Local Thrombolysis for Acute Ischemic Stroke Based on Findings of Diffusion and Perfusion MRI

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Summary

Cerebral perfusion and cerebral tissue integrity were studied in 13 patients with acute embolic stroke in the territory of the internal carotid artery by diffusion-weighted imaging (DWI) and perfusion-weighted imaging (PWI) within six hours after onset. PWI/DWI mismatch lesion was depicted in six patients. MCA was occluded in five of six patients, who underwent local thrombolytic therapy. In three cases, complete restoration of the cerebral circulation was obtained and enlargement of irreversible brain damage compared to initial DWI lesion was prevented. Seven patients without PWI/DWI mismatch did not undergo thrombolytic therapy. Spontaneous reopening of occluded MCA was verified with subsequent cerebral angiography in one of seven patients. CT depicted symptomatic intracerebral hemorrhage in this patient. It is concluded that DWI and PWI in combination are useful in selection of patients for thrombolytic therapy.

Introduction

It is important to evaluate the brain tissue viability, cerebral blood flow and occluded arter-

ies in a short time for the decision of strategies in acute occlusive cerebrovascular disease. Advanced MR techniques; i.e., DWI, PWI, and MR angiography have been used increasingly in recent years to evaluate the ischemic injury in acute stroke patients. We perform not only MR angiography but also DWI and PWI in emergency basis to select patients for local thrombolytic therapy. The aim of the present study was to evaluate a significance of DWI and PWI in the decision of therapeutic strategy for acute ischemic stroke.

Methods

Thirteen patients with clinically diagnosed acute embolic stroke in the territory of internal carotid artery were studied with DWI and PWI as well as conventional MRI and MRA within 6 hours after onset. We performed all of the MRI procedures within 40 minutes. A relative mean transit time map is used as PWI in this study.

Local thrombolytic therapy, urokinase injection into distal site of embolic occlusion, was performed for a PWI/DWI mismatch lesion de-

Figure 1 DWI and PWI on admission and CT or FLAIR on follow up, upper row; Case 3, middle row; Case 8, lower row; case 13.

veloped by MCA occlusion. Mechanical clot disruption was additionally performed in some cases. During the procedure, we tried to restore the cerebral circulation in the eloquent area, initially. Application of urokinase is harmful for bright signal lesions in DWI. We, therefore, carefully injected urokinase into the target ar-

teries. Patients without DWI/PWI mismatch lesion was conservatively treated. Local thrombolysis was not performed in patients with ICA occlusion, either. We compared initial MRI lesion with final infarct size determined by CT or MRI (FLAIR) examined within seven days after onset.

Table 1 iPWI=initial PWI; FIS=final infarct size by CT or MRI (FLAIR) within 7 days after onset; iDWI=initial DWI

No	Age / Sex	Site	Duration	mismatch	Recanal	follow up
1	56 / M	MCA	5:10	-	-	iPWI=FIS=iDWI
2	66 / M	ICA	3:15	-	-	iPWI=FIS=iDWI
3	63 / M	MCA	2:20	-	+	iPWI=FIS=iDWI
4	79 / F	MCA	3:15	-	-	iPWI=FIS=iDWI
5	87 / F	MCA	6:00	-	-	iPWI=FIS=iDWI
6	63 / M	MCA	2:30	-	-	iPWI=FIS=iDWI
7	88 / F	MCA	1:50	-	-	iPWI=FIS=iDWI
8	65 / M	MCA	1:50	+	+	iPWI>iDWI>FIS
9	79 / M	MCA	3:30	+	+	iPWI>FIS≥iDWI
10	54 / F	MCA	3:00	+	+	iPWI>FIS≥iDWI
11	47 / F	MCA	1:50	+	partial	iPWI≥FIS>iDWI
12	67 / M	MCA	1:30	+	partial	iPWI≥FIS>iDWI
13	68 / F	ICA	5:00	+	-	iPWI=FIS>iDWI

Results

MRA indicated ICA occlusion in two and MCA occlusion in eleven (table). The DWI/PWI mismatch lesion was revealed in six cases. Among these six cases, MCA was occluded in five cases and ICA was occluded in one. The DWI/PWI mismatch was not detected in seven cases. The occluded arteries of these seven cases were MCA in six and ICA in one. The interval from the onset of stroke to MRI examination was 167 ± 80 min. in patients with mismatch lesion and 216 ± 161 min. in patients without mismatch lesion. These intervals were not statistically different between two groups.

Local thrombolytic therapy was performed in five patients with MCA occlusion having the DWI/PWI mismatch. Complete recanalization was obtained in three. Final infarct size was rather small compared to the initial DWI lesion in one (Case 8, figure middle row), slightly larger than the initial DWI in two. In two patients, partial recanalization was obtained. The final infarct size of these patients was larger than their initial DWI lesion. No hemorrhagic transformation appeared after thrombolysis in these five patients. Local thrombolytic therapy was not performed in one patient with ICA occlu-

sion. In this case, final infarct size was almost same as PWI lesion (Case 13, figure lower row). Patients with non-mismatch lesion did not undergo local thrombolytic therapy. The initial lesion determined by DWI and PWI resulted in the irreversible infarcted lesion. Spontaneous recanalization appeared after MR examination in one patient with non-mismatch lesion. In this patient, the initial MRA depicted occlusion of the right MCA at distal M1 position and subsequent cerebral angiography (one hour after MRA) showed complete reopening of this artery. He became comatose and intracerebral hemorrhage within massive brain edema appeared on the next day (Case 3, figure upper row).

Discussion

In super acute stroke, reopening of the occluded artery by intravenous¹ or intra-arterial² thrombolytic agents has proved to be beneficial so far. Overall patient benefit, however, remains less than optimal³. DWI has been shown to be sensitive to early ischemic injury in the brain⁴, while alteration in blood flow can be appreciated with PWI⁵. A bright signal area de-

picted by DWI reflects cytotoxic edema, which has already fallen into irreversible damage. Combined DWI/PWI permits new pathophysiological insight in the setting of acute stroke because it allows regional assessment of both reversibly (ischemic penumbra) and irreversibly damaged brain tissue⁶. The larger lesion in PWI compared to that in DWI (DWI/PWI mismatch) predicts further enlargement of irreversible damage in acute stroke^{7,8}. Conversely, the mismatch area can be rescued by immediate appropriate therapies. Therefore, we performed local thrombolytic therapy for patients with DWI/PWI mismatch lesion. As the result, it effectively prevented the further enlargement of irreversible brain damage.

Our study also indicates that the interval from the onset of stroke to start of treatment is not a simple determining factor for the efficacy of the thrombolytic therapy. The appearance of DWI/PWI mismatch is not significantly correlated to the interval from the onset of stroke to MRI examination in our patients. In three of seven patients with non-mismatch lesion, MRI

examination was performed within three hours from the onset. Symptomatic intracerebral hemorrhage is another important unfavorable issue in thrombolytic therapy. It did not appear in our treated patients with DWI/PWI mismatch lesion. However, in one of seven untreated patients without DWI/PWI mismatch lesion, symptomatic hemorrhagic infarction developed within massive brain edema. In this patient, spontaneous reopening of MCA circulation was depicted in follow-up cerebral angiography. This result suggests that restoration of cerebral circulation into the non-mismatch lesion might be more likely to induce symptomatic intracerebral hemorrhage.

Conclusion

1. DWI/PWI in combination is useful for decision of therapeutic strategy in acute ischemic stroke.

2. Local thrombolysis can effectively prevent the enlargement of irreversible brain damage in patients with DWI/PWI mismatch lesion.

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