Dwell Time of Stentriever Influences Complete Revascularization and First-Pass TICI 3 Revascularization in Acute Large Vessel Occlusive Stroke

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■ OBJECTIVE: **In acute ischemic stroke with large vessel occlusion, the interaction between the clot retriever and the stent is critical for achieving successful recanalization. The ideal time of stent deployment (dwell time [DT]) to improve revascularization is currently unknown. We systematically analyzed the effect of different DT on final angiographic and clinical outcomes of patients who underwent mechanical thrombectomy.**

■ METHODS: **The DT was progressively increased from 3 minutes to 5 minutes and then 8 minutes during the study period. The effect of DT on recanalization attempts, successful angiographic outcome (thrombolysis in cerebral ischemia [TICI] 2b or TICI 3), total revascularization time, and immediate and 3-month clinical outcomes were evaluated. The DT of 3 minutes and 5 minutes (DT3-5) was compared against DT of 8 minutes (DT8).**

■ RESULTS: **Forty patients were included in the analysis. Good angiographic outcome was observed in 94.1% of patients in the DT8 cohort with an average attempt of 1.2 compared with 78.3% with average attempts of 2.0 in other group. Single-pass good recanalization (TICI 2b or 3) and single-pass complete revascularization (TICI3) was significantly higher in the DT group compared with the DT3-5 group (82.4% vs. 43.5% [$P = 0.013$] and 42.9% vs. 8.7% [$P = 0.003$], respectively). A favorable trend toward a reduced overall procedural time (34.59 vs. 55.59 minutes) was observed, but was not statistically significant ($P = 0.15$).**

■ CONCLUSIONS: **Mild prolongation of DT to 8 minutes improves revascularization outcome with fewer attempts, possibly because of better clot–stent interaction.**

INTRODUCTION

Endovascular mechanical thrombectomy has become the standard of care for the management of acute ischemic stroke with large vessel occlusion.[1-6] The treatment paradigm is focused on effective and early clot removal, and the approaches vary from standard stentriever technique to a direct aspiration approach using flexible, large-bore catheters (a direct aspiration using first pass technique [ADAPT]), or a combination of these techniques. Although the successful revascularization defined as thrombolysis in cerebral ischemia (TICI) score 2b or 3 is achieved in more than two thirds to three fourths of the patients with large-vessel occlusive stroke, multiple attempts using several additional devices may be needed to attain this result.[7-9] These additional attempts increase the procedural time and could also increase the risk of thromboembolism or other complications during the procedure.

For mechanical thrombectomy using a stentriever, the clot–stent interaction is an important factor determining the successful revascularization. Once the stentriever is deployed, a variable clot migration occurs into the expanding stent lumen, and the entangled clot mass could be removed later after temporary deployment.[10] With current imaging techniques, it is difficult to assess the clot–stent interaction, although an indirect indication

Key words
- Acute large vessel stroke
- Dwell time
- Revascularization
- Stentriever

Abbreviations and Acronyms
ADAPT: A direct aspiration using first pass technique
ASPECTS: Alberta Stroke Program Early CT Score
CTA: Computed tomography angiography
DT: Dwell time
mRS: modified Rankin score
NIHSS: National Institutes of Health Stroke Scale
TICI: Thrombolysis in cerebral ischemia

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of the extent of clot engagement could be gleaned from angiographic signs of loss of early reperfusion.[11] A completely integrated clot could be removed en masse without clot dislodgement, achieving a complete revascularization (TICI3) in the first attempt itself. Hypothetically, clot migration and integration improve with stentriever dwell time (DT), which could potentially improve the revascularization outcome with fewer attempts and lower distal thrombus migration. However, this approach raises the concern of prolongation of overall procedure time, thus delaying the revascularization or may eventually render patients ineligible for further intervention if the procedure extends beyond the window period. The DT for the stentriever is highly variable among the interventionists, and varies widely between 1 and 5 minutes. However, the ideal DT for the stentriever in mechanical thrombectomy is not known, and the effect of DT on revascularization has not been studied systematically in a clinical setting. In this study, we evaluated the influence of DT in achieving successful recanalization of acute large-vessel stroke. We hypothesized that mild prolongation of DT could influence the overall successful recanalization and the extent of complete revascularization (TICI3) without a significant effect on time to recanalization.

MATERIALS AND METHODS

Endovascular Technique

All patients with acute ischemic stroke and referred to the comprehensive stroke care center from December 2014 through November 2016 were included in this retrospective analysis. Patients were considered for mechanical thrombectomy if their clinical presentation was within 6 hours of onset of stroke and Alberta Stroke Program Early CT Score (ASPECTS) score was favorable ($\geq$6) and a large vessel occlusion was demonstrated on computed tomography angiography (CTA) or magnetic resonance angiography. Computed tomography (CT) and CTA was the investigation of choice for acute ischemic stroke decision making; however, magnetic resonance imaging was done for patients with posterior circulation strokes, suspected stroke mimics, and wake-up stroke. Intravenous recombinant tissue plasminogen activator was initiated if the ictus was less than 4.5 hours, at the discretion of the attending neurologist. Cervical internal carotid artery occlusions and posterior circulation strokes were excluded from the analysis. The study was conducted after obtaining institutional ethics committee approval.

Endovascular interventions were usually performed with local anesthesia, and general anesthesia was reserved only for uncooperative, obtunded, or comatose patients. The interventions were performed by 2 operators (J.E.R. and S.K.K.) with 3 and 7 years' experience, respectively, with neurointerventional procedures. The operators received training in flow models before starting the program. Right femoral arterial access was obtained, and systemic heparinization was achieved to maintain activated clotting time values above 200 seconds. After confirming the level of occlusion, an 8-French balloon-tipped guide catheter was placed in the proximal cervical internal carotid artery beyond the carotid bulb. The occluded arterial segment was crossed using a Traxcess micro-guidewire (Microvention, Alisoviejo, California, USA) and a Rebar 18 or 27 microcatheter (Medtronics, Covidien, Irvin, California, USA), and the intraluminal position was confirmed by a microcatheter angiogram. Following this, a Solitaire FR stent (Medtronics/Covidien, Irvin, California, USA) was deployed in the occluded segment for clot entrapment. Solitaire stent (6 $\times$ 30 mm) was the preferred stent in most instances; however, other stents such as 4 $\times$ 20 mm, 5 $\times$ 30 mm, and 5 $\times$ 40 mm were also used when the former stent was unavailable. During the initial part of the study, the stent was deployed for 3 minutes; this was later increased to 5 minutes. However, later in the study period, the DT of the stent was further increased to 8 minutes to improve the clot capture efficiency. Sequential increment of DT was based partly on the conviction that the stent–clot interaction improved with time and partly from the experience of successful revascularization on prolongation of DT in situations where multiple retrieval attempts had failed. Because improvement in recanalization was noted with a mild increase in DT by 2 minutes, a similar increment was adopted after failed DT of 5 minutes, and the DT was arbitrarily set at 8 minutes. A slight increase in DT might not increase the overall procedural time; however, it will also facilitate a study of the effect of DT on revascularization. The stent-microcatheter assembly was removed after achieving temporary flow arrest and capturing the stent transitional zone. The guide catheter was aspirated vigorously with a 50-mL syringe during this process. A check angiogram was obtained to assess the degree of recanalization. If the opening was suboptimal, additional attempts were made until the recanalization was achieved or a window period had elapsed. At the end of the procedure, the arterial sheath was removed using a closure device (Perclose; Abbot Vascular, Chicago, Illinois, USA) or by manual compression.

The following definitions were adopted: *good angiographic outcome* was defined as restoration of TICI 2b or 3 score; *time to revascularization* was defined as the time from securing arterial access till achievement of TICI successful revascularization or abandonment of the procedure; DT was defined as the duration of temporary deployment of stentriever for revascularization. The final angiographic outcome (TICI score) was reported by an independent neuroradiologist blinded to the interventional procedure.

Statistical Analysis

Associations of DT with demographic clinical variables and outcome and performance indicators, such as time to recanalization, number of attempts, and immediate angiographic outcomes were studied using univariate and multivariate analysis. DT of 3 minutes and 5 minutes were grouped into a single category (DT3-5) and compared against DT of 8 minutes (DT8). Student t test (2-sided) for continuous variables and Fisher exact test for categorical binary variables were done to assess statistical significance. A P value less than 0.05 was considered significant. All the analyses were performed using IBM SPSS Statistics for Windows version 21 (IBM, Armonk, New York, USA).

RESULTS

A total of 40 patients (mean age, 56.85 $\pm$ 12.4 years; 65% male) satisfying the inclusion criteria was available for the final analysis. Mean age, sex distribution, and baseline National Institutes of Health Stroke Scale (NIHSS) score were not statistically significant