MR Findings of Cerebral Venous Sinus Thrombosis

Myung Kwan Lim, M.D., Kee-Hyun Chang, M.D.,
Moon Hee Han, M.D., Choong Gon Choi, M.D.

Purpose: To describe MR findings of cerebral venous sinus thrombosis

Materials and Methods: We reviewed 11 MR images of six patients with cerebral venous sinus thrombosis. The MR images were retrospectively analyzed in terms of location and signal intensity of the thrombi, parenchymal lesions such as hemorrhage and edema, and changes in follow-up study obtained in 4 patients.

Results: The thrombus in venous sinus was visualized on MRI in all six patients. The most frequently involved sites were superior sagittal sinus (n=4) and left transverse sinus (n=4). Signal intensity of the thrombus was isointense or hyperintense on both T1- and T2-weighted images with loss of normal signal void of the sinus on all sequences in all patients. Parenchymal lesion was present in five of six cases, manifested as local hemorrhage in three and edema in three cases (one case overlapped). Local edema seen in three patients was completely resolved on follow-up study of seven to 29 days intervals.

Conclusion: It is concluded that iso- or high signal intensity with loss of signal void in venous sinus is virtually diagnostic of venous sinus thrombosis. If there are local parenchymal lesions such as hemorrhage and/or edema of unknown causes, cerebral venous sinus thrombosis should be included in differential diagnosis.

Index Words: Brain, MR
Brain, infarction
Cerebral blood vessels, thrombosis
Sinuses, superior sagittal
Thrombosis, venous

Thrombosis of the cerebral venous sinus and cortical vein, in the past, had been associated with high mortality rate. Only the prompt and appropriate treatment can save the life and decrease the morbidity (1-6). However, diagnosis of the cerebral venous thrombosis is not easy and often delayed because of non-specific clinical and radiological findings. The role of computed tomography (CT) and cerebral arteriography in establishing the diagnosis has been well described (7-10). Even though MR imaging is the best imaging method in demonstration of the patency of the vascular lumen as well as in detecting parenchymal alterations, MR findings of cerebral venous sinus thrombosis have been reported in only a few literature (1, 3-6).

In this report, we describe MR findings of the cerebral venous sinus thrombosis in six patients.

Materials and Methods

Eleven brain MR images of six patients with cerebral venous sinus thrombosis were reviewed retrospectively. The diagnosis was confirmed by angiography in four patients, and by both clinical and follow-up MR imaging in two patients. The patients, five females and a male, ranged in age from 18 to 49 years. Four patients had follow-up MR examinations 3 days to 6 weeks after the initial MR study. One patient had two follow-up MR studies. The predisposing factors to venous sinus thrombosis were found in three patients; two had history of administration of oral contraceptives, and one was in pregnancy. In two patients, dural AV fistula was associated.

In all patients, MR images were obtained using a 2.0 T superconducting magnet (Spectro 20000, Goldstar, Korea). Axial proton-density-weighted (2500/30/1, TR/TE/excitation number) and T2-weighted (2500/90/1) images and sagittal T1-weighted (450—500/25—30/2—4) images were obtained in all patients. In 5 patients, cor-
onal T1- or T2-weighted images were additionally obtained. Contrast-enhanced T1-weighted images were obtained after intravenous injection of gadopentetate dimeglumine (0.1 mmol/kg) (Magnevist, Schering, Germany) in 4 patients. The section thickness and gap were 5 mm and 2 mm, respectively; the matrix was 256 × 192 − 256; FOV was 20 × 25 cm.

The MR images were analyzed with attention to the location of the venous sinus thrombosis, signal intensity of parenchymal lesions and thrombosed sinus, and changes of lesions on follow-up MR studies.

RESULTS

The clinical and MR findings are summarized in Table 1 and 2, respectively. The most frequently involved sinuses were superior sagittal sinus (Fig. 1) and left transverse sinus (Fig. 1, 2) (four patients, respectively). Straight and sigmoid sinuses were also involved in one patient each. Loss of normal signal void of the sinuses was seen in all MR sequences in all patients. Signal intensity of the thrombi was isointense relative to brain parenchyma on both T1- and T2-weighted images in three patients. In the remaining three patients, the thrombi were hyperintense relative to brain parenchyma on T1-weighted images. T2-weighted images of the three patients showed that thrombi were hyperintense, isointense and hypointense, respectively. Contrast-enhanced T1-weighted images of four patients showed dense enhancement of dura adjacent to affected sinuses and the sinuses were filled with material predominantly isointense to brain, producing the delta or empty triangle signs previously described in the CT literature (7–9) in two of four patients. These MR findings were well correlated with angiographic findings.

Parenchymal lesion was present in five of six cases (83%). Localized area of high signal intensity on both T1- and T2-weighted images representing hemorrhage was seen in temporal lobes of three patients with thrombi in transverse sinus (case 1, 2, 6). There was localized area of slight low intensity on T1-weighted images and of high intensity on T2-weighted images associated with mass effect, suggesting local edema, in three patients (case 1, 4, 5). It was seen in thalamus in two and in temporal lobe in one patient. On follow-up MR studies obtained in four patients, all edematous lesions were completely resolved. All hemorrhagic lesions and venous sinus thrombi were partly resolved.

Table 1. Summary of Clinical Data

<table>
<thead>
<tr>
<th>Case</th>
<th>Age/SEX</th>
<th>Chief complaint</th>
<th>Predisposing factors</th>
<th>Location of venous sinus thrombosis</th>
<th>Angiography</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>22 / F</td>
<td>headache</td>
<td>oral contraceptives</td>
<td>SSS, TS(L)</td>
<td>performed</td>
</tr>
<tr>
<td>2</td>
<td>38 / F</td>
<td>headache</td>
<td>pregnancy</td>
<td>TS(L)</td>
<td>performed</td>
</tr>
<tr>
<td>3</td>
<td>49 / F</td>
<td>headache</td>
<td>idiopathic</td>
<td>SSS, TS(L)</td>
<td>performed</td>
</tr>
<tr>
<td>4</td>
<td>18 / F</td>
<td>hemiparesis</td>
<td>idiopathic</td>
<td>VG, STS</td>
<td>performed</td>
</tr>
<tr>
<td>5</td>
<td>43 / F</td>
<td>headache</td>
<td>oral contraceptives</td>
<td>SSS, SigS</td>
<td>NP</td>
</tr>
<tr>
<td>6</td>
<td>30 / M</td>
<td>headache</td>
<td>idiopathic</td>
<td>SSS, TS(L)</td>
<td>NP</td>
</tr>
</tbody>
</table>

SSS: superior sagittal sinus, TS (L): left transverse sinus, VG: vein of Galen, STS: straight sinus, SigS: sigmoid sinus, M: Male, F: Female, NP: not performed

Table 2. Summary of MR Findings

<table>
<thead>
<tr>
<th>Case number</th>
<th>SI of thrombosed sinus</th>
<th>Parenchymal hemorrhage</th>
<th>Parenchymal edema</th>
<th>F/U MRI (interval *)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>high</td>
<td>high</td>
<td>right thalamus</td>
<td>disappeared edema(4wk)</td>
</tr>
<tr>
<td>2</td>
<td>iso</td>
<td>iso</td>
<td>left temporal lobe</td>
<td>-</td>
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<tr>
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<td>iso</td>
<td>left temporal lobe</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
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<td>low</td>
<td>left thalamus</td>
<td>disappeared edema(4wk)</td>
</tr>
<tr>
<td>5</td>
<td>iso</td>
<td>iso</td>
<td>right temporal lobe</td>
<td>disappeared edema(4wk)</td>
</tr>
<tr>
<td>6</td>
<td>high</td>
<td>iso</td>
<td>left temporal lobe</td>
<td>-</td>
</tr>
</tbody>
</table>

SI: signal intensity, T1WI: T1-weighted image, T2WI: T2-weighted image, NP: not performed, F/U: follow-up, interval*: interval between initial and follow-up MRs
DISCUSSION

The predisposing factors of venous sinus thrombosis are numerous. They include pregnancy and postpartum periods, use of oral contraceptives, dehydration, rapid diuresis, polycythemia vera, sickle cell disease, leukemia, thrombocytopenia, disseminated intravascular coagulation, malnutrition, acquired and congenital heart diseases, head trauma, diabetes mellitus, and collagen vascular disease. However, many cases are idiopathic (1-2). In our series, known predisposing factors were oral contraceptive in two patients, and pregnancy in one patient.

The clinical manifestations are usually nonspecific and include headache, increased intracranial pressure, stroke, seizures, personality change, hallucinations, decreased mental function, and coma (1-2). In our study, the most frequent clinical symptom was headache of sudden onset (five cases).

The CT diagnosis of cerebral sinus thrombosis is not easy, even though CT findings including intense tentorial and falcial enhancement and the delta sign have been well described in the postcontrast scans (7-10).

MR imaging is known to be very sensitive in detecting sinovenous thrombosis and parenchymal alterations. In the acute phase of dural sinus thrombosis, usually up to about 7 days, T1-weighted images reveal an isointense signal within the venous sinus instead of the normal flow void. T2-weighted images demonstrate marked hypointense signal within the venous sinus that simulates that of normal flow void, representing the presence of deoxyhemoglobin. Gradient-echo flow images usually fail to demonstrate flow enhancement, that is, a high-intensity signal within the sinus region. After about 7 days, both T1- and T2-weighted images usually demonstrate hyperintense signal within the venous sinus which represents blood clot resulting from the formation of methemoglobin within the thrombus. The hemosiderin stage associated with chronic parenchymal hematomas does not occur in sinus thrombus. The hemosiderin stage associated with chronic parenchymal hematomas does not occur in sinus thrombosis as the veins do not appear to accumulate hemosiderin-laden macrophages. Though the lack of a flow void may be due to thrombosis, it may also be seen with flow related enhancement, even echo rephasing, diastolic pseudogating, or flow compen-

Fig. 1. A 22-year-old woman with history of oral contraceptives ingestion (case 1)

a, b. There is an ill-defined area of low signal intensity (SI) on T1-weighted image (T1WI) (a), and of high SI on T2WI (b) suggesting parenchymal edema in right thalamus.

c. Follow-up MR image obtained 4 weeks later shows new lesion of high SI on both T1WI and T2WI suggesting subacute hemorrhage in left temporal lobe. The edema in right thalamus had completely absorbed (not shown).

d. There is thrombus of high SI in superior sagittal sinus (arrows) on T1WI. The thrombi were confirmed with cerebral angiography.
sation techniques in normal subjects. The use of orthogonal imaging planes and differing repetition times (TRs) and avoidance of gradient moment nulling, e.g., the motion artifact suppression technique, can exclude these false-positive causes of increased signal. Special flow images generated by gradient echos can be obtained and these demonstrate high signal of flowing blood within the patent vessels. Thrombosis will not show the high signal associated with flow(3-6, 11). In our study, the signal intensity of thrombi was either isointense or slightly hyperintense on both T1- and T2-weighted images except one case, which is generally well correlated with acute or subacute onset of clinical symptoms.

In one case, the signal intensity of the thrombi in vein of Galen and straight sinus was high on T1-weighted image and low on T2-weighted image. This patient had sudden onset of severe headache, whose MR imaging was taken 3 days after ictus, probably representing acute stage of thrombosis.

As the complications of sinus thrombosis, parenchymal alterations such as venous infarct, intracerebral hemorrhage or dural arteriovenous fistula were reported(1, 12-15). In our study, parenchymal abnormalities were found in five cases, localized hemorrhage in three cases and parenchymal edema in three cases(one case overlapped). The exact mechanism of parenchymal edema and hemorrhage is unknown. But, Yuh et al(16) explained the pathophysiological change with the concept of “Transependymal effusion”. That is, the pattern of venous sinus thrombosis may be explained by the hypothetical model of the normal physiological shift of bulk interstitial fluid from the capillary bed toward the ventricle. The consequence of elevated venous pressure from venous occlusion can result in a spectrum of changes detectable by MR including a dilated venous and capillary bed, abnormal shift of bulk water, development of interstitial edema, increased CSF production, decreased CSF absorption, and rupture of venous structures(hematoma).

Fig. 2. A 38-year-old pregnant woman with 7 month pregnancy(case 2)

a. b. There is a lesion of lightly high SI (arrows) on T1WI (a) and isosignal (arrows) on T2WI (b) suggesting acute stage of hemorrhage in left temporal lobe.

c. T1-weighted sagittal image shows thrombi of iso-SI instead of normal flow void in left transverse sinus (arrows).

d. Left external carotid arteriography shows dural arteriovenous malformation probably caused by left transverse sinus thrombosis (arrows).

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Fig. 3. A 18-year-old woman with a venous thrombosis of unknown cause (case 4)

a. On T1WI, there is focal low intensity lesion in left thalamus (open arrows) and high signal lesion suggesting thrombi in vein of Galen and straight sinus (black arrows). The thrombi of the straight sinus show low intensity in venous sinus lesion suggesting acute stage of thrombosis (white arrows).

b. Venous phase of vertebral angiography shows multiple filling defects in vein of Galen and straight sinus (arrows).

It is concluded that iso- or high signal intensity with loss of signal void in venous sinus in association with a local parenchymal hemorrhage and/or edema is characteristic of cerebral venous sinus thrombosis.

REFERENCES

경막정맥동 혈전증의 자기 공명 영상

서울대학교 의과대학 진단방사선과학교실

임명관·장기현·한문희·최충곤

목적: 비염증성 원인에 의한 두개내 경막정맥동 혈전증의 자기공명(MR)영상 소견을 기술하고자 하였다.


결과: 가장 흔한 경막정맥동 혈전증의 위치는 상시상정맥동(suprior sagittal sinus, 4예)과 좌측 경막횡정맥동(transverse sinus, 4예)이었으며, 혈전의 신호강도는 5예에서 T1 및 T2강조영상에서 동등 혹은 고신호강도를 나타내었다. 국소적인 뇌실질병변은 5예에서 관찰되었는데, 뇌출혈(3예)과 부종(3예)(1예는 중복)을 보였으며, 부종은 추적 검사상 완전 소실되었다.

결론: MR영상에서 경막정맥동내의 정상적인 무신호강도 대신에, T1 및 T2강조영상 모두에서 동등도 내지 능신호강도를 보일 때 경막정맥동 혈전증을 진단할 수 있고, 원인이 명확하지 않은 뇌출혈이나 부종등의 뇌실질의 병변이 있을 때, 경막정맥동 혈전증이 감별진단에 포함되어야 한다고 생각한다.