

Refinement of a Thrombectomy Technique to Treat Acute Ischemic Stroke: Technical Note on Microcatheter Advance during Retrieving Self-Expandable Stent

급성 허혈성 뇌졸중의 중재치료에서 혈전제거 기법의 개선: 자가팽창성 스텐트의 회수 전 미세도관 전진에 대한 기술적인 증례 보고

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Temporary stenting and thrombectomy by use of the Solitaire stent (ev3, Irvine, CA, USA) has shown prompt and successful recanalization of the acutely occluded major cerebral artery. However, even if rarely reported, inadvertent stent detachment may occur as an innate drawback and full deployment of the stent was considered to increase the risk. In our patients, the Solitaire stent did not fully unfold to prevent inadvertent detachment. Before retrieval of the stent, the tip of the microcatheter was advanced forward carefully under fluoroscopic observation until it met the presumed thrombus segment and a subtle sense of resistance was felt in the fingers guiding the stent. After retrieval, complete recanalization was achieved, and the thrombus was trapped between the tip of the microcatheter and the stent strut. We present 2 cases of successful thrombi captures by advancing a microcatheter during Solitaire stent retrieval, and we suggest that advancing the microcatheter can be a useful refinement to the thrombectomy technique for acute ischemic stroke.

Index terms

Thrombectomy
Acute Ischemic Stroke
Microcatheter Advance
Self-Expandable Stent
Recanalization
Thrombus Capture

INTRODUCTION

The Solitaire AB (ev3, Irvine, CA, USA) is a self-expanding, fully retrievable, nitinol stent. It was originally designed for vessel reconstruction during coil embolization of intracranial aneurysms (1). Similar to other intracranial self-expanding stents that are used for acute ischemic stroke, the Solitaire stent was introduced into the stroke intervention to restore immediate antegrade flow (2-5). Owing to the closed stent design and the

structure attached to the nitinol pushwire, resheathing allows recapture even after full deployment, and thrombectomy became possible by pulling the unfolded stent back.

However, withdrawing the stent in contact with endothelial surface may cause vessel trauma and stent detachment may occur inadvertently (5). Herein, we report 2 interesting cases in which the thrombus was captured safely by advancing the microcatheter along the deployed stent in the course of attempting to minimize thrombectomy-related adverse events.

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CASE REPORT

Case 1

A 71-year-old woman was brought to our institution with sudden onset of stuporous mentality, aphasia, and right sided weakness. The patient's baseline National Institutes of Health Stroke Scale Score (NIHSS) was 17. She had been diagnosed with sick sinus syndrome and atrial fibrillation 4 years prior to this event. On magnetic resonance imaging 2 hours and 30 minutes after stroke onset, diffusion restrictions were found in the left insular and parietal cortices, and perfusion abnormalities were observed on the left middle cerebral artery (MCA) territory, sparing the basal ganglia. We attempted intra-arterial thrombolysis 4 hours after onset of the patient's symptoms. A coaxial system of 6-Fr Flexor Shuttle (Cook, Bloomington, IN, USA) and a 6-Fr Envoy guiding catheter (Codman, Raynham, MA, USA) were inserted into the left proximal internal carotid artery (ICA) via the 8-Fr sheath of the right femoral artery. Baseline angiography showed complete occlusion of the left distal M1 segment (Fig. 1A). A 0.021-inch Rebar microcatheter (ev3, Irvine, CA, USA) was loaded coaxially over a 0.014-inch Synchro microwire (Boston Scientific, Fremont, CA, USA) and was placed through the thrombus into the left MCA superior division. After placement of the microcatheter distal to the thrombus, the extent of the thrombus was verified by microcatheter injection of contrast medium. A 4.5 × 20 mm-sized Solitaire stent was advanced through the microcatheter, and the microcatheter was then pulled back until the stent was half-unfolded. An aliquot of 500 µg Aggrastat (Iroko cardio, Geneva, Switzerland) was infused to restore flow of the left MCA superior division. Afterward, the stent was pulled back into its unfolded state by locking a 3-way hemostatic valve, resulting in occlusion of the distal M1 segment again. A microcatheter was navigated into the inferior division for a second attempt. The stent was placed and deployed from the M2 segment into the M1 segment, with the distal 3/4 of the entire stent length was unfolded, and an antegrade flow through the stent was restored immediately (Fig. 1B). The thrombus segment was shown as a faint filling defect narrowing the M1, and the superior division of the MCA was not demonstrated. After infusion of 250 µg of Aggrastat, the tip of the microcatheter was advanced along the stent under careful fluoroscopic observation, until a subtle

sense of resistance was felt on the finger of the hand guiding the instrument. The microcatheter and stent were slowly pulled into the guiding catheter, and a complete recanalization was achieved (total duration of procedure, 76 minutes) (Fig. 1C). On inspection of the retrieved device, the thrombus was trapped between the microcatheter and the stent (Fig. 1D). Immediately after the procedure, the patient's NIHSS improved to 14. On computed tomography (CT) 1 day after treatment, small areas of low density on the insular and parietal lobes did not increase as compared to baseline diffusion-restrictive lesions. The patient was discharged after 2 weeks with modified Rankin Score of 3.

Case 2

A 78-year-old female was brought to our institution with sudden right hemiparesis and aphasia. Her NIHSS was 13. An initial diffusion weighted image showed focal, small areas of diffusion restriction at the left insular and temporal lobes, and a perfusion-weighted image revealed markedly decreased and delayed perfusion of the left MCA territory. A coaxial system of the 6-Fr Flexor Shuttle and the 6-Fr Envoy guiding catheter were placed into the left proximal ICA via the right femoral artery puncture. Initial angiography confirmed complete occlusion of the left M1 segment (Fig. 2A). The occluded segment was crossed with a coaxial loading of a 0.027-inch Rebar microcatheter and 0.014-inch Synchro wire, and selective angiography confirmed its extent (Fig. 2B). A 6 × 30 mm-sized Solitaire stent was delivered across the occluded segment via the microcatheter, and the distal 2/3 of the entire stent length had unfolded with immediately restoration of flow through the stent (Fig. 2C). A 1000 microgram of Aggrastat was infused to sustain the restored antegrade flow, and the thrombus segment was compressed by a stent in the front tip of the microcatheter. The tip of the microcatheter was advanced along a stent to encroach upon the thrombus segment (Fig. 2D). Afterward, the stent was withdrawn carefully in its unfolded state with a locking 3-way hemostatic valve, and the complete recanalization was achieved (total duration of procedure, 107 minutes) (Fig. 2E). The retrieved device revealed that the thrombus was captured between the microcatheter and the stent (Fig. 2F). Although stenosis of the middle of the M1 segment was considered to be the origin of the thrombus formation, angioplasty was performed by using a balloon or stent was not thought as an es-

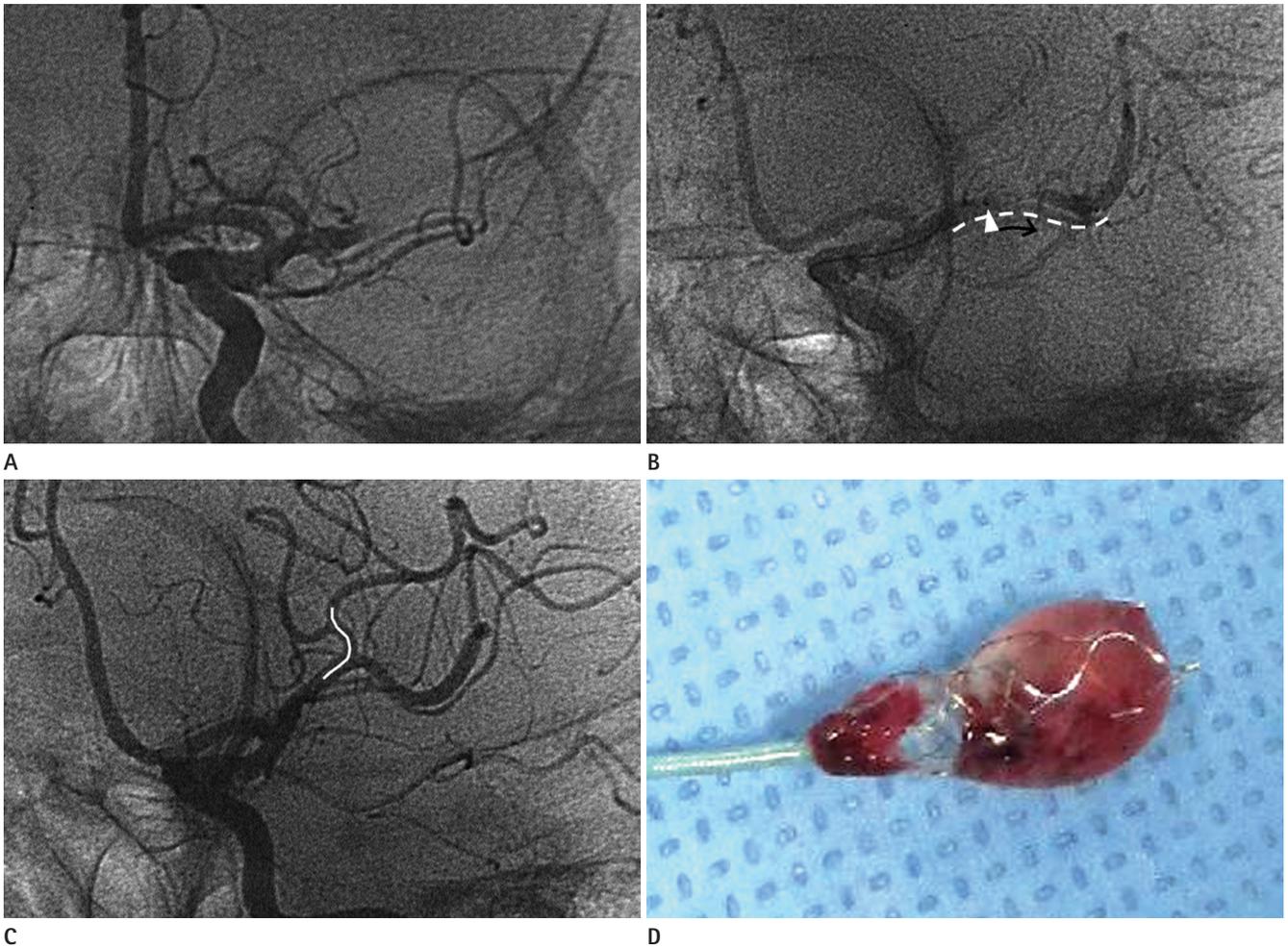


Fig. 1. A 71-year-old woman with stuporous mentality.

A. Initial angiogram shows acute occlusion of left distal M1 segment.

B. After unsuccessful trial of superior division thrombectomy, a microcatheter was navigated into the inferior division for a second attempt. The distal 3/4 of the entire stent length (dashed line) had unfolded, and an antegrade blood flow was restored through the stent immediately. The thrombus segment is shown as a faint filling defect narrowing the M1 at the front tip of the microcatheter (white arrowhead). The tip of the microcatheter had advanced (as seen as at the black arrow) along the stent to capture thrombus segment.

C. After retrieval of the devices, complete recanalization can be achieved. The white line indicates a presumed location of the retrieved thrombus.

D. The thrombus is trapped between the microcatheter and the stent.

sential procedure at that time. Delayed angiography did not show re-occlusion of the left MCA. Immediately after the procedure, the NIHSS decreased to 4. However, the patient's NIHSS was re-aggravated to 15 several hours later. The possibility of re-occlusion was reduced by simple confirmation that no hemorrhagic transformation occurred on serial CT scan. On CT angiography 1 day after treatment, there was re-occlusion of the left M1, and the area of infarct had increased.

DISCUSSION

Although a variety of devices are being developed and nu-

merous thrombolytic trials are underway, prompt and safe recanalization of an acutely occluded proximal cerebral artery remains as unsolved problem (6, 7). Recent studies have reported that stent implantation appears to produce immediate and successful recanalization of occluded intracranial arteries by displacing and retaining a clot along vessel walls (8-10). Permanent implantation of intracranial self-expanding stents is technically feasible, and can be deployed rapidly and safely due to their flexibility and ease of delivery (8, 9). However, the need for an aggressive antiplatelet regimen after permanent stent implantation remains one of the major limitations of its use in the treatment of acute stroke. There are concerns about in-stent throm-

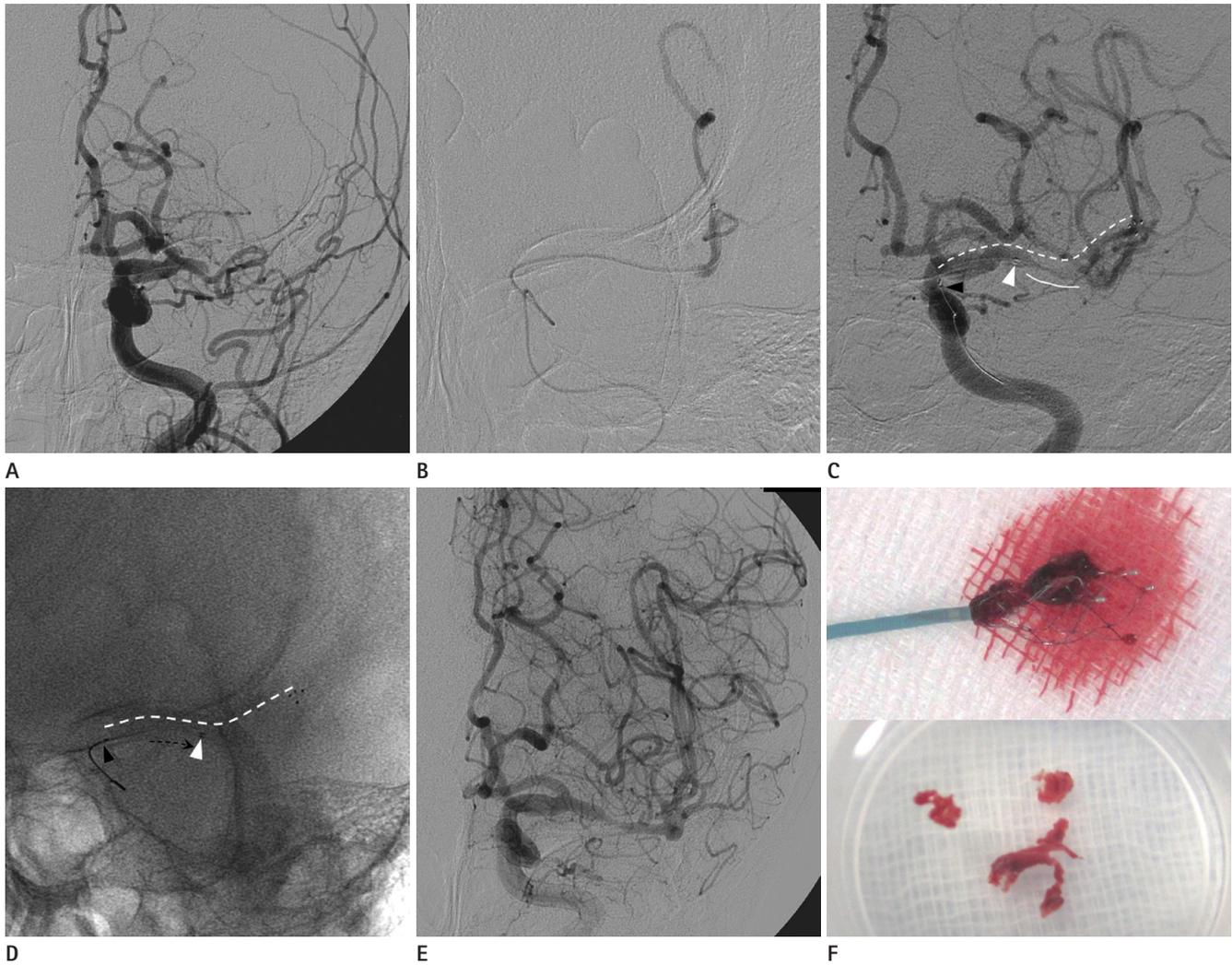


Fig. 2. A 78-year-old woman with acute onset right hemiparesis and aphasia.
A. Baseline angiography shows acute occlusion of left M1 segment.
B. The extent of the thrombus segment was confirmed by microcatheter passage and contrast agent injection.
C. The distal 2/3 of the entire stent length (dashed line) had unfolded, and an antegrade blood flow through the stent was restored immediately. The thrombus segment (white line), which was displaced by stent toward vessel wall, is located at the front of the tip of microcatheter (white arrowhead). The detach zone (black arrowhead) is within the microcatheter.
D. The tip of microcatheter (white arrowhead) was advanced (as seen as dashed black arrow) along the stent (dashed white line) to capture the thrombus segment. The detachment zone (black arrowhead) is within the microcatheter.
E. After retrieval of devices, complete recanalization is achieved.
F. The thrombus is captured between the microcatheter and the stent (upper row), and can be seen as separated from the devices (lower row).

basis, because the clot is not removed from the artery, but has been pressed into the vessel wall. Besides, the placement of an intracranial stent may induce in-stent stenosis in the long-term. An aggressive antiplatelet therapy for these concerns potentially increases the risk of hemorrhagic transformation.

From this point of view, temporary deployment and retrieval of the stent has advantages over permanent implantation by eliminating the need for dual antiplatelet therapy. The advent of closed-cell design has allowed resheathing and retrieval of the

stent after successful recanalization is achieved (2, 10). The Solitaire stent is a fully retrievable, self-expanding stent with closed-cell design, and use of the Solitaire stent to temporarily stent and thrombectomy have been applied successfully to the acute ischemic stroke (2-5).

However, procedural events are unknown, as only initial experiences in small populations have been reported at present. In addition to procedural events including arterial perforation, dissection, or embolization of a previously uninvolved territory,

inadvertent stent detachment may occur as an innate drawback (5). The detachment zone is located at the junction of a stent and a nitinol pushwire, and an inadvertent stent detachment may occur when the traction was applied with a strength more than the detachment zone can endure. Stents that are oversized for the diameter of the artery, or fully deployed stents may resist being pulled back with larger radial force and friction. The exposure of the detachment zone to the blood stream for a long time may weaken the detachment zone by activating an electrochemical detaching process. Theoretically, partial unfolding less than the full length of the stent should be considered to minimize the risk of detachment and vessel trauma by reducing the radial force and by avoiding exposure of the detachment zone. In our patients, the stent was not fully unfolded to prevent inadvertent detachment, although the clot retrieval of partial unfolding technique might not be as successful as that of the technique that allows for full unfolding due to a reduced radial force.

In the original concept of the retrieving stent, a microcatheter was advanced forward to keep the length of the stent segment consistent; this could be exposed by pulling it back. Advancing of the microcatheter was discontinued when a subtle sense of resistance was felt on the fingers. Incidentally, it was found that complete recanalization was achieved after retrieval, and the thrombus was located between a tip of the microcatheter and the stent strut. The retrospective reviews of the angiogram revealed that the thrombus segment was located in front of microcatheter tip, which suggested that the exact localization of microcatheter tip, stent, and thrombus segment may increase the possibility of thrombus capture. In summary, the thrombectomy technique of microcatheter advancement can be a useful refinement towards the treatment of acute ischemic stroke, but requires further investigation.

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급성 허혈성 뇌졸중의 중재치료에서 혈전제거 기법의 개선: 자가팽창성 스텐트의 회수 전 미세도관 전진에 대한 기술적인 증례 보고

윤성원 · 김호균

솔리테어 스텐트를 이용한 일시적인 스텐트 삽입과 혈전제거술은 급성 뇌동맥 폐색을 빠르고 안전하게 재개통시킨다. 그러나 구조상의 결점으로 의도되지 않은 스텐트-지지철사의 분리는 드물게 발생할 수 있는데, 이는 스텐트를 완전히 펼침으로써 발생위험이 증가한다고 사료된다. 본 연구에서는 스텐트-지지철사의 분리를 방지하기 위해 솔리테어 스텐트를 완전히 펼치지 않았다. 스텐트를 회수하기 이전에 스텐트를 축으로 하여, 미세도관의 끝부분을 투시하에 조심스럽게 전진시켜 혈전이 위치할 것으로 예상되는 구간까지 도달시켰으며, 손가락에 미묘한 저항감이 느껴질 때 전진을 중단하였다. 스텐트를 회수한 이후에 뇌혈관은 완전히 재개통되었으며, 혈전은 미세도관의 끝부분과 스텐트 사이에 끼여져 있었다. 저자들은 솔리테어 스텐트를 거두어들일 때 미세도관을 전진시킴으로써 성공적으로 혈전을 포획한 2예를 보고하고자 한다. 미세도관 전진법은 급성 허혈성 뇌졸중을 위한 혈전제거술을 개선한 방법으로 사료된다.

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