Effectiveness of Trevo stent retriever in acute ischemic stroke
Comparison with Solitaire stent

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Abstract
Recently, mechanical thrombectomy with stent retriever has achieved faster and higher rates of recanalization for intracranial major vessel occlusion. However, comparative studies of the most widely used Solitaire and Trevo stents have been rarely published.

The authors retrospectively reviewed a total of 200 patients who performed mechanical thrombectomy at our center during 4 years and divided patients into 2 groups: mechanical thrombectomy with Solitaire stent (Group 1: Solitaire) and mechanical thrombectomy with Trevo stent (Group 2: Trevo). All patients underwent a clinical assessment with National Institutes of Health Stroke Scale (NIHSS) score and underwent modified Rankin Scale (mRS) score. Radiologic results were evaluated using thrombolysis in cerebral infarction (TICI) score and number of stent passes. In addition, multiple time intervals were analyzed.

There was no statistically significant difference in clinical outcome between the 2 groups. Trevo group revealed the shorter procedure time, less number of stent passage, and more one pass cases than Solitaire group with statistically significance (P = .009, P = .014, P = .030). In addition, Trevo group achieved higher successful recanalization (TICI 2b or 3) rate (89.7%) with statistically significant than group1 (82.3%) (P = .018). In multivariate logistic regression analysis, the use of Trevo stent was a predictive for successful recanalization. (odds ratio 1.40, 95% confidence interval 1.250–1.550, P = .028).

Our study suggests that the Trevo stent allows higher recanalization rate through the less number of stent passages and shorter procedure time than the Solitaire stent. More randomized control trials are needed to determine which stents are more effective.

Abbreviations:
ACA = anterior cerebral artery, AF = atrial fibrillation, BGC = balloon guiding catheter, BMI = body mass index, CT = computed tomography, CTA = computed tomography angiography, CTP = computed tomography perfusion, DM = diabetes mellitus, DWI = diffusion weighted images, FDA = Food and Drug Administration, HTN = hypertension, ICA = internal carotid artery, ICH = intracerebral hemorrhage, IV = intravenous, M1 = middle cerebral artery M1 segment, M2 = middle cerebral artery M2 segment, MCA = middle cerebral artery, MRI = magnetic resonance image, mRS = modified Rankin Scale, NCCT = non contrast enhanced CT, NIHSS = National Institutes of Health Stroke Scale, SAH = subarachnoid hemorrhage, TICI = thrombolysis in cerebral infarction, t-PA = tissue-plasminogen activator.

Keywords: angiography, reperfusion, stent, stroke, thrombectomy

1. Introduction
The primary goal of acute ischemic stroke treatment is early recanalization and perfusion recovery of the brain. Since 1996, application of intravenous (IV) alteplase (t-PA) within 4.5 hours from symptom onset has been the first-line treatment for stroke.[1] But, it has limitations with narrow inclusion criteria and a short therapeutic window.[2] Recently reported randomized controlled trials revealed that mechanical thrombectomy is more useful than IV t-PA for recanalization and improves clinical outcomes for patients with acute ischemic strokes.[3-7]

Among the various mechanical thrombectomy techniques, recently the stent retriever thrombectomy has been widely used. These stent retriever thrombectomy techniques were announced by the SWIFT (Solitaire with the Intention for Thrombectomy) trial with the Solitaire Flow Restoration (FR) stent (ev3/Covidien, Irvine, CA) and TREVO 2 (Thrombectomy Revascularization of Large Vessel Occlusions in Acute Ischemic Stroke) trials with the Trevo stent (Stryker Neurovascular, Fremont, CA).[8,9] These retriever stents have significantly higher rates of recanalization and better functional outcomes than non-stent retrievers.[10]

Both the Solitaire and Trevo stent retrievers were cleared by the Food and Drug Administration (FDA) in 2012 for early reperfusion therapy in patients with acute ischemic stroke.[11] These 2 devices have similar designs but slightly different structures and features. The Solitaire stent is a self-expanding stent that offers the unique capability of fully deploying.[12] The Trevo stent is a flexible tapered nitinol core wire with a shaped section at the distal end that integrates the clot into the stent structure and allows the user to retract the device and clot from
2. Methods

2.1. Study population

Institutional review board approval was obtained before starting this retrospective study (IRB No. VC16RIS0220). The authors evaluated data from our institution’s stroke database of patients who performed stent retriever thrombectomy with Solitaire stent or Trevo stent, from October 2014 to September 2017 and identified a total of 200 patients. Patients were divided into 2 groups: mechanical thrombectomy with Solitaire stent (Group 1: Solitaire) and mechanical thrombectomy with Trevo stent (Group 2: Trevo). All of mechanical thrombectomy procedures were performed by 2 neuro-interventionists (A and B) with > 4 years of experience in neuro-intervention. Inclusion criteria were as follows: patients with acute ischemic stroke due to large artery occlusion of the anterior circulation (i.e., internal carotid artery [ICA] or middle cerebral artery [MCA]) confirmed by computed tomography angiography (CTA) or computed tomography perfusion (CTP); neurologic dysfunction; ≤ 8 hours elapsed since stroke onset; and patients who performed mechanical thrombectomy with a retriever stents, such as Solitaire stent and Trevo stent. Exclusion criteria were as follows: the presence of hemorrhage on CT scan; the presence of a large ischemic core, ≤ 6 Alberta Stroke Program Early CT Score (ASPECTS) score; patients with contraindication(s) for contrast-enhanced CT; patients who performed mechanical thrombectomy with non-stent retrieval or other stent retrievers, such as 5 MAX ACE (Penumbra Inc., Alameda, CA), Eric (MicroVention Terumo, Tustin, CA), Revive (Codman Neurovascular, San Jose, CA). In addition, all patients underwent follow-up non-contrast enhanced CT immediately after thrombectomy and CTA at 24 hours after thrombectomy, respectively, to evaluate the hemorrhage.

2.2. Endovascular procedure

Acute ischemic strokes with intracranial large artery occlusion were enrolled. In this study, initiation of intra-arterial treatment had to be possible within 6 to 8 hours after stroke onset for anterior circulation lesions. Eligible patients had an occlusion of the ICA, MCA (M1 or M2) established by CTA or CTP, and a score of ≥ 2 on the National Institutes of Health Stroke Scale (NIHSS; range, 0–42, with higher scores indicating more severe neurologic deficits). Patients who received IV t-PA within 4.5 hours after stroke onset with a maximum dose of 0.9 mg/kg were enrolled in this study. Mechanical thrombectomy involve thrombus retraction with a retrievable stent (Solitaire FR: 4 mm × 20 mm: MCA, 6 mm × 30 mm: ICA, and Trevo XP Provue: 4 mm × 20 mm: MCA, Trevo XP Provue: 6 mm × 25 mm: ICA) according to the neuro-interventionists preference and in some cases an added balloon guiding catheter (BGC: Merci: Concentric Medical Inc., Mountain View, CA).

2.3. Outcomes and complications

Multimodal factors were reviewed, including patient age, sex, underlying disease, obesity (Body mass index: BMI >25), interventionists, location of occluded vessel, IV t-PA, and BGC. All patients underwent clinical assessment with NIHSS score at baseline, after 24 hours, and at 30 days and modified Rankin Scale (mRS) score at 90 days. Good clinical outcomes defined to ≤ 2 at 90 days mRS. Time interval (in minutes) was analyzed by using the following 3 parameters: time from symptom onset to groin puncture, procedure time (from groin puncture to reperfusion time), and time from symptom onset to reperfusion. Radiologic results were evaluated by thrombolysis in cerebral infarction (TICI) score and successful recanalization was defined as a TICI score of 2b to 3. The number of passage was defined that number of stent retrieved times until successful recanalization was achieved. In addition, number of one pass is defined the cases that achievement of successful recanalization with only 1 retriever of stent. The length of thrombus was measured at angiography images and it was defined as the length of the lesion artery not contrasted on the angiography. Safety variables and complications were analyzed regarding progression of ischemic stroke, distal emboli or thrombus, post thrombectomy hemorrhage, and mortality during 90 days. Distal emboli or thrombus were defined as new thrombus or emboli occurred cases in the distal vessel after stent retrieval and post thrombectomy hemorrhage was defined as the occurrence of intracranial hemorrhage (ICH) or subarachnoid hemorrhage (SAH) in the CT scan taken after the procedure. Two neuro-radiologists who were unaware of which stent retrievers were used in each cases evaluated all neuroimaging studies.

2.4. Statistical analysis

All data were analyzed using PASW statics 18 software (South Wacker Drive, Chicago, IL). Chi-square tests were used to analyze differences in multi-variable factors and complications between the 2 groups. Means comparison tests (t tests) was employed to evaluate differences in clinical and radiological variables between the 2 groups. Univariate analysis was used to verify the multiple outcomes: good clinical outcomes and successful recanalization. The covariates with P < .20 in univariate analysis were entered into a backward multivariate logistic regression analysis. Two-tailed P-values of ≤ .05 were considered a significant difference.

3. Results

3.1. Baseline characteristics

A total of 200 patients were enrolled during the study period. Patient ages ranged from 22 to 87 years (113 men, 85 women). Group 1 contained 102 patients (55 men, 47 women; mean age 64.3 years). Group 2 contained 98 patients (60 men, 38 women; mean age 67.9 years). Multi-variable factors such as sex, age, hypertension (HTN), diabetes mellitus (DM), atrial fibrillation (AF), dyslipidemia, obesity, and smoking were not significantly different between groups. A total of 127 patients (63.5%) received IV alteplase (t-PA), and there were no statistically significant differences between groups (P = .272). Two interventionists used 2 stents relatively even, and there was no statistically significant difference between 2 groups (P = .361). The location of occluded vessel as follows: M1 117 (58.5%), M2 16 (8.0%), ICA 67 (33.5%) (Table 1).
### Table 1

**Baseline characteristics.**

|                | Total     | Group 1 (Solitaire) | Group 2 (Trevo) | P-value |
|----------------|-----------|---------------------|----------------|---------|
| Sex (M:F)      | 115:85    | 55:47               | 60:38          | .657    |
| Mean age (IQR) | 66.1 (22–87) | 64.3 (32–87)        | 67.9 (22–87)   | .614    |
| HTN (%)        | 118 (59.0%) | 57 (55.5%)          | 61 (62.2%)     | .257    |
| DM (%)         | 65 (32.5%) | 30 (29.4%)          | 35 (35.7%)     | .393    |
| AF (%)         | 82 (41.0%) | 43 (42.1%)          | 39 (38.2%)     | .585    |
| Dyslipidemia (%)| 105 (52.5%) | 56 (54.3%)          | 49 (50.0%)     | .859    |
| t-PA (%)       | 127 (63.5%) | 68 (66.7%)          | 59 (60.2%)     | .272    |
| Obesity (%)    | 71 (35.5%) | 34 (33.3%)          | 37 (37.7%)     | .367    |
| Smoking (%)    | 72 (36.0%) | 36 (35.2%)          | 36 (36.7%)     | .508    |
| Location       |           |                     |                |         |
| M1 (%)         | 117 (58.5%) | 60 (58.8%)          | 61 (62.2%)     | .052    |
| M2 (%)         | 16 (8.0%) | 8 (7.8%)            | 12 (12.2%)     | .266    |
| ICA (%)        | 67 (33.5%) | 34 (33.3%)          | 25 (25.6%)     | .314    |
| Interventionists (A:B) | 109: 91 | 53: 49             | 56: 42         | .246    |
| BGC (%)        | 136 (68.0%) | 67 (67.6%)          | 69 (70.4%)     | .361    |

ACA = anterior cerebral artery, AF = atrial fibrillation, BGC = balloon guiding catheter, DM = diabetes mellitus, HTN = hypertension, ICA = internal carotid artery, M1 = middle cerebral artery M1 segment, M2 = middle cerebral artery M2 segment, t-PA = tissue-plasminogen activator.

3.2. **Outcomes and time intervals**

Mean initial NIHSS scores in groups 1 and 2 were 11.3 and 11.7, respectively. NIHSS scores at 24 hours were 7.8 for group 1 and 7.1 for group 2, and mean NIHSS score at 30 days for group 1 was 6.2 compared with 5.4 for group 2 without statistically significant difference (P = .440, P = .52). The mRS at 90 days was slightly lower in group 2 (2.9) than group 1 (3.2), but there was no statistical significance (P = .144). In terms of time intervals, procedure time (from groin puncture to reperfusion time) was shorter in group 2 (51 minutes) than group 1 (70 minutes) with statistically significance (P = .009). But, there were no statistically significant differences in other time interval factors such as from onset to groin puncture and onset to reperfusion (P = .289, P = .122). In terms of radiologic outcomes, the mean number of stent passage of group 2 (2.1) was significantly lower, compared with group 1 (2.9) (P = .014) and there were more one pass cases in group 2 (40.8%) than group 1 (28.4%) with statistically significance (P = .030). In addition, group 2 (89.7%) revealed higher successful revascularization (TICI scores ≥2b or 3), compared with group 1 (82.3%) with statically significance (P = .018). The difference of thrombus length between the 2 groups had no statistically significance (P = .347) (Table 2).

### Table 2

**Clinical and radiologic outcomes.**

|                | Total       | Group 1 (Solitaire) | Group 2 (Trevo) | P-value |
|----------------|-------------|---------------------|----------------|---------|
| Initial NIHSS score (IQR) | 11.5 (2–18) | 11.3 (2–18) | 11.7 (4–18) | .868 |
| NIHSS score at 24 hours (IQR) | 7.5 (0–20) | 7.8 (1–20) | 7.1 (0–17) | .440 |
| NIHSS score at 30 days (IQR) | 5.8 (0–19) | 6.2 (0–17) | 5.4 (0–17) | .052 |
| mRS at 90 days (IQR) | 3.0 (0–6) | 3.2 (0–6) | 2.9 (0–6) | .101 |
| Good mRS (%) | 81 (60.9%) | 43 (42.1%) | 48 (48.9%) | .144 |
| Time from onset to groin puncture: min (IQR) | 222 (72–412) | 218 (72–407) | 226 (76–412) | .269 |
| Procedure time: min (IQR) | 61 (27–169) | 70 (27–160) | 51 (30–165) | .009 |
| Time from onset to reperfusion: min (IQR) | 283 (122–469) | 288 (122–469) | 277 (128–452) | .122 |
| Number of passes (IQR) | 2.5 (1–8) | 2.9 (1–8) | 2.1 (1–6) | .014 |
| Number of one pass (%) | 69 (34.8%) | 29 (32.0%) | 40 (40.8%) | .030 |
| Thrombus length: mm (IQR) | 19.6 (5–56) | 19.2 (5–52) | 20.1 (6–56) | .347 |
| TICI score (%) |            |                     |                |         |
| 0 | 3 (1.5%) | 2 (1.9%) | 1 (1.0%) | .511 |
| 1 | 6 (3.0%) | 4 (3.9%) | 2 (2.0%) | .402 |
| 2a | 19 (9.5%) | 12 (11.7%) | 7 (7.1%) | .413 |
| 2b | 45 (22.5%) | 22 (21.5%) | 23 (23.4%) | .611 |
| 3 | 127 (63.5%) | 62 (60.7%) | 65 (66.3%) | .149 |
| TICI score of 2b or 3 on final angiography (%) | 172 (86.0%) | 84 (82.3%) | 88 (89.7%) | .018 |

Good mRS = 0 days mRS ≤2; mRS = modified Rankin Scale, which ranges from 0 to 6, with 0 indicating no symptoms, 1 indicating no clinically significant disability, 2 indicating slight disability, 3 indicating moderate disability, 4 indicating moderately severe disability, 5 indicating severe disability, and 6 indicating death; NIHSS = National Institutes of Health Stroke Scale (NIHSS), which ranges from 0 to 42, with higher scores indicating more severe neurologic deficits; TICI = thrombolysis in cerebral infarction scores of 2b or 3 indicate successful reperfusion.

*Statistically significant.

†P-values were calculated using Chi-square tests, mean comparison tests (t-tests).
3.3. Safety variables and complications

The occurrence rate of ischemic stroke progression and distal emboli had no statistically significant differences between the 2 groups \((P = .198, P = .241)\). In addition, there were no statistically significant differences in post thrombectomy hemorrhage \((P = .928)\) and mortality \((P = .960)\) \(\ast\) between the 2 groups (Table 3).

3.4. Predictors of good clinical outcomes and successful recanalization

Univariate logistic regression analysis of data identified 3 factors as predictors of good clinical outcomes \((90 \text{ days mRS} \leq 2)\): younger age \((P < .001)\), less time interval from symptom onset to groin puncture \((P = .018)\), and TICI score of 2b or 3 on final angiography \((P < .001)\). In multivariate logistic regression analysis, less time interval from symptom onset to groin puncture \((\text{odds ratio [OR]} 0.97 [95\% \text{ confidence interval (CI)} 0.952–0.997], P = .04)\) and higher rate of successful recanalization \((\text{OR} 1.07 [95\% \text{ CI} 1.050–1.090], P = .03)\) were correlated with good clinical outcomes (Table 4). And univariate logistic regression analysis of data shows that 2 factors were the predictors of successful recanalization \((\text{TICI scores}=2b \text{ or } 3)\) such as use of the Trevo stent \((P = .02)\), less number of stent passage \((P = .02)\).

4. Discussion

In acute ischemic stroke, early arterial recanalization is a very important factor for favorable clinical outcomes and low mortality.\[^{[15]}\] Among the various methods for recanalization, mechanical thrombectomy with stent retriever is widely used and this technique improves recanalization rates and reduces peri-procedural complications.\[^{[16]}\] But, there are few direct comparison studies of the 2 widely used stents, the Solitaire and the Trevo, one small series and a systematic review with a meta-analysis have been published previously.\[^{[12,14,17]}\] And they reported that there was no significant difference in recanalization rates or functional outcome between the 2 stents. So, the purpose of this study was to directly compare clinical and radiologic outcomes.

### Table 3

| Safety variables and complications. | Total | Group 1 (Solitaire) | Group 2 (Trevo) | \(P\)-value* |
|-----------------------------------|------|---------------------|----------------|-------------|
| Progression of ischemic stroke (%) | 20 (10.0\%) | 12 (11.7\%) | 8 (8.1\%) | .198 |
| Distal embolus or thrombus (%)     | 18 (9.0\%)  | 11 (10.7\%) | 7 (7.1\%)  | .241 |
| Post thrombectomy hemorrhage (%)  | 11 (5.5\%)  | 6 (5.9\%)  | 5 (5.1\%)  | .201 |
| Mortality (%)                     | 11 (5.5\%)  | 7 (6.8\%)  | 4 (4.0\%)  | .570 |

TICI: thrombolysis in cerebral infarction (TICI) scores of 2b or 3 indicate successful reperfusion.

*Statistically significant.

\(P\)-values were calculated using Chi-square tests.

### Table 4

| Factors for predicting good clinical outcomes. | Univariate analysis | Multivariate analysis |
|---------------------------------------------|---------------------|----------------------|
|                                             | OR (95\% CI) \(P\)-value | OR (95\% CI) \(P\)-value |
| Sex                                         | 0.96 (0.494–1.968) \(.98\) | 0.96 (0.494–1.968) \(.98\) |
| Mean age                                    | 0.92 (0.880–0.960) \(<.001^*\) | 0.96 (0.494–1.968) \(.98\) |
| HTN                                         | 2.55 (0.969–6.781) \(.08\) | 1.06 (0.560–2.207) \(.86\) |
| DM                                          | 2.04 (0.896–4.552) \(.09\) | 0.96 (0.469–1.978) \(.90\) |
| AF                                          | 1.92 (0.906–4.142) \(.09\) | 0.86 (0.410–1.832) \(.72\) |
| Dyslipidemia                                | 0.44 (0.226–0.928) \(.03^*\) | 0.44 (0.226–0.928) \(.03^*\) |
| Obesity                                     | 1.12 (0.430–2.938) \(.82\) | 1.12 (0.430–2.938) \(.82\) |
| Smoking                                     | 0.96 (0.469–1.978) \(.90\) | 0.96 (0.469–1.978) \(.90\) |
| Interventionists                            | 0.66 (0.440–0.880) \(.72\) | 0.66 (0.440–0.880) \(.72\) |
| BGC                                         | 1.06 (0.506–2.207) \(.86\) | 1.06 (0.506–2.207) \(.86\) |
| Stent type                                  | 0.43 (0.312–0.548) \(.02\) | 0.43 (0.312–0.548) \(.02\) |
| Time from onset to groin puncture           | 0.95 (0.942–0.958) \(.018^*\) | 0.95 (0.942–0.958) \(.018^*\) |
| Procedure time                              | 1.14 (0.508–2.208) \(.008\) | 1.14 (0.508–2.208) \(.008\) |
| Time from onset to reperfusion              | 0.94 (0.691–1.039) \(.32\) | 0.94 (0.691–1.039) \(.32\) |
| Number of passes                            | 1.06 (0.836–1.424) \(.54\) | 1.06 (0.836–1.424) \(.54\) |
| Thrombus length                             | 1.07 (1.017–1.157) \(.32\) | 1.07 (1.017–1.157) \(.32\) |
| TICI score of 2b or 3 on final angiography  | 1.06 (1.020–1.100) \(<.001^*\) | 1.06 (1.020–1.100) \(<.001^*\) |

AF = atrial fibrillation, BGC = balloon guiding catheter, DM = diabetes mellitus, HTN = hypertension, mRS = modified Rankin Scale, which ranges from 0 to 6, with 0 indicating no symptoms, 1 indicating no clinically significant disability, 2 indicating slight disability, 3 indicating moderate disability, 4 indicating moderately severe disability, 5 indicating severe disability, and 6 indicating death. NIHSS = National Institutes of Health Stroke Scale (NIHSS), which ranges from 0 to 42, with higher scores indicating more severe neurologic deficits. TICI = thrombolysis in cerebral infarction (TICI) scores of 2b or 3 indicate successful reperfusion, t-PA = tissue-plasminogen activator.

Good clinical outcomes: 90 days mRS \(\leq 2\).

\(^{*}\) \(P\)-values were calculated using univariate logistic regression analysis and multivariate logistic regression analysis.
reperfusion, t-PA works similar. But, the Trevo stent are distinguished from known to have similar radial forces at similar stent sizes and production materials and methods, these 2 types of stents are easy delivery to the target vessel. Although these different of

|                | OR (95% CI) | P-value |                | OR (95% CI) | P-value |
|----------------|------------|---------|----------------|------------|---------|
| Sex            | 0.92 (0.529–1.722) | .81     |                |            |         |
| Mean age       | 0.99 (0.966–1.006)  | .17     |                |            |         |
| HTN            | 0.76 (0.326–1.855)  | .57     |                |            |         |
| DM             | 0.94 (0.436–1.894)  | .91     |                |            |         |
| AF             | 1.09 (0.582–2.031)  | .78     |                |            |         |
| Dyslipidemia   | 1.55 (0.807–3.046)  | .18     |                |            |         |
| h-PA           | 1.33 (0.713–2.430)  | .309    |                |            |         |
| Obesity        | 0.58 (0.297–1.046)  | .09     |                |            |         |
| Smoking        | 1.10 (0.536–2.124)  | .82     |                |            |         |
| Interventionists | 0.62 (0.342–0.898)  | .77     |                |            |         |
| BGC            | 1.08 (0.563–2.054)  | .81     |                |            |         |
| Stent type     | 1.25 (1.050–1.450)  | .02*    |                | 1.40 (1.250–1.550) | .028* |
| Initial NIHSS score | 0.86 (0.840–0.89) | .18  |                |            |         |
| Time from onset to groin puncture | 0.94 (0.896–1.031) | .27 |                |            |         |
| Procedure time | 1.06 (0.506–2.037)  | .88     |                |            |         |
| Time from onset to reperfusion | 0.93 (0.892–1.016) | .17 |                |            |         |
| Number of passes | 0.68 (0.504–0.856) | .02* |                | 0.66 (0.512–0.866) | .002* |
| Thrombus length | 1.08 (1.015–1.159) | .32     |                |            |         |

AF = atrial fibrillation, BGC = balloon guiding catheter, DM = diabetes mellitus, HTN = hypertension, mRS = modified Rankin Scale, which ranges from 0 to 6, with 0 indicating no symptoms, 1 indicating no clinically significant disability, 2 indicating slight disability, 3 indicating moderate disability, 4 indicating moderately severe disability, 5 indicating severe disability, and 6 indicating death, NIHSS = National Institutes of Health Stroke Scale (NIHSS), which ranges from 0 to 42, with higher scores indicating more severe neurologic deficits, TICI = thrombolysis in cerebral infarction scores of 2b or 3 indicate successful recanalization, t-PA = tissue-plasminogen activator.

* P-values were calculated using univariate logistic regression analysis and multivariate logistic regression analysis.

multiple time intervals, and safety variables of 2 widely used stent retriever devices (Solitaire, Trevo).

The authors divided patients into 2 groups based on stent retriever, group 1 (Solitaire stent) and group 2 (Trevo stent), and compared multiple factors. In terms of clinical outcomes, there was no significant difference Trevo stent group and Solitaire stent group in our study. But, Trevo stent group achieved higher rate of successful recanalization than Solitaire stent group and multivariate analysis revealed that the use of Trevo stent was a significant predicting factor for successful recanalization. In addition, the Trevo stent group showed less number of stent passages, more one pass cases and shorter procedure time than Solitaire stent group. These findings mean that Trevo stent group achieved more successful recanalization with more effective procedure than Solitaire stent group. When the authors compared the safety variables and complications, there was no statistically significant difference in complication rate between the 2 groups. This indicates that the Trevo stent achieved more favorable radiologic outcomes without the increasing complications.

The general mechanism of neuro-stent retrievers and mechanical thrombectomy is a self-expandable stent that interacts and entangles with a blood clot, and both stent and clot can be removed from cerebral vessels to restore blood flow. The Solitaire Flow Restoration device is a self-expandable stent retriever that is deployed within a target clot of the cerebral vessel occlusion site to entrap the clot. The stent is then retrieved, and the entrapped thrombus is concurrently extracted. The Trevo stent is composed of a flexible tapered nitinol core wire with a distal tip shaped for thrombus retrieval. This distal tip is attenuated for easy delivery to the target vessel. Although these different of production materials and methods, these 2 types of stents are known to have similar radial forces at similar stent sizes and works similar. But, the Trevo stent are distinguished from Solitaire stents by the distal tip of Trevo stent contains a platinum wire and marker with radiopaque characteristics on fluoroscopy because of this characteristic, the Trevo stent enable visualization of the whole device with clot integration, unlike the Solitaire stent (Fig. 1). This unique feature of Trevo stent enables interventionalists to see the entire stent, confirm its optimal location and adequate vessel wall apposition of stent when deploying the stent. Probably, these optimal location and adequate wall apposition of Trevo stent enable more effective clot retrieval. So, higher successful recanalization rate of Trevo stent could be achieved with shorter procedure time by more one pass cases and less number of stent retrieval, in our study.

Subjectively, the authors feel that the Trevo stent navigates vessels smoother than the Solitaire stent. The high flexibility of Trevo enables easy stent navigation to more distal MCA branches. In addition, its tapered distal tip reduces possible vessel wall damage when the stent is deployed and withdrawn. In contrast, the Solitaire stent has a more rigid stent strut, so the Solitaire stent is more difficult to navigate within vessels. These characteristics can also be assumed to have affected the outcome of our study.

The successful recanalization rate of the Solitaire stent group in this study was higher (82.3%), comparable to previously announced results with a 69% recanalization rate in the SWIFT trial. And the 89.7% successful recanalization rate of the Trevo stent group in our study was superior to the 86% rate of the previously reported TREVO 2 trial. Even in our study, successful recanalization was defined as TICI score of 2b or 3, in contrast to the previously published SWIFT trial and TREVO 2 trial, which defined successful recanalization as 2 or 3. In addition, the SWIFT-PRIME trial and EXTEND-IA trial with Solitaire stents achieved high successful recanalization rates of 88% and 86%, respectively, using the same definition of successful recanalization with our study as TICI score 2b or 3. These successful recanalization rates of SWIFT-PRIME trial and EXTEND-IA trial are superior to our Solitaire stent.
group but inferior to Trevo stent group of our study. In terms of complication, previously published animal studies demonstrate that there was no difference in vessel wall damage between the Solitaire stent and the Trevo stent.\[18\] This result was also found in our study, there was no statistically significant difference in the rate of post thrombectomy hemorrhage caused by vessel injury between the 2 groups.

The major limitations of this study are its relatively small sample size, as the sample was taken from a single center, and the retrospective non-blinded nature of this study. Device selection was not randomized, and stent was selected according to the neuro-interventionists preference, in each case. But, all interventionists used 2 types of stents relatively evenly and the baseline characteristics of the groups were well balanced and there were no statistically significant differences. A learning curve may have affected the results, but mechanical thrombectomy at our institution is performed by 2 neuro-interventionists with >3 years of experience and the difference of mean procedure time in 2 groups was just 4 minutes, although there was no statistically significance. Other potential unmeasured confounding variables were not controlled for, although every effort was made to adjust for the possibility of spurious results. Despite these limitations, we have demonstrated that the Trevo stent shows good clinical and radiological outcomes than the Solitaire stent.

5. Conclusion

This study presents the first single-center study comparing the Solitaire device with the Trevo device. Our study demonstrated that the Trevo stent achieved higher successful recanalization rate with shorter procedure time by less number of stent passages and more one pass cases than the solitaire stent. Additional multi-institutional studies and randomized controlled studies should be performed to verify these findings.

Acknowledgment

The authors acknowledge that the material is not published previously and would like to thank the Department of Radiology of St Vincent’s Hospital, The Catholic University of Korea, Suwon, Korea.

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