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CLINICAL ANALYSIS

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Rescue Therapy for Acute Thromboembolic Occlusion During Endovascular Treatment of Cerebral Aneurysms

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Background and Purpose : One of the most common complications that occurrs during the treatment of cerebral aneurysm is acute thromboembolic occlusion. With the advent of endovascular devices and techniques, various recanalization methods have been introduced. We report our experience with rescue therapies for acute thromboembolic occlusions during endovascular treatment of cerebral aneurysms.

Materials and Methods : From March 2009 to February 2011, acute thromboembolic events occurred in 7 patients during endovascular coil embolization of cerebral aneurysms. We performed rescue treatment for these 7 patients using endovascular methods. Our protocol for recanalization includes intra-arterial chemical and/or mechanical thrombolysis. Urokinase, glycoprotein IIb-IIIa inhibitor (Tirofiban) and self-expandable stents were used for recanalization. We assessed the recanalization results with a TICI grading system immediately after the rescue therapy, and clinical outcomes were reviewed.

Results : Two men and 5 women (age range 49−69, mean age 56 years) were treated with rescue therapy. All 7 patients presented with subarachnoid hemorrhage; intra-arterial chemical thrombolysis was successful in 3, and their TICI grades were 2a (n=3). In the other 4 patients, successful recanalization was achieved with a self-expandable stent, and 3 of them had favorable outcomes as TICI grades were 2b (n=1) or 3 (n=2). Emergency bypass surgery was performed in one patient after a failed endovascular recanalization procedure.

Conclusions : With these rescue treatments, we can minimize permanent neurological deficits from thromboembolic complications after endovascular procedures. Stent-assisted revascularization with concomitant administration of IIb-IIIa inhibitors contributed to the achievement of increased recanalization rates.

KEY WORDS : Thromboembolic occlusion; Rescue treatment; Recanalization; Cerebral aneurysm.

INTRODUCTION

With the advent of endovascular devices and operative techniques, procedure-related complications have decreased in recent years. However, one of the most common complications during endovascular procedures is thromboembolic arterial occlusion. Ries et al. have reported a 9.3%rate of thromboembolic events during aneurysmal coil embolizations (48 cases among 515 cerebral aneurysms).[10] Aggour et al. have reported a 10% rate of thromboembolic events related to the procedures (39 patients among 390 aneurysmal coiling procedures).[2] These thromboembolic complications are closely related to permanent neurological deficits; therefore, early intervention and recanalization proceduresare required as soon as possible.

Conventional management of these complications includes intravenous or intra-arterial pharmacological therapy, including tissue plasminogen activator (t-PA), urokinase or glycoprotein IIb-IIIa inhibitor (Tirofiban). However, in cases of ruptured cerebral aneurysms, these chemical therapies have some limitations due to risk of rebleeding or other hemorrhagic complications. Recently, the effectiveness of self-expandable stents (SESs) has been reported in the recanalization of acute ischemic stroke. Brekenfeld et al. have managed 12 patients with intracranial SESs for acute ischemic stroke, resulting in partial or complete recanalization (thrombolysis in myocardial infarction [TIMI] 2/3) in 92% of the patients.[4] Roth et al. have reported successful revascularization with the use of SESs in 20 of 22 (90.9%) patients (thrombolysis in cerebral infarction [TICI] 2a/b and 3).[11]

We experienced a few cases of acute thromboembolism

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after endovascular treatment of ruptured cerebral aneurysms and tried various rescue therapies, including SESs. We present our experience in this article.

METHODS

We retrospectively reviewed patients with ruptured cerebral aneurysms treated with endovascular means from March 2009 until February 2011 in our department. Among these patients, 7 developed acute thromboembolic events during an endovascular procedure. Two were men and the other 5 were women, and their mean age was 56 years. Among these 7 patients, 5 had middle cerebral artery (MCA) occlusion, 1 had internal cerebral artery (ICA) occlusion and 1 had posterior cerebral artery (PCA) occlusion. We managed these acute arterial occlusions withchemical thrombolysis and/or SESs.The chemical thrombolytic agents we used wereurokinase and the GPIIb/IIIa receptor inhibitor, Tirofiban. In mechanical recanalization, we used Enterprise (Codman Neurovascular, Miami Lakes, FL) and Solitaire stents (ev3 Incorporation, Plymouth, MN) as SESs. Recanalization results were assessed by follow-up angiography immediately after the procedure. We used a TICI grading system for scoring, and neurologic status was evaluated before and after rescue therapy.

RESULTS

Seven patients with ruptured cerebral aneurysmstreated by endovascular methods had acute thromboembolic complications. The characteristics and clinical results of patients treated by rescue therapy were summarized in Table 1. In all 7 cases, chemical thrombolysis was performed as a first line rescue therapy using urokinase and/or glycoprotein IIb/IIIa inhibitors. With concerns about the risk of re-bleeding during the endovascular procedure, substantial doses of chemical agents were not feasible. Among the 7 patients, intra-arterial thrombolysis (IAT) was successful only in 3, and their TICI grades were 2a (n=3). In the other 4 patients, intracranial SESs were used in addition to thechemical agents. Indication for SES insertion was failed IAT during the rescue procedure. Three of these patients (75%) had near complete or complete recanalization, with TICI grades of 2b (n=1) or 3 (n=2). There were no device-related complications. No vessel perforations or dissections were visible, and embolization into another vessel territory was not detected in any cases.

Five of 7 patients had immediate motor recovery in a day or two after rescue therapy and had no neurologic deficits at discharge. One patient had grade 3 motor weakness immediatelyafter surgerybut showed motor grade 4 in neurologic follow-up at discharge, after rehabilitation and physiotherapy. Two of 7 patients had motor and/or sensory aphasia, but their symptoms improved at 3 months follow-up, and they did not show any neurological deficits.

We observedone case of acute in-stent thrombosis after recanalization with SES. A patient with a ruptured M1 aneurysm had stent-assisted coil embolization, and acute ICA occlusion was noted in the final angiography. Enterprise stent insertion was performed after failed IAT, and recanalization of the ICA was achieved, but re-occlusion of the vessel was found. The patient had to undergoemergency STA-MCA bypass operation.

ILLUSTRATIVE CASES

Case 1

This 57-year-old female patient presented with severe headache. Initial brain CT and MR imaging showed SAH (Fisher grade 3, Hunt and Hess score 3). CT angiography showed a ruptured saccular aneurysm in the basilar tip, also indicatedby DSA and 3D DSA. Endovascular coil occlusion of the aneurysm was attempted without heparinization. Withstent-assisted aneurismal coiling, the aneurismal sac was successfully occluded with coils, but in-stent thrombosis was noted in the left PCA territory (Fig. 1A). Despite the use of 1.5 mg of Tirofiban, the PCA occlusion did not improve. Because additional use of thrombolytic

Table 1. Summary of 7 patients treated with res

Case No.	Sex/ age	Diagnosis	Initial treatment	Occlusion	Rescue	IAT	MT	Results (TICI)
1	F/55	SAH, pcom	Coil embolization	MCA occlusion	Chemical	UK 250,000	No	2a
2	M/49	SAH, acom	Coil embolization	MCA occlusion	Chemical	UK 200,000	No	2a
3	F/52	SAH, acom	Coil embolization	MCA occlusion	Chemical	Tirofiban 0.5 mg	No	2a
4	M/53	SAH, M1	Coil embolization	ICA occlusion	SES*, STA-MCA bypass	UK 100,000, Tirofiban 3.6 mg	Enterprise stent	2b→0
5	F/57	SAH, BA	Coil embolization	PCA occlusion	SES*	Tirofiban 1.0 mg	Enteprise stent	3
6	F/63	SAH, pcom	Coil embolization	MCA occlusion	SES*	Tirofiban 0.7 mg	Enterprise stent	3
7	F/69	SAH, acom	Coil embolization	MCA occlusion	SES*	UK 200,000	Solitaire stent	2b

IAT: Intra-arterial thrombolysis, MT: Mechanical thromboembolectomy, SAH: Subarachnoid hemorrhage, Pcom: Posterior communicating artery, MCA: Middle cerebral artery, ICA: Internal carotid artery, STA: Superficial temporal artery, UK: Urokinase, BA: Basilar apex, Acom: Anterior communicating artery, Chem: Chemical thromobolysis, SES: Self-expanding stent, TICI: Thrombolysis in cerebral ischemia

agents was dangerous due to the ruptured aneurysm, we useda self-expendable stent for recanalization of the PCA occlusion. We advanced the microcatheter to the left PCA, and the Enterprise stent was deployed. After stenting, PCA flow was recovered, and full recovery of PCA flow was observed in 20 minutes delayed angiography as well asin DSA the followingday (Fig. 1B). The patient was discharged without any clinical deficits.

Case 2

This 69-year-old female patient presented with aSAH proven by CT (Fisher grade 3, Hunt and Hess score.[2] Conventional angiography with 3D reconstruction showed a ruptured aneurysm at the anterior communication artery (Acom). The patient was old and had an extremely tortuous aortic angle. At the beginning of emergency coil embolization, we usedan Simons-2 guide catheter and advanced a 6 French envoy guiding catheter using exchange guide-wire. At the first angiography, acute MCA occlusion occurred probably because of an atheroma of the common carotid artery (Fig. 2A). Coil embolization of the ruptured Acom aneurysm was performed first, and rescue therapy for MCA occlusion was followed. Chemical recanalization was attempted with urokinase 200,000 units but failed because a significant dose could not be used due to risk of hemorrhage. We deployed a self-expandable Solitaire stent and performed mechanical thrombectomy, pulling back the device in the unfolded state using an aspiration technique. We identified the thrombus within the stent after withdrawal. In the final angiography, MCA flow achieved a TICI grade 2b (Fig. 2B). The patient had grade 4 motor weakness of the contralateral extremities immediately after the procedure but showed recovery to near-normal motor grade at discharge.

DISCUSSION

In several stroke studies, it has been documented that successful recanalization and good outcome after acute ischemic strokesarestrongly associated.[3,4,9] If thromboembolic complicationsoccurin hemorrhagic patients, chemical thrombolysis can yield fatal outcomescompared to cases

Figure 1. Digital subtraction angiogram shows acute PCA occlusion (A). The control angiogram after rescue therapy with Tirofiban and Enterprise stent shows recanalized vessel (B).

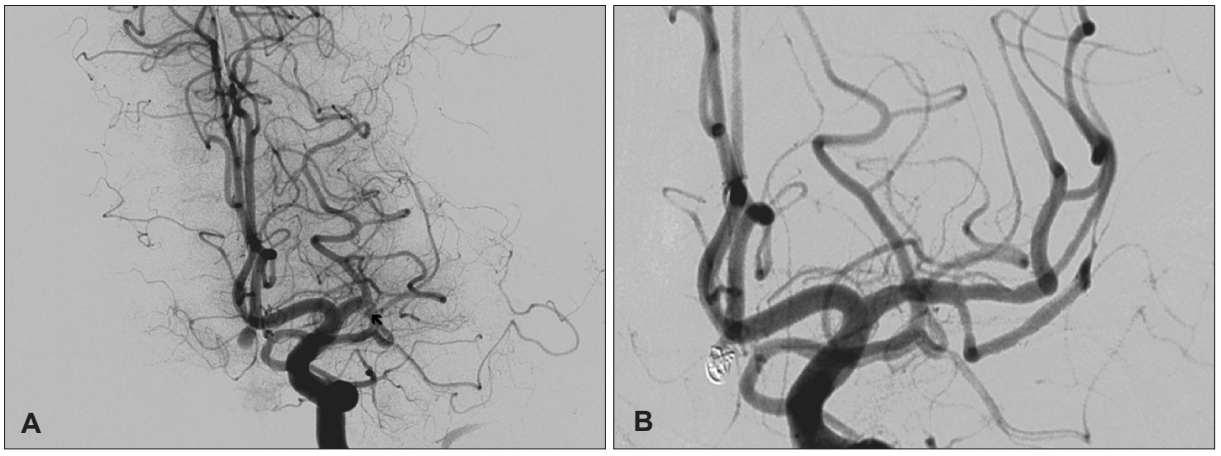

Figure 2. Acute M1 occlusion (A). After mechanical thrombectomy with Solitaire stent and chemical thrombolysis, the vessel is revascularized to a TICI 2b state (B).

of non-hemorrhagic patients. Because every patient in this study had a ruptured aneurysm and SAH, recanalization of occluded cerebral arteries was more challenging than in the setting of acute ischemic stroke.

We used intra-arterial chemical thrombolysis,which means intra-arterial bolus infusion of drugs proximal to the occluded vessel directly,as a first line rescue therapy. However, we could not use high doses of chemical agents because all of our patients had SAH. The use of pharmacologic thrombolysis alone has many concerns: increased risk of bleeding, doubts about the effectiveness of dissolving clots, lengthy times to recanalization, and inability to prevent abrupt re-occlusion at the initial site of obstruction.[6,8] Despite increasing utilization of prourokinase or other antithrombotic agents (e.g., alteplase and reteplase), recanalization rates remain approximately 60% in acute ischemic stroke.[6,8] Not surprisingly, a combination of mechanical and pharmacologic approaches would yield greater benefit in such situations.[8]

The use of other mechanical means has been reported to be effective in recanalization of acute occlusions.[8] Mechanical thrombectomy techniques are reported in cases of failed recanalization after thrombolysis or in patients with contraindications to thrombolytic agents.[1,11] In recent studies, intracranial stent placement has been performed for recanalization of cerebral arterial occlusion in acute stroke patients.[5,7,11] Researchershave reported favorable outcomes with the use of SESs, with recanalization rates of 79% to 100%.[4,11,13] SESs apply a lower radial force than does the inflation of balloon-mounted stents, reducing the risk of vessel rupture in cases of hard thrombus or atherosclerotic stenosis.[4] In the latest studies, mechanical thrombectomy with an unfolded, fully retrievable SES yielded very promising angiographic and clinical results.[11] In one patient, we deployed and withdrew an unfolded Solitaire stent with constant aspiration, performed mechanical thrombectomy, and achieved a TICI grade 2b immediately after the rescue procedure. In recent papers regardingacute ischemic stroke, application of SESs has been reported to produce immediate recanalization and has a very high success rate.[2,4,8,12]

We immediately used aspirin after stent placement, followed by a combination therapy of aspirin and clopidogrel for the next 4 weeks, despite the presence of SAH. Because the ruptured aneurysm was packed with detachable coils, we used double medications to avert stent occlusion and further thrombo-embolism.

There was no spontaneous intracerebralhemorrahge or SAH related to the procedure in our study. None of the patients died or had severe neurologic deficits. There are some limitations in our study. It was a retrospective, single center-study that hada very small number of patients. Also,various different modalities have been used in rescue therapy, so the interpretation of results should be analyzed with caution.

CONCLUSIONS

With use of various endovascularrescue techniques, we can minimize the occurrence of permanent neurological deficits from thromboembolic complications during endovascular procedures. Stent-assisted revascularization with concomitant administration of IIb-IIIainhibitors contributed to the achievement of increased recanalization rates.

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