

Rescue therapy for acute  
thromboembolic occlusion during  
endovascular treatment of cerebral  
aneurysms

So-Yeon Kim

Department of Medicine

The Graduate School, Yonsei University

Rescue therapy for acute  
thromboembolic occlusion during  
endovascular treatment of cerebral  
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Directed by Professor Jin-Yang Joo

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So-Yeon Kim

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This certifies that the Master's Thesis  
of So-Yeon Kim is approved.

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Thesis Supervisor: Jin-Yang Joo

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Jin-Yang Joo: Thesis Committee Member#1

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Jin-Young Jung: Thesis Committee Member#2

-----  
Kyung-Yul Lee: Thesis Committee Member#3

The Graduate School  
Yonsei University

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## <TABLE OF CONTENTS>

ABSTRACT .....	1
I. INTRODUCTION .....	3
II. MATERIALS AND METHODS .....	4
III. RESULTS .....	4
IV. ILLUSTRATIVE CASES .....	6
1. case 1 .....	6
2. case 2 .....	7
V. DISCUSSION .....	8
VI. CONCLUSION .....	10
REFERENCES .....	11
ABSTRACT(IN KOREAN) .....	13

## LIST OF FIGURES

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). .....	7
Figure 2. Acute M1 occlusion (A). After mechanical thrombectomy with Solitaire stent and chemical thrombolysis, the vessel is revascularized to a TIC1 2b state (B). .....	8

## LIST OF TABLES

Table 1. Summary of 7 patients treated with rescue therapy ·	5
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## ABSTRACT

Rescue therapy for acute thromboembolic occlusion during endovascular treatment of cerebral aneurysms

So-Yeon Kim

*Department of Medicine  
The Graduate School, Yonsei University*

(Directed by Professor Jin-Yang Joo)

### ***Background and Purpose:***

One of the most common complications that occurs 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 among 153 cases of endovascular coil embolization. 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 TIC1 (Thrombolysis in cerebral infarction) 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 TIC1 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.

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**Keywords:** thromboembolic occlusion, rescue treatment, recanalization, cerebral aneurysm



# Rescue therapy for acute thromboembolic occlusion during endovascular treatment of cerebral aneurysms

So-Yeon Kim

*Department of Medicine  
The Graduate School, Yonsei University*

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## I. 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)<sup>1</sup>. Aggour et al. have reported a 10% rate of thromboembolic events related to the procedures (39 patients among 390 aneurysmal coiling procedures)<sup>2</sup>. These thromboembolic complications are closely related to permanent neurological deficits; therefore, early intervention and recanalization procedures are 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. 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 (SESts) has been reported in the recanalization of acute ischemic stroke. Brekenfeld et al. have managed 12 patients with intracranial SESts for acute ischemic stroke, resulting in partial or complete recanalization (thrombolysis in myocardial infarction [TIMI] 2/3) in 92% of the patients<sup>3</sup>. 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)<sup>4</sup>.

We experienced a few cases of acute thromboembolism after endovascular treatment of ruptured cerebral aneurysms and tried various rescue therapies, including SESs. We present our experience in this article.

## II. MATERIALS AND METHODS

We retrospectively reviewed patients with ruptured cerebral aneurysms treated with endovascular means from March 2009 until February 2011 in our department. Among 153 patients who treated with coil embolization, 7 patients 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 with chemical thrombolysis and/or SESs. The chemical thrombolytic agents we used were urokinase and the GPIIb/IIIa receptor inhibitor, Tirofiban. In mechanical recanalization, we used Enterprise (Codman Neurovascular, Miami Lakes, FL, USA) and Solitaire stents (ev3 Incorporation, Plymouth, MN, USA) 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.

## III. RESULTS

Seven patients with ruptured cerebral aneurysms treated by endovascular methods had acute thromboembolic complications. 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 the chemical 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).

Table 1. Summary of 7 patients treated with rescue therapy

<i>Cas e No.</i>	<i>Sex/ age</i>	<i>Diagn osis</i>	<i>Initial Treatment</i>	<i>occlusion</i>	<i>Rescue</i>	<i>IAT</i>	<i>MT</i>	<i>Result s (TICI )</i>
1	F/55	SAH, Pcom	Coil embolizati on	MCA occlusion	Chemical	UK 250,000	No	2a
2	M/4 9	SAH, Acom	Coil embolizati on	MCA occlusion	Chemical	UK 200,000	No	2a
3	F/52	SAH, Acom	Coil embolizati on	MCA occlusion	Chemical	Tirofiba n 0.5mg	No	2a
4	M/5 3	SAH, M1	Coil embolizati on	ICA occlusion	SES*, STA-MC A bypass	UK 100,000 , Tirofiba n 3.6mg	Enterpri se stent	2b→0
5	F/57	SAH, BA	Coil embolizati on	PCA occlusion	SES*	Tirofiba n 1.0mg	Entepris e stent	3
6	F/63	SAH, Pcom	Coil embolizati on	MCA occlusion	SES*	Tirofiba n 0.7mg	Enterpri se stent	3
7	F/69	SAH, Acom	Coil embolizati on	MCA occlusion	SES*	UK 200,000	Solitair e stent	2b

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

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 immediately after surgery but 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 observed one 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 undergo emergency STA-MCA bypass operation.

#### IV. ILLUSTRATIVE CASES

##### ***Case 1***

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 indicated by DSA and 3D DSA. Endovascular coil occlusion of the aneurysm was attempted without heparinization. With stent-assisted aneurismal coiling, the aneurismal sac was successfully occluded with coils, but in-stent thrombosis was noted in the left PCA territory (Fig.1 A). Despite the use of 1.5 mg of Tirofiban, the PCA occlusion did not improve. Because additional use of thrombolytic agents was dangerous due to the ruptured aneurysm, we used a self-expandable 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 as in DSA the following day (Fig.1 B). The patient was discharged without any clinical deficits.

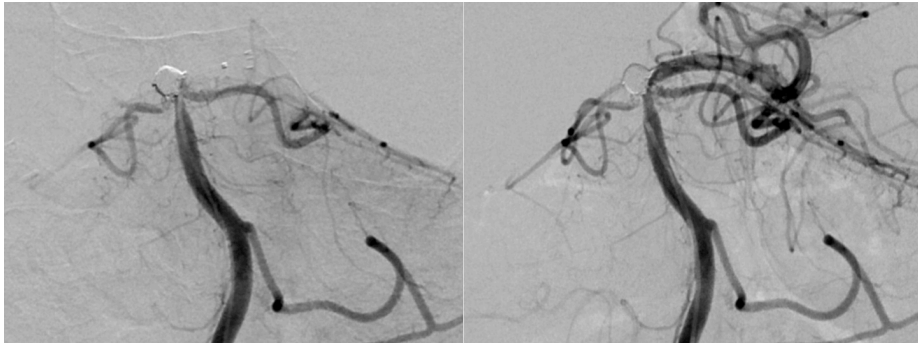


Figure 1. Digital subtraction angiogram shows acute PCA occlusion (A). The control angiogram after rescue therapy with Tirofiban and Enterprise stent shows recanalized vessel (B).

### ***Case 2***

This 69-year-old female patient presented with a SAH 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 used an 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.2 A). 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.2 B). 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.

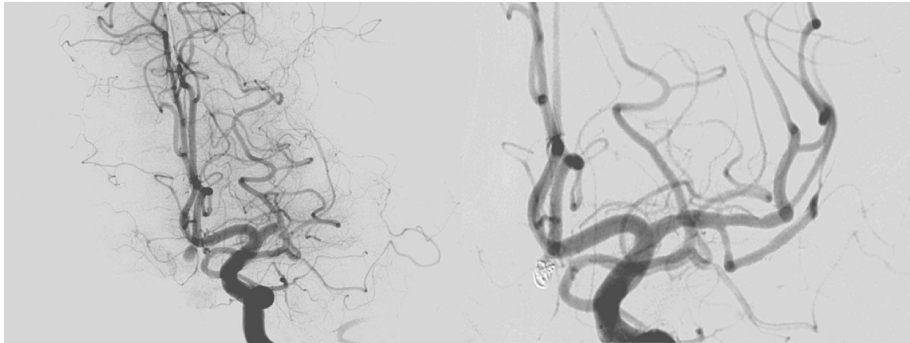


Figure 2. Acute M1 occlusion (A). After mechanical thrombectomy with Solitaire stent and chemical thrombolysis, the vessel is revascularized to a TICI 2b state (B).

## V. DISCUSSION

In several stroke studies, it has been documented that successful recanalization and good outcome after acute ischemic strokes are strongly associated<sup>3, 5, 6</sup>. If thromboembolic complications occur in hemorrhagic patients, chemical thrombolysis can yield fatal outcomes compared to cases 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<sup>7, 8</sup>. Despite increasing utilization of antithrombotic agents (e.g.,

alteplase and reteplase), recanalization rates remain approximately 60% in acute ischemic stroke<sup>7, 8</sup>. Not surprisingly, a combination of mechanical and pharmacologic approaches would yield greater benefit in such situations<sup>8</sup>.

The use of other mechanical means has been reported to be effective in recanalization of acute occlusions<sup>8</sup>. Mechanical thrombectomy techniques are reported in cases of failed recanalization after thrombolysis or in patients with contraindications to thrombolytic agents<sup>4, 9</sup>. In recent studies, intracranial stent placement has been performed for recanalization of cerebral arterial occlusion in acute stroke patients<sup>4, 10, 11</sup>. Researchers have reported favorable outcomes with the use of SESs, with recanalization rates of 79% to 100%<sup>3, 4, 12</sup>.

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<sup>3</sup>. In the latest studies, mechanical thrombectomy with an unfolded, fully retrievable SES yielded very promising angiographic and clinical results<sup>4</sup>. 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 regarding acute ischemic stroke, application of SESs has been reported to produce immediate recanalization and has a very high success rate<sup>2, 3, 8, 13</sup>.

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 intracerebral hemorrhage 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 had a 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. To our knowledge, this is the first study about rescue procedures in

the treatment of ruptured cerebral aneurysms, and it demonstrated a high rate of revascularization.

## VI. CONCLUSION

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



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## ABSTRACT(IN KOREAN)

### 뇌동맥류의 혈관내 치료 중 발생한 급성 혈색전성 폐색증의 구조 치료

< 지도교수 주진양 >

연세대학교 대학원 의학과

김소연

#### **배경 및 목적**

뇌동맥류의 치료 중 흔하게 발생하는 합병증의 하나로 급성 혈색전성 폐색증을 들 수 있다. 최근 혈관내 치료 장비와 기술의 발달과 더불어, 이를 재관류 할 수 있는 여러 가지 방법들이 소개되었다. 이에 뇌동맥류 색전술 중 발생한 우리의 구조 치료 경험을 보고한다.

#### **재료 및 방법**

2009년 3월부터 2011년 2월까지, 본원에서 혈관내 코일 색전술을 시행한 뇌동맥류 환자 153명 중 7명에서 급성 혈색전성 폐색증이 발생하였고, 이 환자들에게 혈관내 치료 방법으로 구조 치료를 시행하였다. 재관류의 프로토콜은 동맥내 화학적 용해술 혹은 이에 추가적으로 기구적 혈전용해술을 사용하였다. 유로키나, 당단백 IIb-IIIa 저해제(Tirofiban)와 자가확장 스텐트 등이 재관류에 사용되었다. 재관류 결과는 구조치료 직후에 TICI 등급체제와 임상적 결과로 평가하였다.

#### **결과**

남자 2명과 여자 5명(나이 49~69, 평균연령 56세)이 구조치료를 받았다. 7명의 환자 모두 뇌지주막하출혈이 동반되어 있었다. 3명의 환자에서는 동맥내 화학적 혈전용해술만으로 성공적 재관류가 이루어졌으며 그들의 TICI 등급은 2a(2명)였다. 다른 4명의 환자에서는 자가확장

스텐트를 사용하여 성공적 재관류가 이루어졌으며, 그 중 3명에서는 TICI 2b(1명)와 3(2명)로 좋은 결과를 얻을 수 있었다. 한 환자에서는 혈관내 재관류에 실패하여 응급으로 우회수술을 시행하였다.

### **결론**

이러한 구조치료들로 우리는 혈관내 치료의 혈색전증 합병증에서 발생할 수 있는 영구적 신경학적 장애를 최소화시킬 수 있었다. 스텐트를 사용한 재관류와 IIb-IIIa 저해제를 같이 사용함으로써 재관류 비율 상승에 도움을 줄 수 있다.

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핵심되는 말 : 혈색전성 폐색증, 구조 치료, 재관류, 뇌동맥류