Relationship between Flow Restoration/Re-occlusion and Recanalization during Deployment of Stent Retriever

Jouji Kokuzawa, Tetsuya Yamada, Kiyomitsu Kanou, Naoki Oka, and Yasuhiko Kaku

Objective: There has been no detailed study reporting the relationship between flow restoration (FR)/re-occlusion status and recanalization results during the acute thrombectomy using stent retrievers. In this study, we examined the influence of FR/re-occlusion during stent deployment on recanalization in our experiences.

Subjects and Methods: In all, 24 patients with cardiogenic cerebral embolism underwent thrombectomy with a TREVO stent retriever (10 males, 14 females, mean age: 77.2 years). Intravenous tissue plasminogen activator (tPA) infusion was preceded in 17 of 24 patients, occlusion sites were as follows: internal carotid artery, 9 patients; M1 of middle cerebral artery, 13 patients; and basilar artery, 2 patients. We investigated the relationship between the presence or absence of FR/re-occlusion and grade of recanalization thrombolysis in cerebral infarction (TICI). We also examined the interval from FR until re-occlusion and frequency of stent deployment.

Results: In the first session of stent deployment, FR and subsequent re-occlusion were observed in 11 patients (11/24, 46%). Of these, TICI 2b or higher grade recanalization was achieved in nine patients (9/11, 81%). Of 10 patients who had FR but no re-occlusion in the first session of stent deployment (10/24, 42%), TICI 2b or higher scale recanalization was achieved in 4 (4/10, 40%). In three patients without FR (3/24, 13%), TICI 2b or higher scale recanalization was not achieved. Of the above 11 patients who showed FR and subsequent re-occlusion in the first session of stent deployment, the waiting time until re-occlusion was 5 minutes in seven patients and 10 minutes in four patients. Of the 10 patients who had FR but no re-occlusion, the waiting time was 5 minutes in four patients, 10 minutes in four patients, and 20 minutes in two patients. In 9 of the 24 patients, several sessions of stent deployment were required, and the total frequency of stent deployment was 37 times. In 37 sessions of stent deployment showed the achievement of FR and re-occlusion in 17 sessions (17/37, 46%). Of these, TICI 2b or higher scale recanalization was achieved in 14 (14/17, 82%). Of 12 sessions with FR but no re-occlusion (12/37, 32%), TICI 2b or higher scale recanalization was achieved in 5 (5/12, 41%). TICI 2b or higher scale recanalization was not achieved in eight sessions without FR (8/37, 22%).

Conclusion: Flow restoration immediately after stent deployment was a necessary condition for recanalization. If re-occlusion is confirmed after FR, satisfactory recanalization may be achieved at a high percentage. The results demonstrated that satisfactory recanalization was not achieved without FR, and less likely without re-occlusion following FR.

Keywords ▶ mechanical thrombectomy, flow restoration, re-occlusion, stent retriever, acute ischemic stroke

Introduction

Stent-type devices for thrombectomy have improved the recanalization rate for relatively large cerebral vessels, such as the internal carotid artery and horizontal part of the middle cerebral artery, contributing to marked advances in the treatment of acute occlusion of the main cerebral arteries. Although several randomized controlled trials (RCTs)1–5 have demonstrated the effectiveness of these devices, the satisfactory reperfusion is not always
undemanding even with a same device. Generally, stent retriever is withdrawn when it is embedded within thrombus and the re-occlusion is occurred after the transient flow restoration (FR) of the target vessel. However, management may be sometimes difficult when FR is absent or when FR does not lead to re-occlusion. Besides, there is no consensus regarding the observational time from FR to re-occlusion. In this study, we retrospectively examined the influence of the FR and re-occlusion status on recanalization results in acute thrombectomy using Trevo stent retrievers.

Subjects and Methods

Subjects

We retrospectively reviewed the clinical and radiographic data of the patients with acute major cerebral artery occlusion due to cardiogenic embolism, who underwent mechanical thrombectomy with TREVO ProVue/XP (Stryker, Fremont, CA, USA) between October 2014 and April 2017. We retrospectively reviewed the clinical and radiographic data of the patients with acute major cerebral artery occlusion due to cardiogenic embolism, who underwent mechanical thrombectomy with TREVO ProVue/XP between October 2014 and April 2017.

Mechanical thrombectomy

Under local anesthesia, a 9 Fr guiding balloon catheter was introduced into the internal carotid or vertebral arteries. A microcatheter was guided distal to the thrombus. After confirming peripheral blood flow and the position of thrombus, a stent was deployed at a position where the thrombus was completely covered. Immediately after the stent deployment, angiography was performed to confirm FR. Angiography was then conducted every 5 minutes to confirm subsequent re-occlusion. When the re-occlusion was observed, the stent was withdrawn, aspirating the blood through the balloon guiding catheter with the balloon inflated. When re-occlusion following FR was absent, stent withdrawal was conducted after waiting for 20 minutes at maximum. When recanalization was not achieved, a stent was additionally deployed up to 3 times. Another thrombectomy device was used in some cases in accordance with the patient status or lesion state.

For statistical analysis, Fisher’s exact test (Excel Statistics; Microsoft Corporation, Redmond, WA, USA) was used. A p value of 0.05 was regarded as significant.

## Results

In all, 24 patients consisted of 10 males and 14 females, with a mean age of 77.2 years (33–88 years). Intravenous tissue plasminogen activator (tPA) infusion was preceded in 17 of 24 patients, occlusion sites were as follows: internal carotid artery, 9 patients; M1 of middle cerebral artery, 13 patients; and basilar artery, 2 patients. The mean frequency of stent deployment was 1.54 ± 0.8 times. In nine patients (9/24, 38%), several stent deployments were conducted. The frequency of stent deployment was twice in six patients, 3 times in two patients, and 4 times in one patient. Overall, 37 sessions of stent deployment were conducted. On the first stent deployment, TICI 2b or higher scale recanalization was achieved in 13 patients (54%). Finally, it was achieved in 19 patients (79%) (Table 1).

The first session of stent deployment resulted in both FR and re-occlusion in 11 patients (11/24, 46%). Of these, TICI 2b or higher scale recanalization was achieved in nine patients (9/11, 81%). Of 10 patients who had FR but no re-occlusion in the first stent deployment (10/24, 42%), TICI 2b or higher scale recanalization was achieved in four patients (4/10, 40%). In three patients without FR in the first stent deployment (3/24, 13%), TICI 2b or higher scale recanalization was not achieved (Fig. 1).

Of the above 11 patients who showed FR and subsequent re-occlusion in the first session of stent deployment, the waiting time until re-occlusion was 5 minutes in seven patients and 10 minutes in four patients. Of the 10 patients who had FR but no re-occlusion, the waiting time was 5 minutes in four patients, 10 minutes in four patients, and 20 minutes in two patients. Of the three patients who did not show FR in the first session of stent deployment, the
With respect to the frequency of stent deployment, of a total of 37 sessions, FR was observed in 29 (29/37, 78%). Of these, re-occlusion following FR was obtained in 17 (17/29, 59%). Of the 17 sessions with FR and re-occlusion, TICI 2b or higher scale recanalization was achieved in 14 (14/17, 82%). On the other hand, of 12 sessions (12/29, 41%) with FR alone in the absence of re-occlusion, TICI 2b or higher recanalization was achieved in five patients (5/12, 41%). TICI 2b or higher scale recanalization was not achieved in eight sessions without FR (8/37, 22%). There were significant differences in the recanalization rate among these three groups (Fig. 2).

**Discussion**

Several large-scale RCTs demonstrated the efficacy of thrombectomy with a stent-type device for acute major cerebral artery occlusion in 2015. Stent-type devices for thrombectomy facilitate prompt, accurate, and safe re-canalization; therefore, they may be primarily applied for acute recanalization therapy. However, these devices have waiting time was 5 minutes in two patients and 10 minutes in one patient 1.

Of two patients in whom effective recanalization was not achieved despite FR and subsequent re-occlusion on the first session of stent deployment, a total of three sessions of stent deployment led to TICI 2b or higher scale recanalization in one patient, whereas satisfactory recanalization was not achieved in the other patient. Of six patients in whom effective recanalization was not achieved in the absence of re-occlusion following FR on the first session of stent deployment, the second session of stent deployment led to TICI 2b or higher scale recanalization in four patients (three patients: FR (+), re-occlusion (+); one patient: FR (+), re-occlusion (−)). In the other two patients, another thrombectomy device was used. Of three patients without FR in the first session of stent deployment, the second session of stent deployment resulted in TICI 3 recanalization through FR and re-occlusion in one patient, whereas neither FR nor effective recanalization was achieved despite several sessions of stent deployment in the other two patients (Fig. 1).

![Flow chart of the treatments in 24 patients with mechanical reperfusion therapy.](image-url)
several limitations: based on the RCT results, the TICI 2b or higher scale recanalization rate was 58.7–88%.1–4) The recanalization rate in the first session of stent deployment was approximately 30%–50%,6,7) and several sessions of stent deployment were required in many cases. Therefore, prompt evaluation of the demanding situation is mandatory, which can lead to other challenges such as re-deployment and/or adaptation of other devices.

When FR was achieved in stent deployment, followed by re-occlusion, satisfactory recanalization could be achieved in a high rate of patients. When FR is absent, it is difficult to select waiting or stent retrieval/re-deployment. Besides, the second strategy must be selected in cases with FR but no re-occlusion.

This study showed that, when FR was not achieved immediately after stent deployment, effective recanalization was not achieved even after stent retrieval. Factors for the absence of FR include stent maldeployment at a segment distal to the thrombus, atherothrombotic occlusion, thrombus properties,8–10) and insufficient stent deployment. Furthermore, additional distal thrombus or vascular collapse due to disturbance of microcirculation may result in the absence of FR. With closed-cell-type stent retrievers, the push and fluff technique is recommended, in which the stent is deployed pressing against the vascular wall. With the push and fluff technique, the recanalization rate after the first stent deployment was 54% and the mean frequency of stent deployment was 1.3r wall, is adopted. The absence of FR includes stent tent retrieval/1.0 times, respectively.7) It is also reported that the stent deployment method improved the recanalization rate.11) Although the recanalization rate could be influenced by thrombus properties or peripheral blood flow, sufficient dilatation of a stent may be more important. If FR is not achieved after stent deployment, the stent should be promptly re-deployed, or other strategy must be considered.

Okawa et al.12) reported that re-occlusion following FR significantly influenced the recanalization rate and prognosis. In their study, TICI 2b or higher scale recanalization was achieved in 82% in the presence of re-occlusion and in 41% in its absence among 29 sessions showing FR. This suggests that FR and re-occlusion are important for effective recanalization.

As for the waiting time until re-occlusion following FR, waiting for 5 minutes after stent deployment is commonly adopted, but a study indicated that the waiting time should be prolonged.12) An optimal waiting time remains to be determined. In this study, re-occlusion following FR was noted after 5 minutes in approximately 60% and after 10 minutes in 40%. In contrast, there was no patient with re-occlusion after ≥10 minute following FR. 10-minute waiting, thus, may be appropriate for the confirmation of re-occlusion.

**Conclusion**

Flow restoration immediately after stent deployment was a necessary condition for recanalization. If re-occlusion was confirmed after FR, satisfactory recanalization may be achieved at a high percentage. The results demonstrated that recanalization was not achieved in the absence of FR, and that the recanalization rate was low when re-occlusion was absent within 10 minutes after FR.

**Disclosure Statement**

There is no conflict of interest regarding this article for the main author and coauthors.

**References**


