Diagnosis of Posttraumatic Transverse Sinus Thrombosis with Magnetic Resonance Imaging/Magnetic Resonance Venography: Report of Two Cases

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Cerebral venous sinus thrombosis is an uncommon but potentially lethal condition that can present with headache, focal deficits, seizures, altered mental status, and papilledema. Nontraumatic dural sinus thrombosis is associated with medical conditions such as oral contraceptive use, pregnancy, dehydration, coagulopathies, connective tissue disorders, and leukemia. Traumatic dural sinus thrombosis has been primarily diagnosed at autopsy and was originally considered benign. The superior sagittal sinus (SSS) has been the main structure associated with traumatic sinus thrombosis. Traumatic thrombosis of other venous sinuses, such as the transverse sinus (TS), is thought to be uncommon but may be underdiagnosed using standard imaging techniques.

During the evaluation of patients who have sustained head trauma, posttraumatic sinus thrombosis, although uncommon, should be considered in the differential diagnosis because of its potentially lethal consequences. A patient with an undiagnosed sinus thrombosis can suddenly worsen if the thrombosis spreads from a sinus to a cerebral vein, leading to epilepsy, neurologic deficits, or death. Furthermore, some authors have ascribed sinus thrombosis a pathogenetic role in the formation of vascular malformations such as dural arteriovenous fistulas (AVFs). In the adult patient, dural AVFs are generally accepted as being acquired disorders because adults with dural AVF frequently have etiologic risk factors for venous sinus thrombosis, including head trauma, neurologic surgery, and ear or sinus infection. Animal models have also supported the theory that sinus thrombosis contributes to the development of dural vascular malformations. Thus, early recognition and diagnosis of venous sinus thrombosis is important for both the acute and long-term management of patients with this potentially lethal condition.

Recognition of cerebral sinus thrombosis can be aided by the use of computed tomographic (CT) scans, angiograms and, most recently, magnetic resonance imaging (MRI) and magnetic resonance venography (MRV). The cases presented here illustrate the role of MRV in the diagnosis of cerebral venous sinus thrombosis after head trauma.

CASE REPORTS

Case 1

A 48-year-old taxicab driver was brought to the emergency department after receiving a small-caliber gunshot wound to the head. He reported no dizziness, hearing loss, visual disturbances, or loss of consciousness. He complained of headache, nausea, and vomiting. His admission Glasgow Coma Scale score was 15. Neurologic examination revealed no sensory deficits or motor weakness. There was tenderness to palpation on the left posterior auricular area, where he had a small 8-mm laceration and a subgaleal hematoma. When the laceration was examined, a depressed skull fracture was palpated without a cerebrospinal fluid leak. A plain radiograph of the skull demonstrated a bullet located at the superoposterior aspect of the left mastoid air cells (Fig. 1A). A CT scan revealed fluid in the mastoid region and a comminuted depressed skull fracture with a bullet fragment just posterior to the air cells (Fig. 1B). There was a multifocal parenchymal contusion in the occipital area with sulcal effacement along the left posterior temporal, parietal, and posterior frontal lobes (Fig. 1C and D).

The bullet fragment was extricated via a 3-cm incision down to the skull without evidence of dural involvement. Twenty-four hours after admission, another CT scan showed a significant interval increase in the left posterotemporal and occipital hemorrhage, with surrounding edema (Fig. 1C and D). The lesion was further evaluated with MRI, which showed areas of T2 signal abnormalities in the left occipital lobe extending into the inferior aspect of the temporal lobe, and surrounding T2 hyperintensity consistent with hemorrhage and edema, respectively (Fig. 2A and B). An area of T2 hyperintensity was also identified within the left cerebellar
hemisphere, with a small focal area of T2 hypointensity consistent with hemorrhage and edema. There was local mass effect with partial effacement of the fourth ventricle. Intracranial MRV identified absence of flow within the left TS consistent with thrombosis (Fig. 2C and D).

The patient was treated conservatively with the anticonvulsant phenytoin and aspirin during his hospital stay. Follow-up MRI and MRV 6 weeks after discharge showed a persistent occlusion of the left TS. Both the left temporal and cerebellar contusions healed without evidence of worsening ischemia or hemorrhage (Fig. 3). At his clinic visit 9 weeks after discharge, the patient had some persistent headaches and tinnitus in his left ear but no focal neurologic deficits. No cranial or cervical bruit was heard.

**Case 2**

An 8-year-old girl was brought to the emergency department after she was struck on the head by a falling television. She reported loss of consciousness but no dizziness, hearing loss, or visual disturbances. She complained of headache, nausea, and vomiting. Her Glasgow Coma Scale score was 15. Neurologic examination revealed no sensory deficits or motor weakness. There was tenderness to palpation on the right posterior auricular area. A computed tomographic (CT) scan revealed a left frontotemporal intraparenchymal injury and a right occipital depressed skull fracture (Fig. 4A and B).
MRI/MRV Diagnosis of Transverse Sinus Thrombosis

The patient was admitted to the intensive care unit for close observation. Twenty-four hours after admission, the lesion was further evaluated with MRI, which showed areas of T2 signal abnormalities in the left frontotemporal lobe and surrounding T2 hyperintensity consistent with hemorrhage and edema, respectively. Intracranial MRV identified decreased flow within the right transverse sinus consistent with thrombosis. This decrement of signal in the right transverse sinus could also be interpreted as a nondominant sinus. However, the T1- and T2-weighted images demonstrated isointense and hypointense signals, respectively, within the right transverse sinus, which would be more consistent with thrombosis.

Fig. 4. (A and B) Axial brain and bone windows from a CT scan demonstrating left frontal subarachnoid hemorrhage and the right occipital bone fracture. (C) Inferior and (D) anteroposterior three-dimensional time-of-flight MRV with maximum intensity projection reformatted images demonstrates decreased flow within the right transverse sinus consistent with thrombosis. This decrement of signal in the right transverse sinus could also be interpreted as a nondominant sinus. However, the T1- and T2-weighted images demonstrated isointense and hypointense signals, respectively, within the right transverse sinus, which would be more consistent with thrombosis.

DISCUSSION

A MEDLINE search of the English literature was performed for the period January 1966 to December 2000. The keyword “sinus thrombosis” and multiple text words (magnetic resonance venogram, magnetic resonance imaging, trauma, transverse sinus, diagnosis, management, treatment, anticoagulation, heparin, and thrombolysis) were combined. All citations were reviewed, and articles that recorded the use of MRV in the diagnosis of sinus thrombosis were acquired for review. Reference lists of these articles were scanned for additional relevant articles. A manual search for books was also conducted. No other cases of posttraumatic transverse sinus thrombosis after a gunshot wound with MRV diagnosis were found. Review of the literature also revealed that very little is known about the diagnosis of dural sinus thrombosis after blunt head trauma.

Given the proximity of this evolving lesion to the transverse sinus, posttraumatic sinus thrombosis was considered in the differential diagnosis of both of these cases. The use of cerebral angiography, CT scanning and, most recently, MRI/MRV can aid in the diagnosis of sinus thrombosis. Angiographic findings include nonopacification of the involved venous sinuses, dilated collateral veins, increased cerebral circulation time, and reversal of flow away from the obstructed sinus. A CT scan may be normal in 10% to 20% of patients with venous sinus thrombosis, but findings suggestive of thrombosis include edema, hydrocephalus, the “dense triangle sign” on contrast-enhanced scans (indicative of thrombus in the posterior SSS), and the “empty delta sign” (which indicates enhancement of collateral veins surrounding a thrombus in the superior sagittal sinus). Recently, recognition of cerebral sinus thrombosis has been aided by the use of MRI and MRV, but no reports exist, to our knowledge, as to their use after focal impact injuries and gunshot wounds to the head.

Early diagnosis of cerebral sinus thrombosis is difficult because of nonspecific and variable clinical presentations. Recently, MRV has been used to characterize dural sinus thrombosis in patients presenting with a syndrome simulating pseudotumor cerebri and to report the characteristics of cerebral sinus thrombosis in cancer patients. In the study by Leker and Steiner, 46 patients presented with a syndrome simulating pseudotumor cerebri. The inclusion criteria were intracranial hypertension and a normal initial CT scan. All patients underwent angiography or MRI/MRV. Twelve patients had MRI/MRV or angiographic findings consistent with sinus thrombosis. Two patients with sinus thrombosis had a rapid progression of symptoms and died. This study illustrates that sinus thrombosis could be fatal and that with the aid of angiography and/or MRI/MRV, sinus thrombosis could be identified in 26% of patients presenting with symptoms and signs typical of pseudotumor cerebri. They concluded that it might be impossible to differentiate between patients with and without sinus thrombosis if MRI/MRV or angiography is not performed in this scenario. Raizer and DeAngelis reported the use of MRI/MRV in diagnosing cerebral sinus thrombosis in cancer patients. They identified 20 patients and found that MRI and MRV correlated in all but three patients and that MRV was more sensitive in four patients in the diagnosis of sinus thrombosis. MRI and MRV,
they concluded, can diagnose cerebral sinus thrombosis accurately in cancer patients. MRI/MRV appears to be a safe, noninvasive, and useful technique for diagnosis and follow-up of dural sinus thrombosis.

Sometimes it may be difficult to differentiate between a true cerebral sinus thrombosis and a sinus that is nondominant or smaller. For instance, MRV in case 2 appears to show small residual flow in the right transverse sinus, which can be interpreted as either a nondominant right transverse sinus or a thrombosed sinus. The other possible explanation is that there is drainage into the transverse sinus from cortical vessels and that this drainage is distal to the portion of the sinus that is thrombosed. The final official reading of the MRI scan by an independent neuroradiologist in this case was more consistent with partial thrombosis.

Optimal management of posttraumatic cerebral venous sinus thrombosis is unclear. Because the MRV findings were consistent with thrombosis of the transverse sinus in both cases presented here, anticoagulation therapy was considered; however, because both patients had only headache and fullness of the respective ear and their neurologic examinations were benign, they were treated conservatively with only the anticonvulsant phenytoin and with aspirin. Both patients went home after a few days of hospitalization.

D’Alise et al. reported a case of a 22-year-old woman who was involved in a minor motor vehicle crash in which she struck her head against the steering wheel without loss of consciousness. She returned 36 hours later with bifrontal headache, nausea and emesis, slurring of speech, and clouding of consciousness; CT scans and digital arteriograms showed SSS thrombosis and bilateral TS thrombosis. Urokinase was infused continuously over a 48-hour period, and a follow-up angiogram and MRV demonstrated restoration of patency to all sinuses. In conjunction with this treatment, her headache and papilledema resolved completely. Kuether et al. reported the case of a 20-year-old man who suffered a closed head injury while skiing. He developed refractory intracranial hypertension, which required induction of a barbiturate coma. Angiography demonstrated thrombosis of the right transverse and sigmoid sinuses, and part of the superior sagittal sinus. CT scans demonstrated right anterior temporal lobe contusion. After administration of intravenous heparin and a local 48-hour urokinase infusion administered despite the presence of known intracranial hemorrhage, serial arteriograms demonstrated sinus patency, after which barbiturates were withdrawn and neurologic status rapidly improved.

**CONCLUSION**

MRV can facilitate the diagnosis of sinus thrombosis in patients with traumatic head injury. This is especially important because an undiagnosed cerebral venous sinus thrombosis can spread to adjacent venous structures with potentially catastrophic consequences. Also, follow-up for these patients may be important, given the potential risk for developing a dural AVF. MRI and MRV are significantly less invasive than angiography. Therefore, MRV should be considered in all patients with traumatic brain injury in whom a cerebral venous sinus thrombosis is suspected.

**REFERENCES**