Olgu Sunumu

The Reliability of Diffusion-Weighted Magnetic Resonance Imaging in Delayed Ischemia After Aneurysmal Subarachnoid Hemorrhage: A Case Report

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Abstract

Vasospasm following aneurysmal subarachnoid hemorrhage is the cause of morbidity and mortality in approximately 30% of patients. We try to describe delayed ischemic neurological deficit (DIND) and the role of diffusion-weighted magnetic resonance imaging (MRI) study in detection of early ischemia caused by vasospasm. There are many techniques which offer some data regarding cerebral blood flow in the setting of DIND. Diffusion-weighted MRI is one of the major tools to identify early ischemia. We present a 73 year old patient who suffered from aneurysmal subarachnoid hemorrhage (SAH) who had a therapy of endovascular aneurysm repair due to anterior communicating artery (ACA) aneurysm. Seven days after endovascular therapy neurological level of the patient depressed. Diffusion-weighted MRI showed multiple focal ischemia in both middle cerebral artery (MCA) feeding areas. The patient was followed with computed tomography (CT). Seven days after MRI, CT showed infarction in the feeding area of ACA. Cerebral infarction occured in a different area from expected. In this report possible causes of the unexpected infarction was discussed. Although a few cases of reversible diffusion-weighted MRI-identified lesions have been described in the literature, the occurrence of changing lesions in the middle cerebral artery to anterior cominicating artery is exceedingly rare.

Key words: Aneurysm, diffusion-weighted magnetic resonance imaging, reversible ischemia

Introduction

Vasospasm following cerebral aneurysm rupture is one of the most damaging condition and the most common cause of delayed ischemic neurological deficit (DIND). Because vasospasm also is the most common cause of morbidity and mortality in patients who survive the initial bleeding episode, it is imperative not only to diagnose the condition but also to predict which patients are likely to become symptomatic. The exact pathophysiology of vasospasm is complex and incompletely elucidated. The frequency, causes, and clinical impact of acute infarction associated with the primary hemorrhage are poorly understood (1). Early recognition of vasospasm is essential because the timely use of several therapeutic interventions can counteract this disease and prevent the occurrence of DIND. However, the prompt implementation of these therapies depends on the ability to predict impending vasospasm or to diagnose it at its early stages. A number of techniques have been developed during the past several decades to evaluate cerebral perfusion, including positron emission tomography, xenon-enhanced computed tomography, single-photon emission computed tomography, perfusion- and diffusion-weighted magnetic resonance imaging, and perfusion computed tomography (1, 2). Diffusion MR imaging provides a novel way to characterize tissues based on sensitivity to the microscope molecular motion of water. Clinical implementation requires strong, fast hardware and careful post-processing of diffusion parameters. It is important to recognize that

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Makalenin Geliş Tarihi: 01.03.2011
Makalenin Kabul Tarihi: 01.05.2011

diffusion images and derivatives such as the trace of the diffusion tensor are quite specific in reflecting the physical properties of diffusion, but are non-specific for pathology. Restricted diffusion is the earliest clinically detectable sign of ischemia (3). Diffusion-weighted imaging (DWI) characteristics provide clinically useful information with respect to diagnosis. Diffusion imaging has a high degree of sensitivity and specificity for diagnosing acute brain ischemia. Although the area identified as hyperintense in DWI is often labeled as infarct this may not be true. This area may show evidence of energy failure and cell regulation defect, however, the cells might not have progressed to ultimate death. Hence there is a definite role to salvage even this so called "infarcted area" (4). Reversibility of DWI lesion is possible? Or DWI in acute stroke is a tool of uncertain value? These questions must be answered with further investigations.

Case Report

This 73-year-old woman was brought to the neuro-radiology service with severe headache and brief loss of consciousness. She was lethargic and had slight nuchal rigidity on neurological examination. Motor and sensory findings were normal. Initial computed tomography (CT) of the brain revealed subarachnoid hemorrhage (SAH), more prominent in the left and right Sylvian fissure and in the anterior fossa. There were no findings suggestive of an ischemic insult. She was hospitalised with a diagnosis of subarachnoid hemorrhage. A cerebral angiogram showed an ACA aneurysm (Figure 1). Also endovascular therapy was performed by coils in the same séance (Figure 2).

Fig. 1. A cerebral angiogram showed an ACA aneurysm.

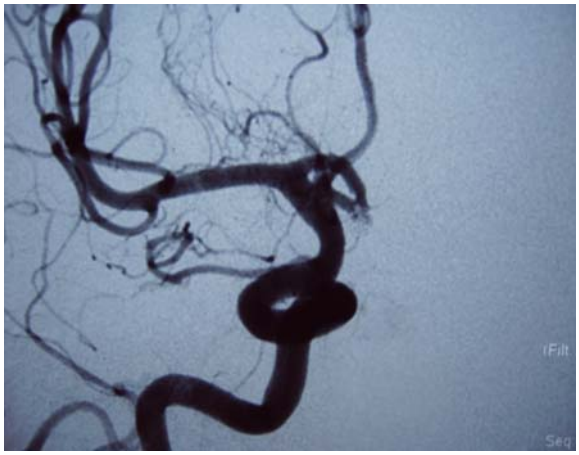

Fig. 2. Endovascular therapy was performed by coils.

After coiling there was no complication. Her neurological examination was normal. On the 4'th day of her admission, her neurological level depressed. She lost her consciousness. She was trying to open her eyes against to pain. She also had left hemiparesis. Diffusion weighted MR showed multiple focal post-SAH vasospasm-related ischemia in both MCA feeding areas (Figure 3).

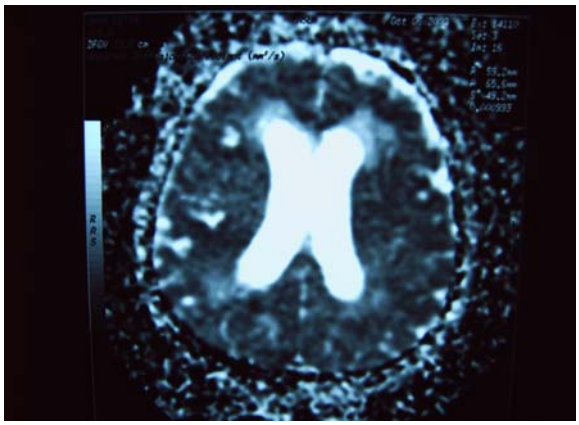

Fig. 3. Diffusion weighted MR showed multiple focal post-SAH vasospasm-related ischemia in both MCA feeding areas.

There was no ischemia in the feeding area of ACA. Medical therapy with thrombolytics was performed by neurologists. Then the patient was followed up with cranial CT. 4 days after diffusion MR, CT showed no ischemia but hydrocephalus with intraventricular hemmorrhage (Figure 4). Then the patient was consultated by our clinic and external ventricular drainage system was performed. 3 days after operation CT showed infarct in feeding area of ACA. But there wasn't any infarct in other areas of brain. According to diffusion weighted MR expected infarct area was MCA feeding areas. Then we

continue to follow patient. When cerebrospinal fluid became adequate for shunting, ventriculo-peritoneal shunt was performed (Figure 5). Neurologic level of the patient increased progressively.

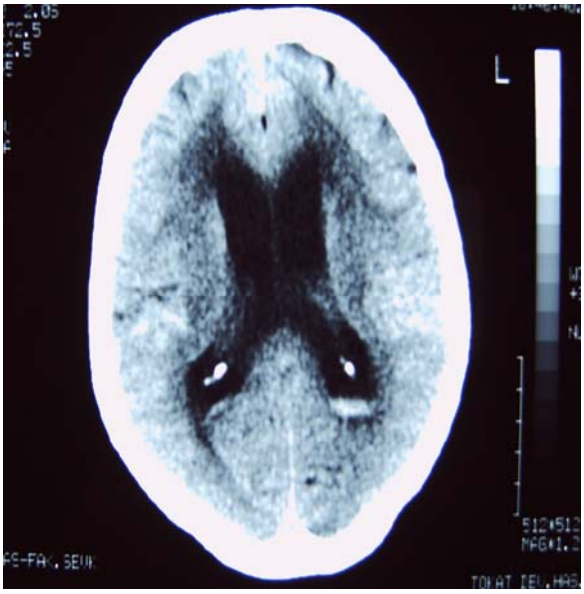

Fig. 4. CT showed no ischemia but hydrocephalus with intraventricular hemorrhage.

Fig. 5. Ventriculo-peritoneal shunt was performed.

Discussion

Symptomatic cerebral vasospasm (CVS) with delayed ischemic neurologic deficits effects about one third of the patients after aneurismal subarachnoid hemorrhage (SAH). In spite of the lack of definite evidence of large clinical trials, the devastating outcome of the natural history of symptomatic CVS demands an aggressive CVS treatment in a practically oriented. Structured multimodal treatment regimen. This policy requires close and fast multidisciplinary collaboration between neurosurgeons, neuroradiologists, competent in endovascular interventions, and specialists for neurointensive care (5). Early recognition of vasospasm is essential because the timely use of several therapeutic interventions can counteract this disease and prevent the occurrence of DIND. It also is possible that alternative causes of neurological deterioration and poor outcome after SAH, including delayed effects of acute global cerebral ischemia, thromboembolism, microcirculatory dysfunction, and cortical spreading depression, play a role. However, the prompt implementation of these therapies depends on the ability to predict impending vasospasm or to diagnose it at its early stages (6). A number of techniques have been developed to evaluate cerebral ischemia. Diffusion MR is accepted as powerfull tool to evaluate early ischemia (7, 8). Our case showed that diffusion weighted MR couldn't predict infarct in the right area. Was this case due to inability of diffusion weighted MR or due to characteristics of ischemia caused by vasospasm. Early detection become as important as treatment of vasospasm. There are many studies in the literature for early detection of vasospasm (1, 2). In studies many radiological techniques are presented to identify areas at increased risk for infarction. So this early diagnosis may help us to start treatment as soon as posibble. For infarction imaged within 6 hours of stroke onset, reported sensitivities are 38% to 45% for CT scan and 18% to 46% for MR imaging. Diffusion weighted imaging has shown to be highly sensitive (88-100%) and specific (86%-100%) in the detection of hyperacute and acute infarction (9, 10, 11). A large series of 691 patients presenting to the emergency department has shown that DWI is superior to MR imaging, first and second CT in the examination of patients with acute stroke within 24 hours of presentation. The superiority is most clearly demonstrated when the imaging is performed in less than or equal to 6 hours following presentation (12). Early detection of cerebral vasospasm allows prompt intervention and treatment, with the goal of preventing further ischemia or infarction. Wani et al. (13) showed efficacy of diffusion weighted MR (DWI) in detecting ischemic injury following anterior communicating artery aneurysmal SAH. Clinical and radiological outcome at follow-up is

related to the DWI. Majoie et al. (14) made a study. Their study showed that; perfusion computed tomography (PCT) can be a useful technique in monitoring angioplasty treatment effects in patients with vasospasm after SAH. Carlson et al. (15) showed perfusion techniques offer clinical data which may be applied to the care of an individual patient so that treatment may be tailored to that patient's physiological needs. This allows the clinician to pursue a rational strategy for diagnosis and treatment of a patient with a delayed neurological deficit following aneurysmal SAH. Frontera et al. (16) pointed that delayed cerebral ischemia (DCI) is a more clinically meaningful definition than either symptomatic deterioration alone or the presence of arterial spasm by angiography or trans cranial doppler (TCD). Carlson et al. (15) recomended truly quantitative techniques such as positron emission tomography and xenon CT to identify areas at increased risk for infarction. Xenon CT is a practical technique which may be performed at the bedside and may be used to assess cerebral blood flow response to a changing variable. Jadhav et al. (17) made an experimental study. Their study showed multimodal MRI reveals acute changes in the brain after SAH and can be used to non-invasively study early brain injury. Weidauer et al. (18) pointed that the infarct pattern after aneurysmal SAH includes cortical band-like lesions. In contrast to territorial infarcts or lacunar infarcts in the white matter which develop as a result of moderate or severe proximal and/or distal vasospasm visible on angiography, the cortical band-like lesions adjacent to sulcal clots may also develop without evidence of macroscopic vasospasm, implying a vasospastic reaction of the most distal superficial and intraparenchymal vessels.

According to many authors; difusion-weighted MR is one of the most reliable technique to identify areas at increased risk for infarction. So how come our case didn't support the reability of MR. Maybe this case is due to charactrestic of ischemia because of vasospasm. Then we have to talk about reversibility of ischemia. Although the area identified as hyperintense in DWI is often labeled as infarct this may not be true. This area may show evidence of energy failure and cell regulation defect, however, the cells might not have progressed to ultimate death. Hence there is a definite role to salvage even this so called"infarcted area". In humans reversibility of DWI lesion is rare. In a review of DWI reversible lesions, Karonen et al. (19) could identify only 21 of thousands of DWI hyperintense lesions that demonstrated reversibility. In animal models a threshold time of around 2 hours has been established for reversibility and a resolution or decrease of the size of the diffusion lesion has been shown if the occlusion in the artery is released within this time. In the setting of intravenous and intra-arterial thrombolysis a decrease in lesion size from the initial DWI abnormality to the final infarct size or a partial reversibility of the initial DWI is common. Tabuchi et al. (20) presented a case with reversible cortical auditory dysfunction caused by cerebral vasospasm after ruptured aneurysmal subarachnoid hemorrhage and evaluated by perfusion magnetic resonance imaging. The case report represented a 52-year-old woman developed subarachnoid hemorrhage (SAH) caused by a ruptured right internal carotid artery (ICA). In their study diffusion-weighted and T2-weighted MR images showed an acute infarction in the right insular cortex caused by vasospasm. Hearing disturbance occured. After the vasospasm was treated with induction of mild hypertension and hypervolemia showed recovery of vasospasm and resolution of perfusion abnormality and hearing disturbance. Powers et al. (21) made a study. In their study; regional cerebral blood flow (rCBF) and regional cerebral metabolic rate of oxygen (rCMRO2) were measured by positron emission tomography (PET) in four patients with subarachnoid hemorrhage and hemiparesis due to cerebral vasospasm. In their study; with resolution of the vasospasm, two patients recovered and two remained hemiparetic. In our case; vasospasm of our patient was treated with adequate therapy. After treatment expected ischemia recovered but unexpected ischemia in different area occured. Severity of vasospasm may cause this condition. Ezaki et al. (22) reported a case with DWI findings after a cerebral ischemic attack. showed the left middle cerebral artery to be occluded at the superior M2 branch. However, on the next day the lesion on DWI, except for the gray matter, was observed to have almost completely resolved, and MR showed complete recanalization of the left superior M2 branch with diminished clinical symptoms. They emphasize that; although a few cases of reversible DWI-identified lesions have been described in the literature, the occurrence of large, reversed DWI lesions in the middle cerebral artery territory with severe apparent diffusion coefficient decreases are rare. In our case beside reperfusion, occlusion occured again but in the different area. This kind of reversibility as in our case is exceedingly rare. To predict vasospsm early in aneuvrismal SAH is the most important condition for early treatment.

So we have to use some techniques to determine vasospasm. Diffusion weighted MR is one of the technique to determine ischemia which caused by vasospasm. Iscemia caused by vasospasm may recover with therapy. Early and adequate therapy may increase recovery posibility. And severity of vasospasm is one of the negative factor for recovery. Diffusion weighted MR detects early ischemia but this should come to mind ischemia may be reversible, changing and repetitive as in our very rare case.

Anevrizmal subaraknoid kanama sonrası oluşan geç iskemide difüzyon-ağırlıklı manyetik rezonans görüntülemenin güvenirliği: Olgu sunumu

Özet

Anevrizmal subaraknoid kanamayı (SAK) takiben oluşan vazospazm, hastaların yaklaşık %30' unda oluşan mortalite ve morbiditeden sorumlu bir durum olarak tanımlanmıştır. Biz bu çalışmamızda geç iskemik nörolojik defisiti ve difüzyon MR'ın vazospazm sonrası oluşan iskeminin erken saptanmasındaki rolünü tanımlamaya çalıştık. Geç iskemik nörolojik defisitin oluşumunda serebral kan akımı hakkında bilgi veren birçok teknik vardır. Difüzyon MR enfarkt için artmış risk alanlarını belirlemede güçlü bir teknik olrak bilinmektedir. Biz 73 yaşında anevrizmal subaraknoid kanama nedeniyle yakınması gelişen ve anterior kominikan arter (ACA) anevrizması tespit edilerek endovasküler tedavi uygulanan bir hastayı sunduk. Endovasküler tedaviden 7 gün sonra hastanın nörolojik düzeyi geriledi. Difüzyon ağırlıklı MR her iki orta serebral arterlerin (MCA) beslediği alanlarda multi-fokal iskemi tespit etti. Hasta BBT ile takip edilmeye başlandı. BBT'de ACA sulama alanında enfarkt tespit edilirken MCA alanlarında enfarkt tespit edilmedi. Enfarkt beklenen alandan farklı bir bölgede oluştu. Biz bu çalışmada beklenmeyen enfarktın muhtemel nedelerini tartıştık. Literatürde difüzyon MR'da tespit edilmiş düzelen lezyonlar tanımlanmış olmasına rağmen, MCA'dan ACA'ya değişen lezyon oluşumu ileri derecede nadir bir durumdur.

Anahtar kelimeler: Anevrizma, difüzyon ağırlıklı manyetik rezonans görüntüleme, geri dönüşümlü iskemi

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