Stent-Assisted Mechanical Recanalization for Treatment of Acute Intracerebral Artery Occlusions

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Background and Purpose—The purpose of this study was to demonstrate a new approach to the use of a self-expanding stent in the treatment of acute ischemic stroke.

Methods—Twenty-two consecutive patients with acute intracerebral artery occlusions were treated with a self-expandable intracranial stent, which was withdrawn in its unfolded state. For this technique, we used the Solitaire AB/FR, which is the only intracranial stent that is fully recoverable. Eight patients had an occlusion of the basilar artery, 12 had a middle cerebral artery occlusion, and 2 had terminal carotid artery occlusions; 6 of these had to be treated first for an acute occlusion originating in the internal carotid artery. Recanalization results were assessed by follow-up angiography immediately after the procedure. Neurologic status was evaluated before and after treatment (90-day follow-up) according to the National Institutes of Health Stroke Scale and modified Rankin scale.

Results—Successful revascularization was achieved in 20 of 22 (90.9%) patients (thrombolysis in cerebral infarction [TICI] 2a/b and 3), a TICI 3 state was accomplished in 12 patients, and partial recanalization or slow distal branch filling with filling of more than two-thirds of the vessel territory was achieved in 8 patients (TICI 2b). There was immediate flow restoration in 21 of 22 (95.4%) cases after deployment of the device. The stent was removed in its unfolded state in all patients. The mean time from stroke symptom onset to recanalization was 277 minutes, with a standard deviation of 118 minutes. Mean National Institutes of Health Stroke Scale score on admission was 19.4, with a standard deviation of 5.7. Almost two-thirds of the patients (63.6%) improved by >10 points on the National Institutes of Health Stroke Scale at discharge, and 50% showed a modified Rankin scale score of ≤2 at 90 days (59% with a modified Rankin scale ≤3). Mortality was 18.1%. In 1 case, an asymptomatic intracranial hemorrhage was detected on control computed tomography, and 2 patients had a symptomatic intracranial hemorrhage.

Conclusion—Withdrawal of an unfolded, fully recoverable, intracranial stent yielded very promising angiographic and clinical results. It combines the advantages of prompt flow restoration and mechanical thrombectomy. (Stroke. 2010;41:2559-2567.)

Key Words: stroke • mechanical recanalization • self-expanding stent • solitaire

Interventional treatment of acute ischemic stroke has evolved in the past few years. The only known drug therapy for acute ischemic stroke is thrombolysis with recombinant tissue plasminogen activator, which has been proven in many clinical trials to be effective in improving clinical outcome and reducing subsequent disability. The only improvement in this therapy has been the extension of the 3-hour time frame to 4.5 hours in which it can be safely administered.1–7 Treatment of ischemic stroke in patients with a large intracranial vessel occlusion still remains a challenge because intravenous thrombolysis often reaches its limit.8,9 The number needed to treat, even with the extended window of 3 to 4.5 hours, is still 14. Ever since the publication of some promising data from the PROACT II trial, in which a recanalization rate of 66% was achieved, several other trials have shown the efficacy of a mechanical approach.10 These trials were able to show that a mechanical approach, alone or in combination with intravenous and intra-arterial tissue plasminogen activator administration, could improve the recanalization rate and thereby the outcome of patients.11–18 Several reports on the use of intracranial stent placement in acute ischemic stroke have been published.14,19–21 In those trials, a recanalization rate of up to 100% was achieved. Recently, a new technique with the Solitaire AB/FR device (ev3, Irvine, Calif) was described.22,23,24 According to these reports, the stent was placed and deployed in the occluded vessel within the thrombus formation and was then withdrawn in its unfolded state. The Solitaire FR is a new

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self-expanding and fully retrievable nitinol stent based on the Solitaire AB, which is commonly used for stent-assisted treatment of intracranial aneurysms.18

In our retrospective analysis, we collected the data for 22 consecutive patients with acute ischemic stroke who were treated with the Solitaire AB/FR stent device. This is the first study on the use of this new technique.

**Subjects and Methods**

Twenty-two consecutive patients with acute ischemic stroke underwent stent-assisted mechanical recanalization in our department. The patient data were collected from October 2009 to May 2010. Neurologic evaluation (as per the National Institutes of Health Stroke Scale [NIHSS]) was performed on admission, at discharge, and 30 days after therapy; the modified Rankin Score (mRS) was assessed by 2 experienced stroke neurologists (S.W., S.B.) at 30 and 90 days after treatment. An mRS of 0 to 2 was defined as a good neurologic outcome; poor outcome was assumed when the mRS score was 3 to 6.

Computed tomography (CT), CT perfusion, and CT angiography were performed on admission to rule out intracranial hemorrhage (ICH) and to assess the initial thrombolysis in cerebral infarction (TICI) score (Table 1) and perfusion deficits. Control CT and/or magnetic resonance imaging scans were acquired 24 hours after treatment and before discharge, or when the patient’s symptoms worsened. Before treatment, informed consent was obtained from either the patient him/herself or a legal representative.

**Patient Selection**

The main inclusion criteria were (1) patient age ≥18 years; (2) NIHSS score ≥8; (3) TICI score of 0 or 1 in an accessible vessel; (4) no detection of ICH and no marked ischemia on the CT scan; and (5) arrival at the hospital within 6 hours of symptom onset for the anterior circulation; the time window was extended for the posterior circulation when magnetic resonance imaging ruled out extensive ischemic damage.

When a large-vessel occlusion was found (for example, occlusion in the M1 segment of the middle cerebral artery, internal carotid artery [ICA], or basilar artery), treatment was started with intravenous tissue plasminogen activator. Patients were then transferred for interventional treatment. Depending on the patient’s neurologic status, they were treated either under sedation or under intubation and ventilation. Table 2 gives an overview of the patient data.

**Device Used**

The Solitaire AB/FR (ev3) is a laser-cut, self-expanding, and fully retrievable split-design nitinol device. The device, which is available in several sizes ranging from 4×15 mm to 6×30 mm, is attached to a nitinol pushwire. With these sizes, vessels from 2 to 5.5 mm in diameter can be treated. The advantage of this device is that it is a fully recoverable, self-expanding-stent (SES) platform-based device that can be used as both a temporary endovascular bypass and a thrombectomy device. Moreover, it can be electrolytically detached like a coil in case permanent stent placement is necessary, such as in the setting of an atherothrombotic lesion. It runs through a 0.021-in. microcatheter (for example, the Rebar-18; ev3).

**Interventional Treatment**

All procedures were performed on a biplane angiography machine (Siemens Axiom Artis, Siemens Healthcare, Erlangen, Germany). After occlusion of the target vessel was verified angiographically and rated on the TICI scale, a long, 6F sheath (Flexor Shuttle Select; Cook Medical Inc; Strada, St. Jude Medical) was placed either in the vertebral artery or the ICA, and intravenous lytic therapy was halted. The target vessel was navigated with a 0.014-in. microwire (Traxcess, Microvention Inc; Silverspeed, ev3) and a 0.021-in. microcatheter (Rebar, ev3). After placement of the microcatheter distal to the thrombus, as verified by intra-arterial contrast medium injection, the Solitaire device was advanced through the microcatheter. The microcatheter was then pulled back until the Solitaire was completely unfolded. The device was placed with the proximal third within the thrombus. A control angiogram was performed after successful unfolding of the stent device to evaluate re-establishment of flow. Afterward, the device was pulled back in its unfolded state under continuous aspiration with a 50-mL syringe together with the microcatheter into the guiding sheath. After removal of the device and microcatheter, another 50 mL was aspirated from the guiding sheath to prevent re-embolization of possibly lost clot. When the subsequent control angiogram showed a TICI score <2, the procedure was repeated until a TICI score of ≥2 or 3 was reached. In contrast to the guidelines for the ev3 regarding use of the Solitaire FR stent system, which is basically a Solitaire AB certified for

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**Table 1. TICI Score Overview**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
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<td>0</td>
<td>No perfusion: No antegrade flow beyond the point of occlusion.</td>
</tr>
<tr>
<td>1</td>
<td>Penetration with minimal perfusion: The contrast material passes beyond the area of obstruction but fails to opacify the entire cerebral bed distal to the obstruction for the duration of the angiographic run.</td>
</tr>
<tr>
<td>2</td>
<td>Partial perfusion: The contrast material passes beyond the obstruction and opacifies the arterial bed distal to the obstruction. However, the rate of entry of contrast into the vessel distal to the obstruction and/or its rate of clearance from the distal bed are perceptibly slower than its entry into and/or clearance from comparable areas not perfused by the previously occluded vessel, eg, the opposite cerebral artery or the arterial bed proximal to the obstruction.</td>
</tr>
<tr>
<td>2a</td>
<td>Only partial filling (≤2/3) of the entire vascular territory is visualized.</td>
</tr>
<tr>
<td>2b</td>
<td>Complete filling of all of the expected vascular territory is visualized, but the filling is slower than normal.</td>
</tr>
<tr>
<td>3</td>
<td>Complete perfusion: Antegrade flow into the bed distal to the obstruction occurs as promptly as into the obstruction, and clearance of contrast material from the involved bed is as rapid as from an uninvolved other bed of the same vessel or the opposite cerebral artery.</td>
</tr>
</tbody>
</table>

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**Table 2. Overview of Patient Data and Outcome**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
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</thead>
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<td>Age, mean±SD, y</td>
<td>64.8±19.5</td>
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<td>Female, n/N</td>
<td>6/22</td>
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<tr>
<td>Mean NIHSS score at baseline</td>
<td>19.4±5.7</td>
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<td>Site of occlusion</td>
<td>Terminal ICA, No. 2 (1 with acute stenting of ICA origin)</td>
</tr>
<tr>
<td></td>
<td>Middle cerebral artery, No. 12 (5 with acute stenting of ICA origin)</td>
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<tr>
<td>Basilar artery, No.</td>
<td>8</td>
</tr>
<tr>
<td>TICI 0+1</td>
<td>22 (21/1)</td>
</tr>
<tr>
<td>Mean±SD time from stroke symptom onset to recanalization, min</td>
<td>277±118</td>
</tr>
<tr>
<td>&gt;10-point improvement on NIHSS</td>
<td>14 (63.6%)</td>
</tr>
<tr>
<td>mRS =2 at 30 days</td>
<td>11 (50%)</td>
</tr>
<tr>
<td>mRS =2 at 90 days</td>
<td>11 (50%)</td>
</tr>
<tr>
<td>mRS =3 at 90 days</td>
<td>13 (59%)</td>
</tr>
<tr>
<td>Device-related complications</td>
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</tbody>
</table>
thrombectomy, we did not use a balloon guide catheter to achieve
flow arrest, nor did we work with a special aspiration catheter.

Results

Patient Data

The 22 patients treated with the Solitaire AB system were
selected from a group of patients arriving at our institution
with acute ischemic stroke and an occlusion of an intracranial
vessel (ICA, middle cerebral artery, or basilar artery) con-
firmed by CT angiography. The patients’ mean NIHSS score
on admission was 19.4 points with a standard deviation of 5.7
points. All patients had an NIHSS ≥13 on admission. The
mean time interval from stroke onset to admission was
207±110 minutes. Nine patients had contraindications to
intravenous tissue plasminogen activator therapy, but the
others received a standard 10% bolus of the maximum dose
(0.9 mg/kg body weight). Intravenous administration of tissue
plasminogen activator was halted in all cases when the
occlusion site was accessed. Depending on the achieved TICI
score, the patients with TICI ≥3 received intra-arterial tissue
plasminogen activator after recanalization to help clear distal
branches of the thrombus load (10 patients, 45.5%) up to a
maximum dose of 40 mg and not exceeding the total
maximum dose. Twenty-one patients had a TICI score of 0 on
the initial angiogram, 1 patient had partial flow to the
periphery (TICI 1), 8 patients had an acute occlusion of the
basilar artery, 12 patients had an acute M1 occlusion, and 2
showed a carotid T occlusion, 6 in combination with an acute
ICA-origin occlusion. Table 2 gives an overview of the
patient data and outcome.

Angiographic Outcome

Successful revascularization was achieved in 20 (90.9%)
patients (TICI grades 2a/b and 3). Embolization into a second
vessel territory, owing to lost clot during removal of the stent,
was not observed in any of the 22 cases, as verified on control
angiograms. We did, however, detect clot formation in the
hemostatic valve of the guiding sheath in a few cases, and we
also detected clot formation in the aspirated blood from the
sheath. The mean time from stroke symptom onset to recan-
alization was 277 minutes with a standard deviation of 118
minutes. The stent was removed in its unfolded state in all
patients: 40% needed 1 run to achieve final recanalization,
and 60% needed 2 or more runs (mean, 1.77 runs). The
maximum number of runs needed was 4. In 21 of 22 (95.4%)
cases, immediate flow restoration was achieved after deploy-
ment of the device (Figures 1 through 3). In 3 cases, slight
vasospasm was visible in the target vessel after the interven-
tional procedure (Figure 4). This resolved after a few min-
utes, and no additional treatment was necessary. In all but 2
cases (90.9%), thrombus was visible in the stent mesh after its
removal from the guiding sheath (Figure 5). No vessel
perforations or dissections were visible on any control series.
Embolization into another vessel territory was not detected on
the control angiograms performed after every run. ICA stent
placement (Wallstent, Boston Scientific) was necessary in 6
patients to access the target vessel, owing to acute occlusion of the ICA. These patients received an additional 500 mg of intravenous acetylsalicylic acid and 75 mg clopidogrel on the following day to protect the ICA stent. There were no device-related complications. Table 3 shows the angiographic outcome of the treated patients.

**Clinical Outcome**

Almost two-thirds (63.6%) of the patients improved by ≥10 points on the NIHSS at discharge, and 50% had an mRS score of ≤2 at 30 days; this number did not change during the 90-day follow-up. Four patients (18.1%) in this series died within 7 days, 1 of an acute myocardial infarction. In 3 cases (13.6%), an ICH occurred; 1 was asymptomatic (detected on control CT). Two of the patients who had an ICH had to be treated for an acute ICA-origin occlusion first and therefore received aggressive anticoagulation. None of the other cases had ICHs visible on any control CT.

**Discussion**

Successful recanalization is associated with improved outcomes after acute ischemic stroke. A critical stepping stone to improved clinical outcome after recanalization is the time to recanalization. Tissue plasminogen activator is effective in treating acute ischemic stroke when given intravenously to patients within 4.5 hours of stroke symptom onset. However, the recanalization rates achieved with intravenous tissue plasminogen activator for large-vessel arterial occlusions are poor. Intra-arterial thrombolysis extends this time window for patients with middle cerebral artery occlusions up to 6 hours. Despite increasing use of pro-urokinase or other antithrombotic agents (for example, alteplase and reteplase), recanalization rates remain at ~60%.10

Mechanical thrombectomy techniques are widely used for treatment in case of failed recanalization after thrombolysis or in patients with contraindications to thrombolytic therapy. A variety of devices have been developed; however, the outcome remains relatively poor. The MERCI trial showed a rate of Thrombolysis in Myocardial Infarction grade 2/3 recanalization of 69%. The clots may adhere to the intima and become refractory to mechanical disruption or retrieval. The use of the Penumbra system, an aspiration device, showed high vessel recanalization rates (>80%). However, the functional outcome (mRS ≤2 at 90 days) was surprisingly low (29%) in patients with successful recanalization.

Intracranial stent placement for recanalization of cerebral arteries has been performed earlier in acute stroke patients. Recent studies have reported positive outcomes with SESs in patients with acute intracranial occlusions. In these series, recanalization rates of 79% to 100% were achieved after stent placement. The first prospective trial, SARIS, demonstrated a recanalization rate of 100% in 20 patients, defined as Thrombolysis in Myocardial Infarction grade 2 to 3 flow, as evidenced by angiography.12 These studies have suggested the possibility that clot removal itself is not critical; instead, revascularization should be the focus of intervention. The application of SESs in acute stroke appears to have several advantages compared with other interventional techniques. In the first place, stenting has...
a very high reported rate of successful recanalization. Second, whereas other techniques often take hours to achieve recanalization, SES implantation typically produces immediate recanalization.\textsuperscript{12,14,21,27,31} At the same time, there are important disadvantages to stenting in the setting of acute stroke. The clot is only pressed to the vessel wall and not removed from the vessel, so there are concerns about early rethrombosis. Furthermore, placement of an intracranial stent may induce late in-stent stenosis. Finally, implantation of a permanent, intracranial SES requires aggressive antiplatelet

**Figure 3.** Large thrombus formation is visible on the initial CT angiogram (A). The initial digital subtraction angiogram (C) shows complete occlusion of the basilar artery. The control angiogram after stent withdrawal shows a reopened vessel with some remaining wall-adherent thrombus (D). After several minutes, rethrombosis of the vessel occurred. The control CT scan shows extensive infarction in the hind brain and the brain stem (B); the patient died the following day.

**Figure 4.** Acute M1 occlusion is visible on the initial digital subtraction angiogram (A). After stent placement, the control series shows immediate flow restoration (B). Vasospasm is visible after stent withdrawal (D). The control magnetic resonance imaging shows only a small infarct in the internal capsule (C); time-of-flight angiography conducted 24 hours later shows smooth vessel walls in the former spastic vessels (E).
therapy, which can lead to an increase bleeding risk, as reported in studies that have used a combination of acetylsalicylic acid, clopidogrel, a glycoprotein IIb/IIIa receptor inhibitor, and thrombolytics.33

The Solitaire AB/FR is a laser-cut, self-expanding, and fully retrievable, split-design nitinol device designed for stent-assisted coil embolization of aneurysms, which are characterized by a wide neck.34,35 Recently, 2 case reports and animal data on the use of this device as a thrombectomy device have been published.22–24 In this study, we used the Solitaire AB device, and later on, as soon as it was available, the FR variant, to perform stent-assisted mechanical recanalization. In contrast to recent studies in which SESs were used,12,14,21,31,32 we withdrew the unfolded stent into the guide catheter with constant aspiration. In contrast to the guidelines from ev3 regarding use of the Solitaire FR stent system, which is basically a Solitaire AB certified for thrombectomy, we did not use a balloon guide catheter to achieve flow arrest, nor did we use a special aspiration catheter. The flow arrest should prevent embolization of any lost clot in other vessels. However, we did not observe a single case among our 22 patients in whom a clot was lost into another or the same vessel territory, so we do not think that flow arrest is absolutely necessary, especially because an 8F system is needed in the ICA to achieve optimal flow arrest. Such a situation is not possible in the case of a tortuous anatomy, which is common among typical stroke patients. Use of a special aspiration catheter, for example, the DAC catheter from Concentric Medical, could be considered if the vessel anatomy allows it, but the excellent capability of the Solitaire device to catch and hold the clot might not require the use of a third catheter system. Because there is no difference in device design between the AB and the FR variants of the Solitaire system, we did not detect any differences in recanalization rates or behavior during the procedure. The Solitaire device is the only intracranial stent that is fully recoverable. Therefore, this device combines the advantages of prompt flow restoration and mechanical thrombectomy. Because the stent can be removed, there are no concerns about early rethrombosis and late in-stent stenosis. Furthermore, there is no need for aggressive antiplatelet therapy.

In this study, we have demonstrated that deployment and withdrawal of the unfolded Solitaire stent appear to be a safe, technically feasible method to achieve recanalization when treating acute ischemic stroke resulting from an acute intracranial artery occlusion. A recanalization rate of TICI 2a/b or 3 flow was achieved in 20 of 22 patients (90.9%); TICI 3 in 54.5% and TICI 2a/2b in 36.3%. This high recanalization result is comparable to the results of the recent studies that used SESs.12,14,21,31,32 Withdrawal of the stent could be easily done in all cases. In 95.4% of cases, immediate flow restoration was achieved. We identified thrombus material adjacent to the stent struts in all but 2 cases. To our knowledge, this has not been reported in previous mechanical thrombectomy studies. Mild vasospasm was noticed in 3 cases. We observed no device-related complications, such as dissections or worsening of the situation at the target vessel.

The patients’ neurologic recovery and functional outcome showed an improvement of NIHSS ≥10 in 63.6% of patients at discharge. We defined a good clinical outcome as an mRS ≤2; 50% of patients had an mRS score ≤2 after 30 and 90 days. The 30-day mRS score is comparable to the outcome of the SARIS study, with a 30-day mRS score of ≤3 for 60%
versus an mRS \( \leq 3 \) for 59.1% (n=13) of our patients.12 Mortality was 18.1%. The clinical improvement observed in the present study is higher in comparison with the clinical outcome reported in other studies in which mechanical thrombectomy devices were used. In our opinion, this is due to the early treatment after symptom onset, the fast and effective clot removal, and the possibility to restore flow between different retrieval attempts, a feature that is impossible with devices used in the MERCI, Multi MERCI, and Penumbra trials. In the MERCI trial, the functional outcome of an mRS \( \leq 2 \) was achieved in only 20% of the patients (vs 36% in the Multi MERCI trial), with a recanalization rate of 43% (vs 69.5% in the Multi MERCI trial). The Penumbra trial showed an outcome of mRS \( \leq 2 \) in only 29%, with a recanalization rate of 81.6%.17,28

The difference in functional outcome between stent-assisted recanalization and mechanical thrombectomy may be due to the immediate flow restoration that is achieved with stent deployment. Experimental research in animal stroke models has shown that postconditioning (intermittent restoration of flow to the infarct area) can reduce final infarct size.36 Because the device used in this study can restore flow immediately, once deployed it performs some kind of “postconditioning,” especially when a subsequent retrieval maneuver does not produce a Thrombolysis in Myocardial Infarction score \( \geq 1 \). This might be another explanation for the good clinical outcome of our patients. Another important factor for final outcome is the time in which recanalization was achieved after the onset of stroke. In our patients, the mean time was 277 minutes compared with 393 minutes in the study of Brekenfeld et al.14 Brekenfeld et al also used SESs and achieved a similar recanalization rate (91.6%) but with a lower initial median NIHSS score (14 vs 19.4). However, only 25% of the patients had a good outcome (mRS \( \leq 2 \)).

The ICH rate of 13.6% (n=3) in the present study is similar to a previously reported rate in another acute intracranial stenting series (5% to 22%).14,20,21 However, there is the possibility of vasospasm when withdrawing an unfolded stent, which occurred in 3 patients in our study. The stent may also cause injury to the vessel wall, which can lead to secondary stenosis. Our study has several limitations. First, the number of patients was small. Second, it was not a randomized, controlled trial and therefore, it has the limitations of case series methodology.

Conclusions
The withdrawal of an unfolded, fully recoverable, intracranial stent yielded very promising angiographic and clinical results. It combines the advantages of prompt flow restoration and mechanical thrombectomy. Further prospective studies with more patients will be needed to verify whether this technique can be the treatment of the future in interventional acute stroke.

### Table 3. Angiographic Data

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Target Vessel</th>
<th>TICI at Baseline</th>
<th>TICI at End Point</th>
<th>Vasospasm</th>
<th>No. of Runs</th>
<th>Type of Device, AB/FR</th>
<th>Thrombus in Device Mesh</th>
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<tr>
<td>1</td>
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<td>FR</td>
<td>–</td>
</tr>
<tr>
<td>19</td>
<td>MCA</td>
<td>0</td>
<td>2b</td>
<td>0</td>
<td>3</td>
<td>FR</td>
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</tr>
<tr>
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<td>BA</td>
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<td>3</td>
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<td>1</td>
<td>FR</td>
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</tr>
<tr>
<td>21</td>
<td>BA</td>
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<td>3</td>
<td>0</td>
<td>1</td>
<td>FR</td>
<td>–</td>
</tr>
<tr>
<td>22</td>
<td>ICA, MCA</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>FR</td>
<td>+</td>
</tr>
</tbody>
</table>

All patients 13.6% 1.77 (mean) 90.9%

BA indicates basilar artery; MCA, middle cerebral artery; +, present; and –, absent. “No. of Runs” refers to the number of runs needed for recanalization.
Table 4. Patient Outcome

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>NHSS at Baseline</th>
<th>NHSS at Discharge</th>
<th>mRS at 30 Days</th>
<th>mRS at 90 Days</th>
<th>ICH</th>
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<td>*</td>
<td>6</td>
<td>6</td>
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<td>8</td>
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<td>–</td>
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<tr>
<td>3</td>
<td>15</td>
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<td>5</td>
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<td>–</td>
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<tr>
<td>4</td>
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<td>7</td>
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<td>*</td>
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<td>6</td>
<td>+</td>
</tr>
<tr>
<td>12</td>
<td>18</td>
<td>9</td>
<td>3</td>
<td>5 Exacerbation of pulmonary disease, sepsis</td>
<td>–</td>
</tr>
</tbody>
</table>

Indicates absent; +, present.

*Deceased.

Disclosures

None.

References


Stent-Assisted Mechanical Recanalization for Treatment of Acute Intracerebral Artery Occlusions

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급성 뇌내 동맥 폐쇄의 치료를 위한 스텀트 보조 기계적 재개통

Stent-Assisted Mechanical Recanalization for Treatment of Acute Intracerebral Artery Occlusions

C. Roth, MD; P. Papanagiotou, MD; S. Behnke, MD; S. Walter, MD; A. Haass, MD; C. Becker, MD; F. Fassbender, MD; M. Politi, MD; H. Körner, MD; M.-S. Romann, MD; W. Reith, MD

(Stroke. 2010;41:2559-2567.)

Key Words: stroke ■ mechanical recanalization ■ self-expanding stent ■ solitary

배경과 목적
본 연구의 목적은 급성 혈혈뇌혈증(ischemic stroke)에서 자가 확장성(self-expanding) 스텀트를 사용하는 새로운 접근 방식을 알리고자 하는 것이다.

방법
일련의 급성 뇌내 동맥 폐쇄(intracerebral artery occlusion) 환자 22명을 자가 확장성 두개내 스텀트로 치료하였다. 이 스텀트는 점히지 않은 상태로 이후 재개졌으며, 이 속기를 위하여 저자들은 Solitaire AB/FR을 사용하였으며, 이는 완전히 재개될 수 있는 두개내 스텀트로는 유일한 것이다. 8명은 기저동맥(basilar artery) 폐쇄였으며, 12명은 증대뇌동맥 (middle cerebral artery) 폐쇄, 2명은 경동맥 말단의 폐쇄였다. 이 중 6명은 안쪽 내경동맥(internal carotid artery)에서 시작되는 급성 폐쇄에 대한 치료를 받아야 했다. 치료 전후의 신경학적 상태를 National Institutes of Health Stroke Scale 및 modified Rankin Scale로 평가하였다(90일 추적 관찰).

결과
환자 22명 중 20명(90.9%)에서 성공적으로 치료되었다(TICI [thrombolysis in cerebral infarction] 2a/b 및 3). TICI 3은 12명에서 관찰되었으며, 부분적인 재개통 혹은 판류 부위 2/3 이상 범위의 자연성 관류(TICI 2b)는 8명에서 확인되었 다. 스텀트 설치 후 즉각적인 혈류 개통은 22명 중 21명 (95.4%)에서 관찰되었다. 모든 환자에서 스텀트는 점히지 않은 상태로 재개졌으며, 뇌출혈 증상 발생 이후 재개통까지 평균 소요 시간은 277분이었으며, 표준편차는 118분이었다. 평균 National Institutes of Health Stroke Scale 점수는 19.4였고, 표준편차는 5.7점이었다. 약 2/3의 환자(63.6%)에서 퇴원 시점 National Institutes of Health Stroke Scale 점수는 10점 이상 호전되었으며, 50%의 환자가 90일에 modified Rankin Scale 점수 2점 이하하였다(59%에서 modified Rankin Scale 점수 3점 이하). 사망률은 18.1%였다. 한 환자 에서 컴퓨터단층촬영상 무중상성 두개내출혈(intracranial hemorrhage)이 발생하였으며, 2명에서 중상성 두개내출혈이 일어났다.

결론
점히지 않은 상태로 완전히 재계하진 수 있는 두개내 스텀트 시술은 매우 급정적인 혈관조영술 및 임상적 결과를 보였다. 이는 즉각적인 혈류 재개통 및 기계적 혈전계기술(thrombectomy)의 장점을 함께 가지고 있다.
Figure 2. Initial CT angiogram shows an acute M1 occlusion (A). Digital subtraction angiogram after deployment of the stent (C) shows reopening of the vessel; distal stent markers (black arrowhead) and stent narrowing (black arrow) are visible. After stent withdrawal, the vessel is fully recanalized (D). A small infarct area is visible on the control magnetic resonance imaging scan (B).

Figure 5. Examples of stents after withdrawal. Note how the thrombi are adherent to the stent struts.
Stroke-Assisted Mechanical Recanalization for Treatment of Acute Intracerebral Artery Occlusions

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Abstract

Stent-Assisted Mechanical Recanalization for Treatment of Acute Intracerebral Artery Occlusions

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Background and目的: In this study, we present the results of a retrospective analysis of patients treated with stent-assisted mechanical recanalization for acute intracerebral artery occlusion.

Methods: We included patients treated with stent-assisted mechanical recanalization who met the study criteria. The primary endpoint was successful recanalization defined as Thrombolysis in Cerebral Infarction (TICI) grade 2b. Secondary endpoints included clinical improvement, modified Rankin Scale (mRS) at 90 days, and mortality.

Results: A total of 42 patients were included in the analysis. Successful recanalization was achieved in 34 patients (81%). Clinical improvement was observed in 29 patients (69%). The median mRS at 90 days was 2 (0-6). Mortality was 14% (6 patients).

Conclusion: Stent-assisted mechanical recanalization is a safe and effective treatment for acute intracerebral artery occlusion. Further research is needed to determine the optimal timing and patient selection criteria.

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