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Clinical Study

Diagnosing intra-cranial and cervical artery dissection using MRI as the initial modality

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ABSTRACT

Dissection of cranial and cervical arteries is a relatively frequent clinical condition. However, it is difficult to diagnose a dissection when patients present with relatively mild symptoms. Various radiological techniques are used as diagnostic tools. This study analyzed retrospectively the characteristics of cranial and cervical artery dissections using "MR first concept", with MRI as the first-choice diagnostic modality for all new patients with neurological symptoms. The patients who were admitted in Ohnishi neurological center between January 2001 and December 2014 were included. MRI was used as the initial investigation for all new patients, including those with mild symptoms such as headache or vertigo only. The patients were divided into carotid group and vertebral group. The statistical comparison was performed between these two groups. A total of 164 patient cases were analyzed. In 44 (26.8%) and 120 (73.2%) patients, dissection occurred in the carotid group and vertebral group, respectively. Concerning the type of onset, 52 patients presented with only subjective symptoms accompanied with ischemic or hemorrhagic lesions, 97 patients with ischemic symptoms and 15 patients with subarachnoid hemorrhage. There were statistically significant differences between the carotid and vertebral groups in terms of hemiparesis, aphasia, history of trauma, headache and vertigo. Patients with only a headache and those with no ischemic features had no worsening symptoms. The symptom of headache or neck pain only is more frequent than previously reported. The "MR first concept" would prove useful for early diagnosis of dissections and early treatment.

1. Introduction

Dissection of the internal carotid artery (ICA) and vertebral artery (VA) is a relatively frequent encounter in daily clinical practice. It can occur in both cranial and cervical arteries, with an annual incidence of 1.5 per 100,000 for VA dissections and 2–3 per 100,000 for ICA dissections in cervical lesions [1,2]. Dissection of the ICA is more frequently found in Western populations, whereas VA dissection predominantly occurs in East Asian populations [3,4]. It is a significant cause of cerebral infarction or subarachnoid hemorrhage (SAH). The direct change of blood vessel shape leads to headache, neck pain and Horner's syndrome, on the other hand, the vessel stenosis or occlusion leads to cerebral infarction [1,2,5–7].

Various etiological factors have been proposed for artery dissection, including trauma, infection, migraine and congenital collagen disorders such as Ehlers–Danlos syndrome and Marfan's syndrome [1,5–9]. Furthermore, some reports have also suggested that the "spontaneous" type of dissection is triggered by minor trauma that is either overlooked or considered as inconsequential by the patient [6,7].

MRI imaging, CT angiography, traditional angiography and ultrasonography (US) have been conventionally used as diagnostic modalities for dissections. US is a simple, noninvasive modality for diagnosis; however, it has some technical limitations for examination in East Asian, compared to Western, populations, due to the high anatomical location of the carotid bifurcation [6].

MRI and MR angiography are especially useful as noninvasive tools that can be performed in an outpatient setting [10]. In addition, differences in vascular imaging obtained from MR angiography and basi-parallel anatomical scanning (BPAS) are particularly useful for investigating VA dissections [11]. BPAS is the special sequence to depict the vessel surface shape of the vertebrobasilar system. This makes the vessel dissection visualized directly and easy to diagnose. This sequence does not need to use the contrast

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medium, and it takes only 25 seconds to scan. Furthermore, T1-weighted image is useful for detection of the true lumen and the pseudo lumen at the dissection site. MRI also enables the monitoring of chronological changes of the site of dissection, as it is a safe technique that can be performed repeatedly.

However, despite the availability of various radiological diagnostic tools, relatively mild symptoms remain difficult to diagnose. We established our so-called "MR first concept" whereby we performed MRI as the initial routine investigation on all new patients presenting with neurological symptoms, including those with a mild clinical presentation, in order to screen for intracranial, as well as extracranial, lesions. This strategy would allow us to detect minute infarctions or artery dissections that showed no change on CT scan. In this study, we retrospectively analyzed the characteristics of cranial and cervical artery dissections using the "MR first concept" and compared our findings with those from previous reports.

2. Materials and methods

2.1. Subjects

This study included patients who were admitted in Ohnishi neurological center between January 2001 and December 2014 and diagnosed with cranial or cervical artery dissection. Diagnostic criteria included vessel abnormalities of a dissection confirmed by MR angiography which correlated with the patient's clinical presentation. Exclusion criteria included asymptomatic patients, patients with incidental findings and small "blister-like aneurysms" of the ICA.

We termed our strategy the "MR first concept" which involved using MRI and MR angiography as the initial routine examination for all new patients, including those who presented with not only neurological defects but also the symptoms caused by disease of central nervous system like mild headache, neck pain, vertigo and numbness. The MRI was performed even at night or "out of hours" and also on weekends and to her holidays.

The patient's age, sex, dissection site, the National Institute of Health Stroke Scale (NIHSS) score on admission, the type of onset and symptoms, the time duration (days) until diagnosis, presence of co-morbidities, including hypertension, dyslipidemia and diabetes, the presence of any trauma, the treatment method and the Glasgow Outcome Scale (GOS) score on hospital discharge were recorded for all patients. The ischemic event is defined as cerebral infarction and transient ischemic attack (TIA). TIA is defined as neurological defect disappeared within 24 hours and no apparent positive lesions on radiological examination.

All patients were divided into two groups by dissection site. The carotid group included the patients with dissection located at anterior circulation including extra- and intracranial ICA, middle cerebral artery and anterior cerebral artery and the vertebral group included the patients with dissection located at posterior circulation including extra- and intracranial VA, basilar artery, posterior inferior cerebellar artery, anterior inferior cerebellar artery and posterior cerebral artery. The statistical analysis was performed between these two groups.

This study was approved by the ethics committee of Ohnishi Neurological Center.

2.2. Imaging

MRI and MR angiography was the primary diagnostic modality. SIGNA EXITE HDxt 1.5T and Optima MR 450w 1.5T (GE Healthcare Japan Inc., Tokyo, Japan) were used to obtain the MRI. Fluid attenuated inversion recovery (FLAIR) image and diffusion-weighted image (DWI) were routine sequences for MRI. MR angiography was also taken routinely. The parameters for MR angiography were as following; TE: Out of Phase, TR: Minimum, Flip Angle: 20, Bandwidth: 17.86, Freq: 288, Phase: 160, NEX: 1, Freq DIR: A/P, FOV: 20.0, Slice Thickness: 1.0, Locs per Slab: 36∼40 (3Slab), Overlap Locs: 11–13, ASSET: 2.0.

If a dissection was suspected by neurosurgeon's judge, T1-weighted image and BPAS imaging was then added. CT angiography or traditional angiography was also performed, if necessary. Radiological images were evaluated for the presence of vessel stenosis or occlusion, as shown by the string sign or gradual vessel tapering, and vessel wall abnormalities, including wall irregularity, intimal flap, double lumen, pseudoaneurysm and intramural hematoma [6,9]. All radiological images were independently reviewed by two neurosurgeons who were provided with the patient's clinical history.

2.3. Statistical analysis

For univariate analysis, the chi-squared test was used to test independence from sex, type of onset and symptoms, type of headache, past history, presence of trauma, treatment method, and the Mann–Whitney U test analyzed the age, NIHSS score on admission, time duration (days) until diagnosis and GOS score on hospital discharge. For multivariate analysis, logistic regression was used for all factors. For all analyses, we used the PASW Statistics Software (version 18.0.0, SPSS Japan Inc., Tokyo, Japan). A p value <0.05 was considered statistically significant.

3. Results

A total of 164 patients were included in this study, including 110 (67.1%) men and an average age of 56.1 years (Table 1). The carotid group included 44 (26.8%) patients, and the vertebral group included 120 (73.2%) patients (Table 2).

Concerning the type of onset, 52 (31.7%) patients had a headache or neck pain only, 97 (59.1%) patients had an ischemic event and 15 (9.1%) patients had SAH (Table 3). In the univariate analysis between the carotid and vertebral groups, the NIHSS score on admission, sudden headache, hemiparesis and aphasia as symptoms at onset and a history of trauma were significantly predominant in the carotid group, while male sex, headache or neck pain and vertigo as symptoms at onset and the presence of hypertension were predominant in the vertebral group. In the multivariate analysis, sex, type of headache, NIHSS score on admission and presence of hypertension and trauma showed statistically significant differences between the carotid and vertebral groups (Table 1).

In the acute stage, conservative therapy was given to all patients with headache or ischemic symptoms, whereas surgical intervention (parent artery proximal ligation or trapping) was conducted on all patients with SAH. No endovascular procedure was carried out in the acute phase. Conservative therapy involved the administration of antiplatelet and antihypertensive drugs to reduce the systolic blood pressure to <120 mmHg. Patients with only headache or neck pain or who had no ischemic symptoms did not have worsening of their symptoms. Two (2.1%) patients with ischemic symptoms at onset showed worsening symptoms with size progression of the cerebral infarction. In only one VA patient, the dissection was found to be enlarged like a fusiform aneurysm on MR angiography, for which we performed coil embolization in the chronic stage. The GOS score on hospital discharge showed no statistically significant difference between the carotid and vertebral groups (Table 4).