Diagnostic value of magnetic resonance imaging in perimesencephalic and nonperimesencephalic subarachnoid hemorrhage of unknown origin

Clinical article

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Object. The aim of this study was to evaluate the diagnostic value of MR imaging in perimesencephalic (PM) and nonperimesencephalic (non-PM) subarachnoid hemorrhage (SAH) of unknown origin.

Methods. The authors conducted a retrospective review of all patients with SAH (1226 patients) in their department between January 1991 and December 2008. Included in the study were cases of spontaneous SAH diagnosed using CT scans obtained within 24 hours of the initial symptoms and initially negative digital subtraction (DS) angiograms. Patients with traumatic SAH and an unknown history were excluded from the study. Patients with initially negative DS angiograms were divided into 2 groups: Group 1, a typically PM bleeding pattern (PM SAH); and Group 2, a non-PM bleeding pattern (non-PM SAH) such as hemorrhage in the sylvian or interhemispheric fissure. Cranial MR imaging including the cranio-cervical region was performed within 72 hours after SAH was diagnosed in all patients in Groups 1 and 2.

Results. One thousand sixty-eight patients underwent DS angiography, and among them were 179 (16.7%) with negative angiograms—47 patients (26.3%) from Group 1 and 132 patients (73.7%) from Group 2. Magnetic resonance imaging demonstrated no bleeding sources in any case (100% negative). Thirty-four patients in Group 1 and 120 patients in Group 2 underwent a second DS angiography study. Digital subtraction angiography revealed an aneurysm as the bleeding source in 1 case in Group 1 and in 13 cases in Group 2.

Conclusions. Magnetic resonance imaging of the brain and cranio-cervical region did not produce additional benefit for the detection of a bleeding source and the therapy administered for PM SAH and non-PM SAH (100% negative). The costs of this examination exceeded the clinical value. Despite the results of this study, MR imaging should be discussed on a case-by-case basis because rare bleeding sources are periodically diagnosed in cases of non-PM SAH. A second-look DS angiogram is necessary because aneurysmal hemorrhage occasionally produces PM SAH as well as non-PM SAH. Further prospective studies are needed to verify the authors’ results in the future. (DOI: 10.3171/2010.6.JNS10310)

Key Words  • perimesencephalic subarachnoid hemorrhage  • subarachnoid hemorrhage of unknown origin  • diagnostic magnetic resonance imaging  • digital subtraction angiography

Abbreviations used in this paper: ACoA = anterior communicating artery; DS = digital subtraction; MCA = middle cerebral artery; PM = perimesencephalic; SAH = subarachnoid hemorrhage.

hemangiomas, or venous leakage.9,17,19 The aim of this study was to investigate the efficient and suggested use of MR imaging to detect a bleeding source in spontaneous nonaneurysmal SAH.

Methods

We retrospectively reviewed data from all patients with spontaneous SAH between January 1991 and December 2008 in our department (1226 patients) through an analysis of our database. Patients with traumatic SAH and an unclear history were excluded from the study. Diagnosis was made using CT scanning and was scored using the Fisher classification. If hemorrhage was missing on CT, diagnosis was made by analysis of CSF via lumbar puncture. Four-vessel DS angiography was performed in 1068 patients. In the absence of a bleeding source, both external carotid arteries were catheterized (6-vessel DS angiography).
angiography) to rule out rare nonaneurysmal bleeding sources such as developmental venous anomalies.

The remaining 158 patients were not examined using DS angiography because of a poor clinical condition (Hunt and Hess Grade V), rapid death, or immediate neurosurgical treatment (for example, because of a space-occupying intracerebral hemorrhage). Patients with initially negative DS angiograms were divided into 2 groups. Group 1 included the patients (47 patients) with PM SAH according to the previously mentioned radiological features and a CT scan obtained within 24 hours after the occurrence of clinical symptoms. Group 2 consisted of patients (132 patients) with a bleeding pattern different from that of PM SAH (non-PM SAH), such as hemorrhage in the tentorium or interhemispheric or sylvian fissure. All patients underwent standard monitoring and received standard therapy for aneurysmal SAH in the intensive care unit. Clinical condition at the time of presentation was scored using the Hunt and Hess classification scheme. Patients with negative DS angiography studies underwent MR imaging (Phillips 3-T MR imaging with T1-weighted spin echo, T2-weighted turbo spin echo, T2-weighted steady state free precession, FLAIR, time-of-flight MR angiography, and venous bold sequences) of the brain and craniocervical region during the initial 72 hours after SAH was diagnosed.

Results

Overall, we analyzed data from 1226 patients with spontaneous SAH. The breakdown is shown in Fig. 1. One thousand sixty-eight patients underwent DS angiography, whose results were negative in 179 cases (16.7%). Forty-seven patients were categorized as having PM SAH (Group 1, 26.3%) and 132 as having non-PM SAH (Group 2, 73.7%). Magnetic resonance imaging of the brain and craniocervical region detected no bleeding sources in Group 1 or 2 (100% negative findings). Thirty-four patients in Group 1 underwent a second DS angiography study. In 1 case DS angiography demonstrated an aneurysm of the superior cerebellar artery despite previously negative MR imaging results. The remaining 13 patients in Group 1 refused a second DS angiography study given the mild clinical course of the disease.

One hundred twenty patients in Group 2 underwent a second DS angiography study, which demonstrated an aneurysm as the bleeding source in 13 cases. Specifically, there were 5 MCA aneurysms, 2 ACoA aneurysms, 2 internal carotid artery aneurysms, 2 posterior inferior cerebellar artery aneurysms, 1 anterior cerebral artery aneurysm, and 1 basilar tip aneurysm. The remaining 12 patients died before the second DS angiogram could be obtained because of an initial poor clinical condition or other diseases not directly associated with SAH, such as myocardial infarction or pulmonary embolism.

Illustrative Cases

Case 1

This 64-year-old woman presented in our department with mild headache and meningismus. A CT scan showed a typical PM SAH especially in the prepontine cisterns (Hunt and Hess Grade II, Fisher Grade 3; Fig. 2A). Digital subtraction angiography revealed a right-sided MCA aneurysm, which was an incidental finding and not the source of the PM bleeding pattern (Fig. 2B). There was no evidence of aneurysms of the vertebrobasilar circulation. Magnetic resonance images obtained the next day did not reveal any bleeding sources. During the hospital stay, the MCA aneurysm was treated with microsurgical clipping. Digital subtraction angiography studies after surgery showed complete occlusion of the MCA aneurysm. The patient recovered well without neurological deficits.

Case 2

This 58-year-old woman presented in our department with crushing headache, neck pain, and recurrent vomiting. Subarachnoid hemorrhage was diagnosed via CT scanning performed on the same day (Hunt and Hess Grade III, Fisher Grade 3). According to our study criteria the patient was included in Group 2 with non-PM SAH (Fig. 3). Initially obtained DS angiograms showed no bleeding sources (Fig. 4A). Magnetic resonance imaging performed on the following day showed no bleeding sources either. The patient was somnolent in the continuing course, and CT scanning showed an enlarged ventricular system. Consequently, external ventricular drainage was necessary. A week later, DS angiography studies were repeated and an ACoA aneurysm was detected (Fig. 4B). The aneurysm was treated with microsurgical clipping. The patient recovered well, and the transient hydrocepha-
Perimesencephalic and nonperimesencephalic SAH

Discussion

The etiology of SAH is divided into traumatic and spontaneous formations. Traumatic SAH has an incidence of 80%—by far more frequent than spontaneous SAH—and requires no active treatment in general. Basal SAH due to traumatic brain injury is reported as well and results from direct intracranial vessel laceration, often with a poor clinical outcome.6,18 Spontaneous SAH is most often associated with ruptured intracranial aneurysms (70–80%), less frequently with arteriovenous malformations (4%).1,3,4 However, according to different studies, a bleeding source is not identified on the first DS angiogram in up to 27% of cases.8,11,12,13,16 The reason could be initial local vasospasm or occlusion of the ruptured aneurysm due to blood clots.12 Authors of a number of studies have proved an initial nonfilling aneurysm on a second DS angiogram.4,12,13,17

Jung et al.11 postulate that about 60% of all cases of SAH with negative DS angiograms can be attributed to PM SAH. Given our results of 26.3% patients with PM SAH, the incidence of 60% seems very high. At this point we consider it important to note the radiological features and CT scanning within 24 hours after the occurrence of symptoms for an exact diagnosis. Computed tomography scanning a few days after initial symptoms can lead to false-positive findings due to variance in bleeding patterns and redistribution of blood in the PM space.

Perimesencephalic SAH itself is debated to be a benign subtype of aneurysmal SAH. Patients most commonly present with crushing headache and meningismus, although severe neurological deficits are not generally observed. Hunt and Hess grade at presentation is predominantly I–II; higher grades are very rare. The clinical course is usually uneventful, without dreaded complications such as rebleeding and ischemic neurological deficits following cerebral vasospasm. Long-term follow-up examinations have revealed a good prognosis for PM SAH.3,15

Considering the negative initial DS angiogram, a cranial MR image including the craniocervical region is routinely obtained to rule out bleeding sources.15,20 In reviewing the literature, we found that the detection of a bleeding source by MR imaging is reported very infrequently.

Yamamoto et al.21 described a case of SAH caused by a cavernous hemangioma in the right cerebellar hemisphere, which was not visible on DS angiography. The hemorrhage was localized in the cisterna magna and can be included in the non-PM SAH pattern. Rogg et al.15 reviewed MR images from 25 patients with PM SAH and 26 patients with non-PM SAH. Magnetic resonance imaging revealed 4 patterns with brain ischemia as possible bleeding sources in the PM SAH group, although vascular malformations were missing. In the non-PM SAH group, MR imaging demonstrated a bleeding source in 4

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**Fig. 2.** Case 1. A: A CT scan showing a PM SAH. B: Digital subtraction angiogram demonstrating double-lobed aneurysms of the right MCA (arrows).

**Fig. 3.** Case 2. A CT scan demonstrating a non-PM SAH.

**Fig. 4.** Case 2. A: Initial DS angiogram showing no aneurysm. B: Second DS angiogram showing an aneurysm of the ACoA (arrow).
cases: a small parafalcine meningioma, frontal and temporal hemorrhagic contusion, posterior inferior cerebellar artery infarction, and an aneurysm of the pericallosal artery. Andaluz and Zuccarello reviewed 45 patients with PM SAH and 47 with non-PM SAH and detected only a single case with a cranio cervical dural arteriovenous fistula on spinal MR imaging. Interestingly, this case was 1 of 47 patients with non-PM SAH. Wijdicks et al. performed MR imaging in 18 patients with PM SAH and detected only 1 capillary telangiectasia as a possible bleeding source.

In our series of 47 patients with PM SAH and 132 with non-PM SAH, MR imaging had 100% negative findings. Considering our results and the published data, it is justified to challenge the indication for the MR imaging examination in nonaneurysmal SAH and as the sequel to administered therapy.

Based on our series, it can be concluded that an MR imaging examination in patients with PM SAH didn’t produce further benefit for the detection of a bleeding source and the administered therapy. The costs of this examination clearly exceeded the clinical value. Note, however, that it is very important to diagnose PM SAH correctly, and it has clearly defined radiological features. Despite our observations, the opportunity of performing MR imaging should be discussed in selected patients, especially those with non-PM SAH, to avoid rare constellations such as cervical schwannoma with primarily neck or upper back pain.

The ideal time of examination remains investigation. It is yet to be proven whether MR imaging should be performed in the continuing course as a control examination instead of CT scanning, as episodes of rebleeding have been infrequently reported. Because aneurysmal hemorrhage occasionally produces PM SAH (especially basilar tip aneurysms) as well as non-PM SAH, a second-look DS angiogram remains necessary.

At this point we underline the retrospective nature of our work. Future prospective studies with distinct test conditions are necessary to verify our observations. Despite this restriction, we think that our study presents well-founded data on this issue. The results of our study could serve as a data source for other institutions for further investigations.

Conclusions

Perimesencephalic SAH is a well-defined disease and features a mild clinical course and good outcome. Magnetic resonance imaging of the brain and cranio cervical region added no further benefit in detecting a bleeding source or administering the therapy for PM SAH and non-PM SAH (100% negative). The costs of this imaging examination exceeded the clinical value. Despite our results, however, the option of MR imaging should be discussed on an individual basis because rare bleeding sources are periodically diagnosed in cases of non-PM SAH. A second-look DS angiogram is necessary because aneurysmal hemorrhage occasionally produces PM SAH as well as non-PM SAH. Further prospective studies are necessary to verify our results in the future.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: Maslehaty. Acquisition of data: Barth. Analysis and interpretation of data: Maslehaty, Petridis, Barth. Drafting the article: Maslehaty. Critically revising the article: Petridis, Barth. Reviewed final version of the manuscript and approved it for submission: all authors. Study supervision: Barth.

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