Safety and Effectiveness of a Modified ASAP Technique during Mechanical Thrombectomy for Acute Ischemic Stroke: Initial Clinical Experience

Abstract

Objectives: For patients with acute ischemic stroke, various endovascular approaches have been reported with high recanalization rates and good clinical outcomes. However, the best technique for the first attempt at mechanical thrombectomy remains a matter of debate. In this study, we evaluated the efficacy of a modified version of a stent-retrieving into an aspiration catheter with a proximal balloon (ASAP) technique. Materials and Methods: Modification 1: After stent deployment, the microcatheter was not removed immediately. Modification 2: After the withdrawal of the stent retriever into an aspirator and its removal from the entire system, we focused on the drainage of fluid into a pump. The aspirator was withdrawn slowly until the fluid appeared to be draining continuously into the pump. Before the removal of the aspirator, we performed angiography through the aspirator. We carried out a retrospective analysis of 30 consecutive patients with acute ischemic stroke caused by occlusion of the anterior circulation who were treated with the modified ASAP technique at our institution. Results: A thrombolysis in cerebral infarction score of 2B or 3 was achieved in 29/30 patients (96.7%). The average number of passes was 1.2 ± 0.5. The mean time from puncture to recanalization was 17.6 ± 6.84 min. Twenty-three (76.7%) patients achieved a modified Rankin Scale score of 0-2 at 3 months after the procedure. Conclusions: We found that the modified ASAP technique yielded fast recanalization, minimal complications, and good clinical outcomes of mechanical thrombectomy in this case series.

Keywords: Combined technique, endovascular thrombectomy, stent clot retriever

Introduction

Mechanical thrombectomy is a widely used treatment in patients with acute ischemic stroke. Recently, several companies have launched aspiration catheters and stent clot retrievers of various sizes and characteristics. The fact that many combinations of these devices and various techniques can be used,[1-9] may generate confusion among operators. Furthermore, which technique is better suited for a quick approach using a single device or a secure recanalization using multiple devices remains a controversial issue.

We used a stent-retrieving into an aspiration catheter with proximal balloon (ASAP) technique as the first-line approach to manage patients with acute ischemic stroke caused by occlusion of the anterior circulation.[9,10] Through an accumulation of procedures, the ASAP technique has been improved gradually based on the launching of new devices and the gleaning new knowledge from both clinical and experimental data. Here, we report the modified ASAP technique that is used currently at our institution. And our clinical results were compared with results that had been reported using various techniques.

Materials and Methods

Patients

Patients with acute ischemic stroke were examined at admission to our institution using the National Institutes of Health Stroke Scale (NIHSS). Patients with an NIHSS score ≥4 were treatable by mechanical thrombectomy, and computed tomography (CT) and magnetic resonance imaging were immediately performed. Mechanical thrombectomy was performed in cases in which the presence of internal

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carotid artery (ICA) or middle cerebral artery (MCA) occlusion was confirmed by magnetic resonance angiography and intracranial hemorrhage was ruled out by CT. Patients who were treated with mechanical thrombectomy at our institution between May 2019 and April 2020 were included in the study. We performed a retrospective analysis of 30 consecutive cases with acute ischemic stroke caused by occlusion of the anterior circulation who were treated with the modified ASAP technique at our institution. Informed consent was obtained after a certified neuroendovascular physician explained the content of treatment and study to each patient or his/her family. This study was approved by the ethics review board of our hospital (Application No.: 2020-083).

The preoperative patient characteristics, including age, sex, thrombus location, Alberta stroke program early CT score with diffusion-weighted magnetic resonance imaging (ASPECTS-DWI),[12] NIHSS score, and time from onset to puncture, as well as the postoperative thrombolysis in cerebral infarction (TICI) score,[13] the number of passes necessary to achieve recanalization, time from puncture to recanalization, procedural complications (including embolization to the new territories and asymptomatic subarachnoid hemorrhage), and clinical outcome, were assessed. Successful recanalization was defined as TICI score of 2B or 3 and good clinical outcome was defined as a modified Rankin Scale (mRS) score of 0–2 at 3 months after the thrombectomy.

Protocol of the modified ASAP technique

All procedures were performed under local anesthesia via femoral puncture. A 9-F balloon-attached guiding catheter was advanced into the proximal ICA of the affected side using a coaxial 5-F inner catheter. After an angiographic study, a 0.027-inch microcatheter with a 0.014-inch microguidewire was advanced through a large caliber aspiration catheter (≥0.068-inch) in a triaxial fashion. In cases of distal MCA occlusion, we used a 0.021-inch microcatheter. The tip of the microcatheter was shaped as a tiny pigtail; alternatively, a preshaped type was used.[14-16]

The advancement of the aspirator was stopped at the infra-clinoid portion of the ICA. The proximal balloon was inflated before passage through the thrombus using the microwire, to prevent distal migration of the thrombus. Simultaneous angiography through both the microcatheter and the aspirator was performed, to document the exact position of the thrombus. After the deployment of a stent retriever, the microcatheter was not removed, which was in contrast with the original method of the ASAP technique (Modification 1) [Figure 1a]. Continuous aspiration was initiated via the aspirator via connection to a mechanical pump. The aspirator was advanced up to a position just proximal of the thrombus, to accomplish contact aspiration, while the deployed stent was used as an anchor. In cases with a second division of the MCA (M2), the aspirator was kept at the first division of the MCA (M1). The stent and microcatheter were withdrawn into the aspirator and completely removed from the entire system. Subsequently, the aspirator was withdrawn until the fluid appeared to be continuously draining into the pump. This constituted Modification 2 [Figure 1b]. Rather than removing the aspirator from the guiding catheter, we performed angiography through the aspirator. If there was no residual clot, the balloon of the guiding catheter was deflated. Cone-beam CT was performed before the guiding catheter was pulled out.

Simple experimental evaluations

We evaluated the differences in the speed with which the mechanical pump (Penumbra Inc., Alameda, CA, USA) aspirated water [Figure 2A]. First, the microcatheter was positioned to deploy the stent. After the stent deployment, the microcatheter was withdrawn until the tail of the microcatheter reached the same location as the tail of the stent delivery wire. The microcatheter was then removed from the entire system, and the stent was removed from the aspiration catheter. Using the indicator attached to the mechanical pump [Figure 2B], we also evaluated the pressure at the tip of the aspirator with microcatheters of various sizes and without the microcatheter: The 0.068-inch aspiration catheter alone, the 0.0165-inch microcatheter inside the aspirator, the 0.021-inch microcatheter inside the aspirator, and 0.027-inch microcatheter inside the aspirator.
Results

A summary of the cases is provided in Table 1. The average age of the patients was 75.1 ± 10.1 (range, 43–91) years. Seventeen out of the 30 participants were male (56.7%). The mean ASPECTS-DWI was 7.3 ± 2.0 (range, 2–10). The mean NIHSS score was 14.7 ± 6.4 (range, 5–29). The mean time from stroke onset to puncture was 122.7 ± 37.8 (range, 60–210) min, except for two cases with unknown stroke onset. A TICI score of 2B or 3 was achieved in 29/30 patients (96.7%). The average number of passes was 1.2 ± 0.5 (range, 1–3). The mean time from puncture to recanalization was 17.6 ± 6.84 (range, 9–39) min. One patient (3.3%) developed minor subarachnoid hemorrhage postoperatively. Seventeen patients (56.6%) achieved an mRS score of 0–1, whereas 23 patients (76.7%) achieved an mRS score of 0–2 at 3 months after the thrombectomy. The results of the simple experimental evaluations are illustrated in Figure 3. When the microcatheter was removed from the entire system, aspiration became dramatically faster. The pressure at the tip of the aspirator was not affected by the presence or absence of the microcatheter.

Discussion

Rationale of the modifications

Modification 1

In the original ASAP technique, the microcatheter was fully removed from the entire system after the deployment of the stent. This step was based on a simple experiment that evaluated the difference in the time required to aspirate water into the aspirator [Figure 3A]. Therefore, we considered that the removal of the microcatheter increased the flow velocity from the aspirator. However, we assumed that the contact aspiration affected the degree of pressure at the tip of the aspirator, rather than the velocity of the aspiration. We evaluated this pressure in various situations.

| n         | 30 |
|-----------|----|
| Age, years (range) | 75.1±10.1 (43-91) |
| Location   |    |
| Internal carotid artery | 7 (23.3) |
| Carotid T       | 3  |
| Proximal M1    | 12 (40)  |
| Distal M1      | 3 (10)   |
| M2            | 8 (26.7)  |
| Tissue plasminogen activator | 16 (53.3)  |
| ASPECTS-DWI (range) | 7.3±2.0 (2-10)  |
| NIHSS score (range) | 14.7±6.4 (5-29)  |
| Time from onset to puncture, minute (range) | 122.7±37.8 (60-210)* |
| Time from puncture to recanalization, minute (range) | 17.6±6.84 (9-39)  |
| Number of passes |    |
| 1            | 25 (83.3) |
| 2            | 4 (13.3)   |
| 3 or more    | 1 (3.3)    |
| Thrombolysis in Cerebral Infarction score |    |
| 0-2A         | 1 (3.3)    |
| 2B           | 7 (23.3)   |
| 3            | 22 (73.3)  |
| Embolization to the new territory | 0 (0) |
| Intracranial hemorrhage | 1 (3.3) |
| Modified Rankin Scale score |    |
| 0-1          | 17 (56.6)  |
| 0-2          | 23 (76.7)  |
| 3-6          | 7 (23.3)   |

*Except one of unknown onset. M1 - First division of middle cerebral artery; M2 - Second division of middle cerebral artery; ASPECTS-DWI - Alberta Stroke Program Early CT Score with Diffusion-Weighted magnetic resonance Image; NIHSS - National Institute of Health Stroke Scale; CT - Computed tomography

Table 1: Summary of the patients treated with modified aspiration catheter with a proximal balloon technique in our institution
compared with the continuous aspiration prior to intracranial aspects of the use of the modified ASAP technique for quick re-access. This is one of the most advantageous
were no significant differences between the presence or absence of the microcatheter inside the aspirator.

The results are shown in Figure 3B. The pressure at the tip of the aspirator was not affected by the presence or absence of the microcatheter. Moreover, when the microcatheter was covered with the proximal marker of the deployed stent, the stent could be retrieved easily into the aspirator. The microcatheter worked to decrease the deflections of the flexible aspirator.

**Modification 2**

In the original ASAP technique, just after the stent and microcatheter were completely removed from the entire system, the aspirator was also withdrawn and completely removed from the guiding catheter out of the body.\(^5\) We stopped the withdrawal of the aspirator until the fluid appeared to be continuously draining into the pump [Figure 1b]. In almost all cases, continuous draining was confirmed when the tip of the aspirator came back in the ICA, because of release from a wedge and/or a vasospasm. At that position, we performed angiography via the aspirator. In cases of unsuccessful recanalization or the presence of a residual clot, we thought that the second approach was able to perform quickly via the remaining aspiration catheter. We used the remaining aspirator as a distal access catheter, for quick re-access. This is one of the most advantageous aspects of the use of the modified ASAP technique compared with the continuous aspiration prior to intracranial vascular embolectomy (CAPTIVE),\(^6\) stent retriever assisted vacuum-locked extraction (SAVE),\(^7\) and aspiration-retriever technique for stroke (ARTS)\(^8\) methods, in which both the stent retriever and the aspirator are retrieved as a unit.

**Comparison with other methods**

There is no clear consensus regarding which technique is more effective for the first-line attempt at mechanical thrombectomy. The representative techniques of mechanical thrombectomy that have been reported are summarized in Table 2. Our modified ASAP technique yielded the best results regarding the number of passes, the embolization to the new territory, the symptomatic intracranial hemorrhage, and the mRS score at 3 months after the procedure.

The simple stent-retrieving method has been widely used after a meta-analysis of five trials demonstrated its benefits.\(^9\) However, the simple stent-retrieving methods have some limitations, such as intracranial hemorrhage caused by the vessel shift phenomenon. Conversely, some reports have recommended a direct aspiration first pass technique (ADAPT)\(^5\) for the first attempt. However, Delgado Almazán et al.\(^4\) reported that ADAPT was unsuccessful in approximately one-third of patients who required salvage. Moreover, it was often challenging to navigate the currently available large-caliber aspirators quickly into the distal cerebral arteries.

Several combination techniques using both an aspiration catheter and a stent retriever have been reported. The so-called Solumbra techniques represent a method in which there is no contact between the tip of the aspirator and the thrombus.\(^4,5\) Conversely, the CAPTIVE,\(^6\) SAVE,\(^7\) ARTS,\(^8\) and ASAP\(^9\) techniques are used for contact aspiration. In our modified ASAP technique, we suggest that the large caliber aspiration catheter played an important role in the highly successful recanalization rate. The deployed stent retriever works as a strong anchor during the navigation of the large-caliber aspirator. Therefore, using our technique, even the large bore aspirators could be navigated more smoothly than the ADAPT. All seven cases in whom a REACT 71 aspiration catheter (Medtronic, Irvine, CA, USA) was used in our series exhibited 1-pass recanalization with an average 12.1 ± 1.8 (range, 9–15) min from puncture to recanalization.

**Limitations**

The present study had significant limitations, including the small initial experience population, the retrospective and nonrandomized nature of the analysis, the absence of a control group, and the involvement of a single institution. Self-adjudicated results were also a limitation of our study. Therefore, the efficacy of the modified ASAP technique may have been overestimated. Nonetheless, regardless of the lack of statistical power, we believe that this case study will be of great interest to many physicians and patients.
Table 2: Summary of the results of the reported representative literatures

| References                  | Year | Microcontact | Withdrawing angiography | Time from puncture to recanalization in cerebral territory (minutes) | Number of patients | Time from puncture to recanalization score 2B and 3 (%) | Intracranial hemorrhage (%) months | Rankin/Sex to the new territory 4.2 (for 22 weeks) or after 3 months | Intracranial hemorrhage (%) | Symptomatic intracranial hemorrhage (%) | Aspiration catheter | Stent-retriever | Aspiration catheter | Stent-retriever assisted vacuum-locked extraction | ARTS | BGC |
|-----------------------------|------|--------------|--------------------------|-------------------------------------------------------------------|-------------------|--------------------------------------------------------|-----------------------------------|------------------------------------------------------------------------|----------------------|--------------------------------------------|------------------|----------------|------------------|---------------------------------------------|-----|-----|
| [1] Goyal M, Demchuk AM, Menon BK, Eesa M, Rempel JL, Thornton J, et al. | 2015 | Solumbra     | Remove                   | 105                                                               | 165               | Step by step                                           | 3.3 (1)                           | 17.6                                                                 | 85.2                 | 33 (21)                     | Asp + SR (ADAPT) | Asp + SR (Solumbra) | Asp + SR + BGC (ARTS) | Asp + SR + BGC (ASAP) | Remove |
| [2] Mueller-Kronast NH, Zaidat OO, Froehler MT, Jahan R, Aziz-Sultan MA, Klucznik RP, et al. | 2017 | Solumbra     | Remove                   | 105                                                               | 165               | Step by step                                           | 3.3 (1)                           | 17.6                                                                 | 85.2                 | 33 (21)                     | Asp + SR (ADAPT) | Asp + SR (Solumbra) | Asp + SR + BGC (ARTS) | Asp + SR + BGC (ASAP) | Remove |
| [3] Turk AS, Frei D, Fiorella D, Mocco J, Baxter B, Siddiqui A, et al. | 2016 | Solumbra     | Remove                   | 105                                                               | 165               | Step by step                                           | 3.3 (1)                           | 17.6                                                                 | 85.2                 | 33 (21)                     | Asp + SR (ADAPT) | Asp + SR (Solumbra) | Asp + SR + BGC (ARTS) | Asp + SR + BGC (ASAP) | Remove |
| [4] Delgado Almendoz JE, Kayan Y, Young ML, Fease JL, Scholz JM, Milner AM, et al. | 2014 | Solumbra     | Remove                   | 105                                                               | 165               | Step by step                                           | 3.3 (1)                           | 17.6                                                                 | 85.2                 | 33 (21)                     | Asp + SR (ADAPT) | Asp + SR (Solumbra) | Asp + SR + BGC (ARTS) | Asp + SR + BGC (ASAP) | Remove |
| [5] Humphries W, Hoit D, Doss VT, Elijovich L, Frei D, Loe D, et al. | 2015 | Solumbra     | Remove                   | 105                                                               | 165               | Step by step                                           | 3.3 (1)                           | 17.6                                                                 | 85.2                 | 33 (21)                     | Asp + SR (ADAPT) | Asp + SR (Solumbra) | Asp + SR + BGC (ARTS) | Asp + SR + BGC (ASAP) | Remove |
| [6] McTaggart RA, Tung EL, Yaghi S, Cutting SM, Hemendinger M, Gale HI, et al. | 2016 | Solumbra     | Remove                   | 105                                                               | 165               | Step by step                                           | 3.3 (1)                           | 17.6                                                                 | 85.2                 | 33 (21)                     | Asp + SR (ADAPT) | Asp + SR (Solumbra) | Asp + SR + BGC (ARTS) | Asp + SR + BGC (ASAP) | Remove |
| [7] Maus V, Behme D, Kabbasch C, Borggrefe J, Tsogkas I, Nishizawa T, et al. | 2017 | Solumbra     | Remove                   | 105                                                               | 165               | Step by step                                           | 3.3 (1)                           | 17.6                                                                 | 85.2                 | 33 (21)                     | Asp + SR (ADAPT) | Asp + SR (Solumbra) | Asp + SR + BGC (ARTS) | Asp + SR + BGC (ASAP) | Remove |
| [8] Massari F, Henninger N, Loy D, et al. | 2018 | Solumbra     | Remove                   | 105                                                               | 165               | Step by step                                           | 3.3 (1)                           | 17.6                                                                 | 85.2                 | 33 (21)                     | Asp + SR (ADAPT) | Asp + SR (Solumbra) | Asp + SR + BGC (ARTS) | Asp + SR + BGC (ASAP) | Remove |

Conclusions

The findings of this study support the hypothesis that the modified ASAP technique provides faster recanalization, fewer complications, and better clinical outcomes compared with other techniques. A further large-scale study is necessary to evaluate the efficacy of this preliminary study.

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Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Goyal M, Demchuk AM, Menon BK, Eesa M, Rempel JL, Thornton J, et al. Randomized assessment of rapid endovascular treatment of ischemic stroke. N Engl J Med 2015;372:1019-30.
2. Mueller-Kronast NH, Zaidat OO, Froehler MT, Jahan R, Aziz-Sultan MA, Klucznik RP, et al. Systematic evaluation of patients treated with neurothrombectomy devices for acute ischemic stroke: Primary results of the STRATIS registry. Stroke 2017;48:2760-8.
3. Turk AS, Frei D, Fiorella D, Mocco J, Baxter B, Siddiqui A, et al. ADAPT FAST study: A direct aspiration first pass technique for acute stroke thrombectomy. J Neurointerv Surg 2014;6:260-4.
4. Delgado Almendoz JE, Kayan Y, Young ML, Fease JL, Scholz JM, Milner AM, et al. Comparison of clinical outcomes in patients with acute ischemic stroke treated with mechanical thrombectomy using either Solumbra or ADAPT techniques. J Neurointerv Surg 2016;8:1123-8.
5. Humphries W, Hoit D, Doss VT, Elijovich L, Frei D, Loy D, et al. Distal aspiration with retrievable stent assisted thrombectomy for the treatment of acute ischemic stroke. J Neurointerv Surg 2015;7:90-4.
6. McTaggart RA, Tung EL, Yaghi S, Cutting SM, Hemendinger M, Gale HI, et al. Continuous aspiration prior to intracranial vascular embolectomy (CAPTIVE): A technique which improves outcome. J NeuroInterv Surg 2016;9:1-6.
7. Maus V, Behme D, Kabbasch C, Borggrefe J, Tsogkas I, Nishizawa T, et al. Maximizing first-pass complete reperfusion with SAVE. Clin Neuroradiol 2018;28:327-38.
8. Massari F, Henninger N, Lozano JD, Patel A, Kuhn AL, Howk M, et al. ARTS (aspiration-retriever technique for stroke): Initial clinical experience. Interv Neuroradiol 2016;22:325-32.
9. Goto S, Ohshima T, Ishikawa K, Yamamoto T, Shimato S, Nishizawa T, et al. A stent-retrieving into an aspiration catheter with proximal balloon (ASAP) technique: A technique of mechanical thrombectomy. World Neurosurg 2018;109: e468-e475.
10. Ohshima T, Niwa A, Kawaguchi R, Matsuo N, Miyachi S. Novel technique for detection of actual position of clot during endovascular clot retrieval: Assessment of microcatheter withdrawing angiography. World Neurosurg 2020;137:229-34.
11. Lyden PD, Lu M, Levine SR, Brodt TG, Broderick J, NINDS rtPA Stroke Study Group. A modified National Institutes of Health Stroke Scale for use in stroke clinical trials: Preliminary reliability and validity. Stroke 2001;32:1310-7.
12. Hirai T, Sasaki M, Maeda M, Ida M, Katsuragawa S, Sakoh M, et al. Diffusion-weighted imaging in ischemic stroke: Effect of display method on observers’ diagnostic performance. Acad Radiol 2009;16:305-12.
13. Higashida R, Furlan A, Roberts H, Tomsick T, Connors B, Barr J, et al. Trial design and reporting standards for intraarterial cerebral thrombolysis for acute ischemic stroke. J Vasc Interv Radiol 2003;14:S493-4.

14. Sato M, Ohshima T, Ishikawa K, Goto S, Yamamoto T, Izumi T, et al. A novel technique of safe and versatile microguidewire shaping with neuroendovascular therapy: Modified pigtail method. J Neuroendovasc Ther 2017;11:266-71.

15. Ohshima T, Ishikawa K, Goto S, Yamamoto T. Relationship between clot quality and microguidewire configuration during endovascular thrombectomy for acute ischemic stroke. World Neurosurg 2017;107:657-62.

16. Ohshima T, Kawaguchi R, Maejima R, Yukiue N, Matsuo N, Miyachi S. Initial clinical experience of using a newly designed preshaped microguidewire in acute endovascular thrombectomy. Asian J Neurosurg 2020;15:241-4.

17. Goyal M, Menon BK, van Zwam WH, Dippel DW, Mitchell PJ, Demchuk AM, et al. Endovascular thrombectomy after large-vessel ischaemic stroke: A meta-analysis of individual patient data from five randomized trials. Lancet 2016;387:1723-31.