The Accuracy of Magnetic Resonance Venography for Diagnosis of Dural Sinus Thrombosis

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Abstract : **A retrospective study of 24 patients who underwent magnetic resonance venography (MRV) was performed. The MRV used a 3D-PC technique and thick-slab multiplanar reconstruction. Four patients underwent conventional angiography. There were 4 males and 20 females with an age range of 8-71 years. The MRV was considered as positive for dural sinus thrombosis (DST) in 8 patients and negative in 16 patients. There were 2 false positive results in the MRV. The sensitivity of MRV is 100%, specificity 88%, positive predictive value 75% and negative predictive value 100%. We concluded that MRV is a valuable screening method for DST. One pitfall concerning the use of MRV is that a false positive interpretation may occur due to hypoplasia of the transverse sinus which is a normal variant.**

Key words : Dural sinus, Venous thrombosis, Magnetic resonance angiography

เรื่องย่อ : **การวินิจฉัยหลอดเลือดดำในสมองอุดตันด้วยเอ็มอาร์วี**

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สารศิริราช 2545; 54: 231-234.

ได้ทำการศึกษาย้อนหลังในผู้ป่วยที่ได้รับการตรวจเอ็มอาร์วี 24 รายที่มีข้อมูลทางคลินิกครบ ผู้ป่วยทั้งหมดได้รับการตรวจเอ็มอาร์วีด้วยวิธี 3D-PC MRV และสร้างภาพจากข้อมูลดิบแบบ thick-slab multiplanar reconstruction ผู้ป่วย 4 รายได้รับการตรวจรังสีหลอดเลือดด้วย ผู้ป่วยเป็นชาย 4 ราย หญิง 20 ราย อายุระหว่าง 8-71 ปี ผลเอ็มอาร์วีให้การวินิจฉัยว่าเป็น dural sinus thrombosis 8 ราย และไม่มีภาวะนี้ 16 ราย เมื่อเทียบกับการวินิจฉัยสุดท้ายทั้งโดยการตรวจรังสีหลอดเลือดและโดยคลินิก พบว่า เอ็มอาร์วีวินิจฉัยว่าเป็นโรคผิด 2 ราย สรุปผลการศึกษาพบว่าเอ็มอาร์วีเป็นวิธีที่ดีในการตรวจผู้ป่วยที่มีอาการสงสัยว่าเป็น dural sinus thrombosis.

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INTRODUCTION

Diagnosis dural sinus thrombosis (DST) is often missed and in many situations can be difficult. The variety of clinical and radiological presentations often causes difficulty in diagnosis and treatment can be delayed. Early administration of anticoagulant is very crucial in order to save life and morbidity. A CT brain is a noninvasive method for diagnosing DST. It may show brain edema, infarction or hemorrhage, none of which is specific.[1] The more specific empty "delta" sign or "cord" sign to indicate the presence of intraluminal thrombus is not always reliable, especially when partial occlusion is present. The gold standard for the diagnosis of DST is still catheterized angiography. However, it is invasive and may cause complications. Conventional angiography may be not practical especially in the early stages of the disease and CT is often "normal". MRI has been reported to have several advantages over CT and conventional angiography and it is advocated as the investigation of choice for the diagnosis of DST.[2,3]

A magnetic resonance venogram (MRV) is also currently considered to be the method of choice for both the diagnosis and follow up of DST.[4,5] There are many techniques used such as 3D-time of flight (TOF), 2D-phase contrast (PC) and 3D-PC. Each technique has its own advantages and disadvantages. 3D-TOF and 2D-PC take less time but produce less information than 3D-PC. In this study we evaluated the sensitivity and specificity of 3D-PC MRV in the diagnosis of DST and demonstrated the pitfalls of this method.

MATERIALS AND METHODS

A retrospective study was performed by analyzing the data of patients who underwent MRV at our institute during the 2-year period (1999-2000). The images were reviewed by 2 experienced neuroradiologists. Both radiologists were blinded to the clinical information and final diagnosis. The clinical course and information were reviewed by two neurologists who made the final diagnosis of DST. The neurologists were also blinded to the result of MRV and angiography. If a conventional angiogram was done, the final diagnosis was announced by the radiologist on a separate occasion. The sensitivity, specificity, positive predictive and negative predictive values of the MRV for the diagnosis of DST were calculated.

MRV techniques

The inferior saturation pulse was used to suppress the arterial signal. 3D-PC stacks, 1.5 mm slice thick in the axial plane, were done using TR/TE = 30/9.4 msec, flip angle = 20 degrees and velocity encoding gradient (VE) = 20 cm/sec. The thick-slab multiplanar reconstruction(MPR) of the volumetric data set was done in 6 slabs for selected planes, i.e., both parasagittal planes covering the mid-line, axial planes at the vertex and transverse sinus levels, and coronal planes at the occipital and cavernous sinus regions (Figure 1).

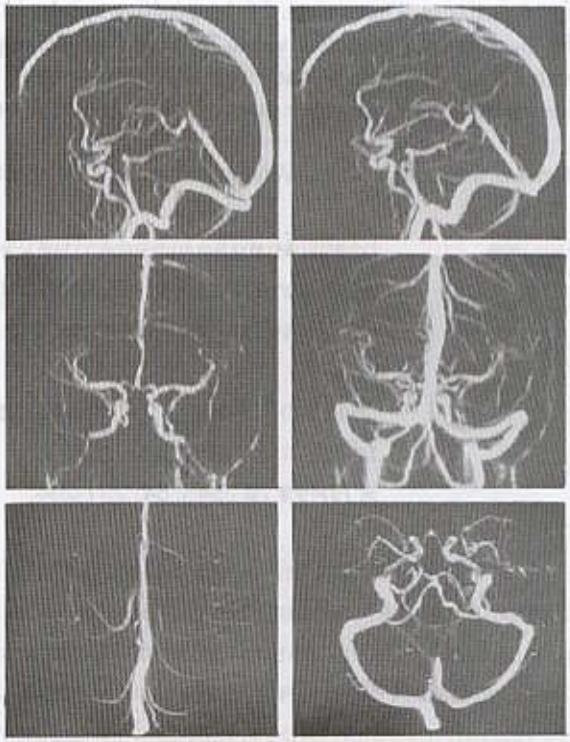

Figure 1. Normal 3D-PC MRV of brain with MPR. *A,B:* both parasagittal planes including midline, *C:* coronal at cavernous sinus region, *D:* coronal at occipital region, *E:* axial at vertex level, *and F:* axial at transverse sinus level.

RESULTS

During the period 1999-2000, 39 patients underwent MRV. Only 24 cases had complete clinical and neuroimaging data. There were 4 males and 20 females with an age range of 8-71 years. Four patients also had a conventional angiogram.

Of the 24 cases, the diagnosis of DST by MRV was positive in 8 patients and negative in 16 patients. The final diagnosis found 6 patients with positive MRV had DST and 18 patients were negative. There were 2 false positives and no false negatives. One of the 2 false positive MRV showed a left transverse sinus stenosis (Figure 2). The other one had systemic lupus and a hemorrhagic infarction which produced an irregular superior sagittal sinus (SSS) on MRV (Figure 3). The clinical course and laboratory investigation did not correlate with a diagnosis of DST. This patient improved after conservative treatment without heparin administration.

The sensitivity of MRV for the diagnosis of DST in this study was 100% and the specificity was 88% with positive predictive and negative predictive values of 75% and 100% respectively.

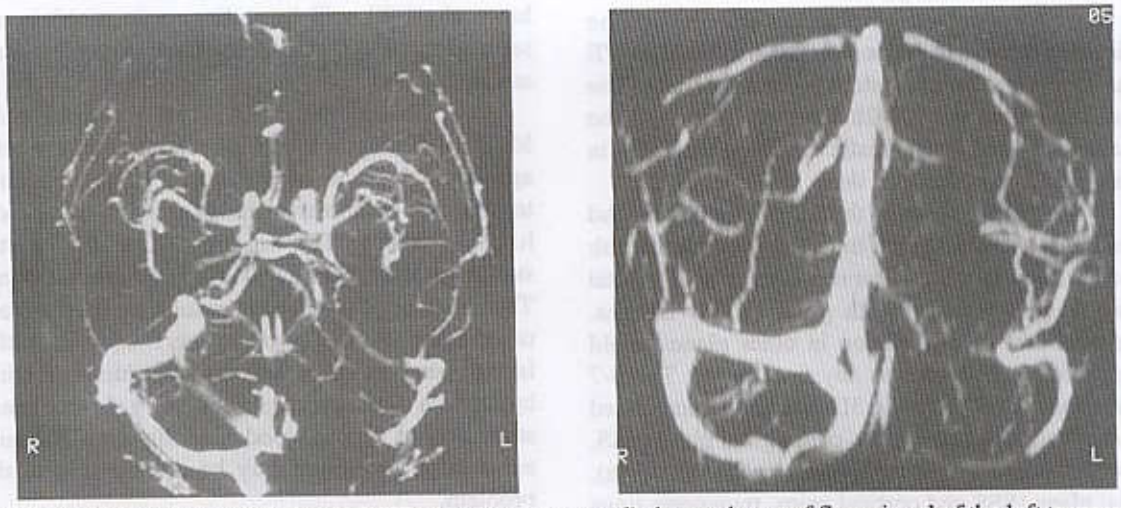

Figure 2. MRV of a patient without DST (A: axial, B: coronal) shows absent of flow signal of the left transverse sinus.

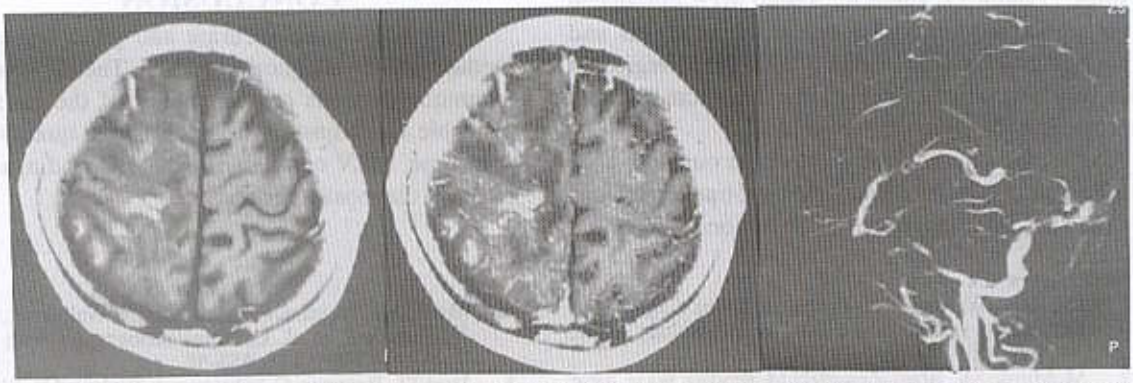

Figure 3. MRI (A: pre-, B: post- Gd-enhanced) and MRV (C) of a patient with history of systemic lupus show hemorrhagic infarction of the right parietal lobe and irregular loss of flow signal of the SSS. Note the enhancement of the SSS with no filling defect in B.

DISCUSSION

Several techniques of MRV can be used for the evaluation of dural sinuses.The 2D-TOF in the plane perpendicular to the sinus flow (such as the coronal plane for the SSS) is the easiest method. Signal loss of the torcular herophili from the in-plane flow saturation may cause a problem in diagnosis. We used this technique at our institute initially because it had the shortest scan time. Later, a phase contrast technique has been used to improve the quality of the images and to avoid the effect of slow flow signal loss which is often found in patients with increased intracranial pressure.

We applied thick slab 2D-PC in the following period to reduce the scan time. The VE was 20 cm/sec and 6-7 slabs for each patient. The total scan time was 24-28 minutes. Although the images acquired were satisfactory, reconstruction in other planes could not be done.

Finally, we tried the 3D-PC technique and found that the actual scan time was 15 minutes with an additional 15 minutes for reconstruction. The total time was 30 minutes with good quality images. Furthermore, reconstruction in other planes could also be done if there was any uncertainty. The 6-7 thick slabs MPR from the 3D data set demonstrated all dural sinuses clearly, i.e., parasagittal plane (SSS, sigmoid, jugular and deep central venous structures), axial plane (SSS and cortical veins, transverse sinus and base of skull), and coronal plane (cavernous sinus, transverse sinus, sigmoid sinus and jugular sinus) (Figure 1). These thick-slab MPR eliminated the unwanted superimposed vascular signal and artifact in each demonstrated dural sinus region in comparison with the total volume maximum intensity projection (MIP) in various angles.

One of the false positives in our study was from a normal variant of a hypoplastic transverse sinus which has been reported in 31% of normal MRV.[6]

The velocity gradient (VE) of venous flow is important in cerebral MRV. A high VE may cause loss of signal from slow flowing blood. On the other hand, a low VE may also cause the loss signal from aliasing effect of the higher flow. In general, a VE of 15-20 cm/sec is the most appropriate range. If there is any uncertainty about the images, a repeat MRV with a lower VE such as 10-15 cm/sec is recommended. However, a technique using a low VE will improve visualization of the collateral flow.

Gadolinium enhanced MRV has been reported to increase the sensitivity of small and slow flow vessels in 3D-TOF. However, thrombus which has a short T1 will be a diagnostic problem and saturation of the stationary tissue may be more advantageous.

We recommend 3D-PC MRV with thick-slab MPR in the regions that are of interest; covering appropriate plane of the dural sinus is a good technique to demonstrate dural sinus thrombosis with high accuracy. The images show no "dirty" superimposed artifacts and unwanted arterial signal. The information obtained is enough for the diagnosis of DST and no false negative was found. The pitfall is the same as other MRV techniques including hypoplasia of transverse sinus or very slow or nearly static flow of venous blood. Gadolinium MRV using subtraction technique may be the solution to this problem.

CONCLUSION

MRV is an accurate and good screening method for the diagnosis of DST. The appropriate technique depends on the quality of the machine available and adjusting between image quality and scan time. MRV correlated with MRI findings will increase diagnostic accuracy.

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