate dimeglumine injection, they usually appeared hyperintense

on spin-echo T1-weighted images. Occluded dural sinuses showed isointense signal on spin-echo T1-weighted images and intermediate hyperintense signal on both echoes of spin-echo T2-weighted images. On flow-sensitive images, absence of the normal hyperintense signal because of flow-related enhancement was observed in the occluded sinus. In all four cases, on spin-echo T1-weighted images after gadopentetate dimeglumine injection, intense and homogeneous enhancement was observed within the occluded sinus (Figs 1–4). The enhanced occluded portions of dural sinuses were indistinguishable from the adjacent normally flowing venous channels, which also were hy-

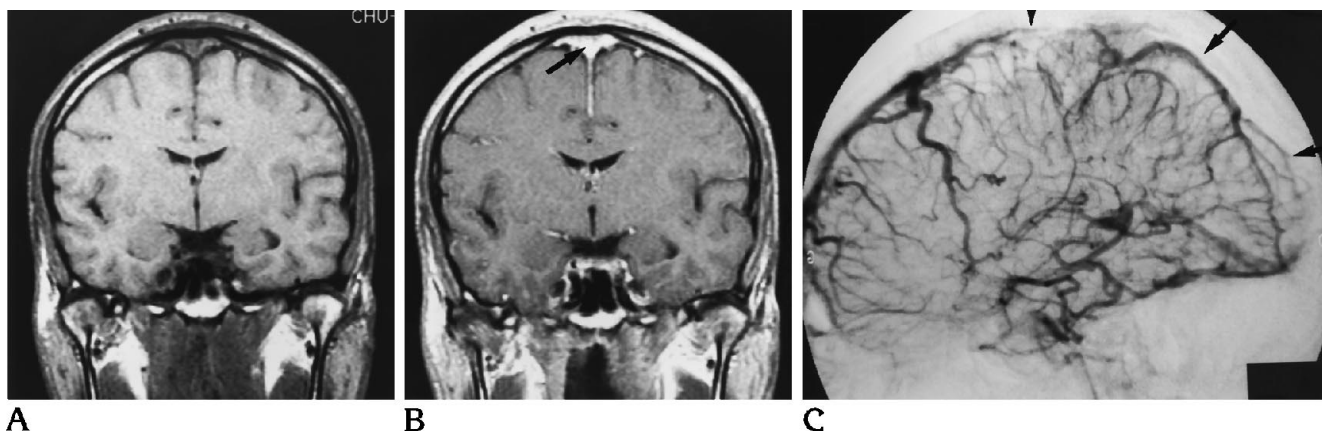


Fig 3. Case 3. 35-year-old man with thrombosis of the middle and posterior thirds of the superior sagittal sinus in the late stage.

A, Coronal spin-echo T1-weighted image (500/20/2) shows isointense signal in the occluded superior sagittal sinus.

B, Coronal spin-echo T1-weighted image (500/20/2) after injection of gadopentetate dimeglumine (same level as A) shows enhancement in the thrombosed superior sagittal sinus (arrow).

C, Left carotid angiogram, lateral view, venous phase, shows occlusion of the superior sagittal sinus (arrows).

perintense. Figure 1 (case 1) shows the aspect of an occluded dural sinus on all different sequences without and with gadopentetate dimeglumine. Occlusion of the dural sinus was confirmed on digital selective bilateral carotid angiography in case 3 (Fig 3).

In the patient (case 4) studied with 3-D time-of-flight MR angiography, the occluded portion of the superior sagittal sinus was well identified on MR without contrast. On contrast-enhanced MR and on contrast-enhanced MR angiography, the thrombosed sinus was not distinguishable from the normal sinus because of thrombus enhancement mimicking blood flow (Fig 4).

Discussion

MR is considered the method of choice in the noninvasive diagnosis of dural sinus thrombosis. In reports on MR findings in dural sinus thrombosis (1, 2, 17), two stages of thrombus evolution have been described: initial (or "acute") and intermediate (or "subacute"). In the initial stage, the thrombus was described as isointense on T1-weighted images and hypointense on T2-weighted images. In the intermediate stage, the thrombus is hyperintense on both T1- and T2-weighted images (in a few cases, hyperintense on T1- and hypointense on T2-weighted images). In these papers, the late stage was described as "the beginning of recanalization of the vessel" with reappearance of flow void in venous channels. Other authors (3, 4) described a late stage of dural sinus thrombosis, before the recanalization of the vessel,

with the presence of a chronic thrombus. At this latter stage, the thrombus signal is characterized by isointensity on T1- and hyperintensity on T2-weighted images. The use of flow-sensitive gradient-echo MR sequences also was proposed for the diagnosis of dural sinus thrombosis (18, 19). With these sequences, flowing blood and subacute thrombosis appear hyperintense.

An MR study (6) has described the postcontrast appearance in one case of a septic left transverse sinus thrombosis. A pronounced enhancement of tentorium and of the wall of the sinus was observed, which is similar to the empty delta sign described on CT (20–24). This sign is probably related to the thrombus within the dural sinus surrounded by contrast material in the smaller collateral veins and in the wall of the sinus. The specificity of the empty delta sign is high, but its sensitivity is surprisingly low: it is observed in only 30% of cases of sagittal sinus thrombosis (24).

The use of MR angiography for the diagnosis of dural sinus thrombosis has been reported (10–12). To avoid saturation of the venous structures, some authors (13, 15) have proposed contrast-enhanced 3-D time-of-flight MR angiography and have showed that contrast injection greatly improves the visibility of the venous structures. However, time-of-flight images are also T1 dependent, and problems associated with the use of this technique are the risk of confusion of high-signal regions, which can be attributable to blood flow but also to an enhancement of a normal or pathologic structure.

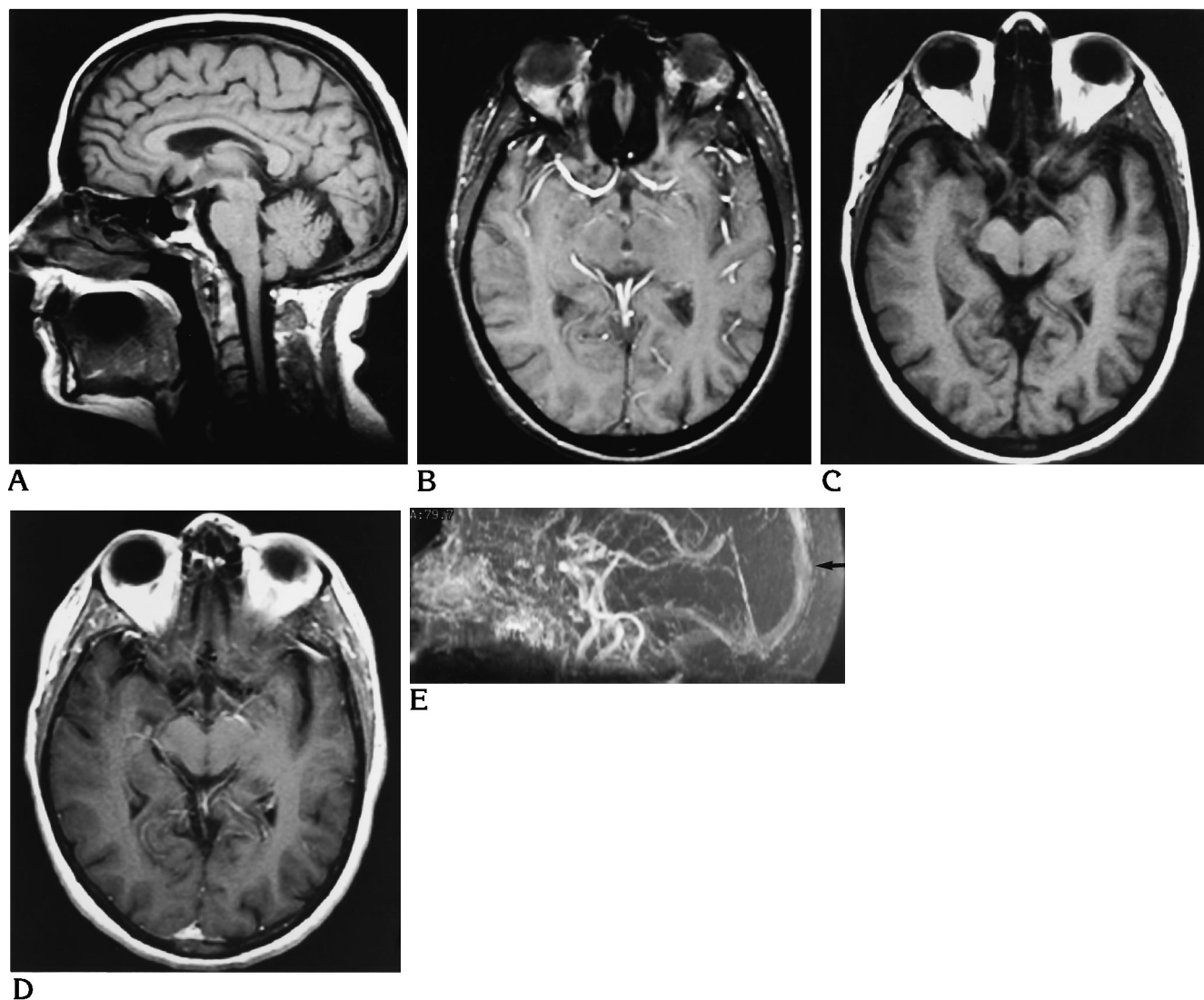


Fig 4. Case 4. 46-year-old woman with rheumatoid polyarthritis. Thrombosis in the late stage of the posterior third of the superior sagittal sinus.

A, Sagittal spin-echo T1-weighted image (600/11/2) shows localized isointense signal within the posterior segment of the superior sagittal sinus.

B, Axial flow-sensitive multiplanar gradient-echo image (100/14/4, 90° flip angle) shows absence of the normal hyperintense signal because of superior sagittal sinus thrombosis.

C, Axial spin-echo T1-weighted image (420/11/2) shows isointense signal in the superior sagittal sinus.

D, Axial spin-echo T1-weighted image (420/11/2) after injection of gadopentetate dimeglumine shows intense enhancement within the thrombosed dural sinus.

E, Axial 3-D time-of-flight MR angiography (40/6.9/1, 25° flip angle) after injection of gadopentetate dimeglumine. Lateral view obtained with a maximal intensity projection algorithm. Localized thrombosis of the posterior portion of the superior sagittal sinus is not visible because of clot enhancement (arrow).

In our four patients, unenhanced MR scans demonstrated dural sinus thrombosis. Signal characteristics of the clot were those of a chronic thrombus. It was possible to affirm the occlusion of the dural sinuses because signal abnormalities were observed in all sequences and with different section orientation. In all patients with chronic dural sinus thrombosis stud-

ied with gadolinium, enhancement of the thrombus was observed, but our series is too limited to affirm that this is a constant finding. Enhancement within the occluded dural sinus is a phenomenon best explained by organization of the thrombus. The thrombus is invaded by fibroblasts and capillary channels and is thus converted into vascularized connective tissue (25).

Because of the hypervascularization of this tissue, enhancement of the organized thrombus occurs after injection of contrast material. Because of this, caution is advised in the use of contrast-enhanced 3-D time-of-flight MR angiography to study venous anatomy. This technique could be particularly misleading if dural sinus thrombosis is being considered.

In conclusion, we have observed contrast enhancement of the clot in patients with dural sinus thrombosis in the late stage of thrombus evolution. This could lead to false-negative results in patients with dural sinus thrombosis in the late stage with the use of contrast-enhanced MR and time-of-flight MR angiography techniques. Phase-contrast (with or without contrast agent) or time-of-flight (without contrast agent) MR angiography techniques are therefore preferred for the evaluation and follow-up of patients with suspected dural sinus thrombosis.

References

- Macchi PJ, Grossman RI, Gomori MJ, et al. High field MR imaging of cerebral venous thrombosis. *J Comput Assist Tomogr* 1986;10:10-15
- Mc Murdo SK, Brant-Zawadzki M, Bradley WG Jr, Chang GY, Berg BO. Dural sinus thrombosis: study using intermediate field strength MR imaging. *Radiology* 1986;161:83-86
- Sze G, Simmons B, Krol G, Walker R, Zimmerman RD, Deck MD. Dural sinus thrombosis: verification with spin echo techniques. *AJNR Am J Neuroradiol* 1988;9:679-686
- Dormont D, Anxionnat R, Evrard S, Louaille C, Chiras J, Marsault C. IRM des thromboses veineuses cérébrales. *J Neuroradiol* 1994;21:81-99
- Tsuruda JS, Shimakawa A, Pelc NJ, Saloner D. Dural sinus occlusion: evaluation with phase-sensitive gradient-echo MR imaging. *AJNR Am J Neuroradiol* 1991;12:481-488
- Harris TM, Smith RR, Koch JK. Gadolinium-DTPA enhanced MR imaging of septic dural sinus thrombosis. *J Comput Assist Tomogr* 1992;16:25-29
- Dumoulin CL, Souza SP, Walker MF, Wagle W. Three dimensional phase contrast angiography. *Magn Reson Med* 1989;9:139-149
- Edelman RR, Mattle HP, Atkinson DJ, Hoogewoud HM. MR angiography. *AJR Am J Roentgenol* 1990;154:937-946
- Nishimura DG. Time-of-flight angiography. *Magn Reson Med* 1990;14:194-202
- Pernicone JR, Siebert JE, Potchen EJ, Pera A, Dumoulin CL, Souza SP. Three-dimensional phase-contrast MR angiography in the head and neck: preliminary report. *AJNR Am J Neuroradiol* 1990;11:457-466
- Rippe DJ, Boyko OB, Spritzer CE, et al. Demonstration of dural sinus occlusion by the use of MR angiography. *AJNR Am J Neuroradiol* 1990;11:199-201
- Mattle HP, Wentz KU, Edelman RR, et al. Cerebral venography with MR. *Radiology* 1991;178:453-458
- Chakeres DW, Schmalbrock P, Brogan M, et al. Normal venous anatomy of the brain: demonstration with gadopentetate dimeglumine in enhanced 3-D MR angiography. *AJNR Am J Neuroradiol* 1990;11:1107-1118
- Creasy JL, Price RR, Presbrey T, et al. Gadolinium-enhanced MR angiography. *Radiology* 1990;175:280-283
- Marchal G, Michelis J, Bosmans H, Van Hecke P. Contrast-enhanced MRA of the brain. *J Comput Assist Tomogr* 1992;16:25-29
- International Study Group for Behçet's Disease. Criteria for diagnosis of Behçet's disease. *Lancet* 1990;335:1078-1080
- Zimmerman RA, Bilaniuk LT, Hackney DB, Goldberg HI, Grossman RI. Magnetic resonance imaging of dural venous sinus invasion, occlusion and thrombosis. *Acta Radiologica* 1986;369:110-112
- Daniels DL, Czervionke LF, Hendrix LE, et al. Gradient-recalled echo MR imaging of superior sagittal sinus occlusion. *Neuroradiology* 1989;31:134-136
- Yousem DM, Balkrishnan J, Debrun GM, Bryan RN. Hyperintense thrombus on GRASS MR images: potential pitfall in flow evaluation. *AJNR Am J Neuroradiol* 1990;11:51-58
- Buonanno FS, Moody DM, Ball MR, Laster DW. Computed cranial tomographic findings in cerebral sinovenous occlusion. *J Comput Assist Tomogr* 1978;2:281-90
- Ford K, Sarwar M. Computed tomography of dural sinus thrombosis. *AJNR Am J Neuroradiol* 1981;2:539-543
- Goldberg AL, Rosenbaum AE, Wang H, Kim WS, Lewis VL, Hanley DF. Computed tomography of dural sinus thrombosis. *J Comput Assist Tomogr* 1986;10:16-20
- Rao KCVG, Knipp HC, Wagner EJ. Computed tomographic findings in cerebral sinus and venous thrombosis. *Radiology* 1981;140:391-398
- Virapongse C, Cazenave C, Quisling R, Sarwar M, Hunter S. The empty delta sign: frequency and significance in 76 cases of dural sinus thrombosis. *Radiology* 1987;162:779-785
- Robbins SL, Cotran RS. *Pathologic Basis of Diseases*. 2nd ed. Philadelphia, Pa: WB Saunders Co, 1979:123-124