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Case Report

Sylvian Hematoma Removal after the Stent-Retriever Thrombectomy Accompanied by Arteriole Avulsion: Case Report

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Objective: We describe an instructive case of post-thrombectomy subarachnoid hemorrhage (PTSAH) by sylvian hematoma removal.

Case Presentations: An 83-year-old female presented with an acute cardiogenic right M1 occlusion. After the thrombectomy with combined stent retriever and aspiration technique with total five passes, TICI 2b reperfusion was achieved; however, CT imaging displayed subarachnoid hematoma (SAH) along the right sylvian fissure. Throughout the approach, contrast extravasation was not confirmed. The SAH grew up to become the sylvian hematoma; therefore, removal of the sylvian hematoma was conducted. An abrupt arteriole tear around the distal M2 of parietal artery was confirmed as bleeding point and those teared arteriole's stumps were electrically coagulated not to re-bleed.

Conclusion: We suggest that the PTSAH is possible even in invisible-extravasation cases and the sylvian hematoma removal is effective to elucidate the etiology of the PTSAH, and is a reliable method to prevent the re-bleeding and is anticipated to improve the prognosis. Craniotomy is required for medically resistant PTSAH after thrombectomy, and avulsion of the pial artery can be the cause.

Keywords▶ arteriole avulsion, invisible extravasation, post-thrombectomy subarachnoid hemorrhage, stent retriever, mechanical thrombectomy, sylvian hematoma removal

Introduction

Post-thrombectomy subarachnoid hemorrhage (PTSAH) has been reported as 9.4%–16.4% of incidence, and all of them are exclusively in stent-retriever thrombectomy, not in thrombus aspiration technique.[1–3] Vessel dissection, perforation, and avulsion of arteriolar branches are speculated as the etiology of PTSAH; however, the literature describing about the bleeding point proved by the microsurgical finding is still rare. Using only figures, some authors reported cases of PTSAH with small pseudoaneurysms on the injured small arteries, focusing solely to the etiology of subarachnoid hemorrhage.[4,5] Displaying the operative video, however, we present the bleeding point from arteriole by avulsion in stent-retriever thrombectomy, additionally demonstrating the microsurgical vasospasm protective manipulations of sylvian hematoma removal which might improve 3 months later prognosis.

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Case Presentation

An 83-year-old female suddenly suffered a consciousness deterioration and left hemiparesis, then was taken to our hospital in an ambulance. The altered level of consciousness was stupor and the National Institute of Health Stroke Scale (NIHSS) was 21 points. On MRI, diffusion-weighted imaging (DWI) demonstrated slight hyper-intensity areas (HIAs) only in the right posterior rim of internal capsule and posterior corona radiata, corresponding to the lateral lenticulostriate artery area (**Fig. 1a**). DWI-Alberta Stroke

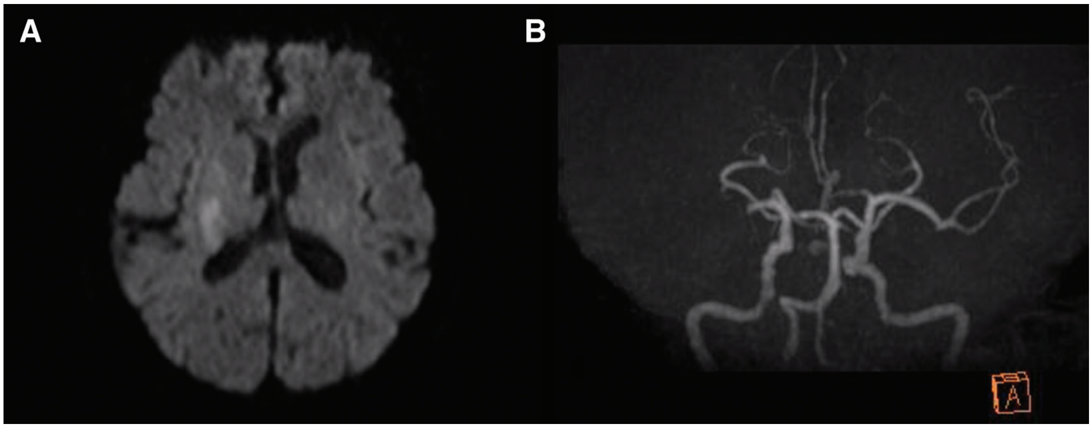

Fig. 1 (**A**) On MRI, DWI demonstrated slight HIAs only in the right posterior rim of internal capsule and posterior corona radiata, corresponding to lateral lenticulostriate artery area. (**B**) The MRA showed the occlusion at the right proximal MCA; therefore, endovascular thrombectomy was planned. DWI: diffusion-weighted imaging; HIAs: hyper-intensity areas; MCA: middle cerebral artery

Program Early CT Score (DWI-ASPECT) was 9 points. The MRA showed the occlusion at right proximal middle cerebral artery (MCA); therefore, endovascular thrombectomy was planned (**Fig. 1b**).

Endovascular treatment

Immediately after the administration of recombinant tissue plasminogen activator (t-PA) (0.6 mg/kg), she was transferred into the Angio-suite. The right femoral artery was punctured under local anesthesia at an Onset to Puncture of 128 minutes and Door to Puncture of 75 minutes. A 25 cm long catheter introducer (Medikit, Tokyo, Japan) was inserted into the right femoral artery; thereafter, the systemic heparinization was performed by intravenous injection of Heparin 3000 unit. As balloon guiding catheter (BGC), a 9Fr Cello balloon catheter (Fuji Systems, Tokyo, Japan) was directed to the right internal carotid artery (ICA) up to high cervical portion, using a Radifocus Guidewire 0.035 inch 180cm (Terumo, Tokyo, Japan) and a 6Fr Countdown JB2 catheter 125 cm (Medikit). Initial angiography demonstrated right proximal M1 occlusion (**Fig. 2a**). Then, the thrombectomy with combined stent retriever and aspiration technique was carried out. Through the BGC, a 6Fr Sophia flow plus 125 cm (Microvention, Aliso Viejo, CA, USA), as an aspiration inner catheter, was advanced up to right proximal M1. Using a CHIKAI 0.014 inch 200 cm (Asahi Intecc, Aichi, Japan) as a microguidewire, a Marksman microcatheter (Medtronic, Minneapolis, MI, USA) was guided through the thrombosed segment to the M2 portion, confirmed by angiography through the microcatheter. A stent retriever, Trevo XP ProVue 4.0–20 mm, was deployed from proximal M2 to proximal M1. Under the proximal balloon ICA occlusion with a BGC and aspiration condition from a Sophia flow plus, the deployed stent retriever was pulled back and captured by orifice of a Sophia flow plus, then stent retriever and aspiration inner catheter were pulled out together from the BGC. After the first pass, red thrombus entangled in the stent was confirmed and contrast opacified length of M1 was extended; nevertheless, reperfusion of whole M1 was not achieved. The second pass resulted in extension of the opacified M1 and the reperfusion of anterior temporal artery, originated from the distal M1 portion. Eventually, after the third pass using the same stent retriever, reperfusion of whole M1 segment and M2 inferior trunk area was achieved. Additionally, M2 superior trunk and central artery were recanalized; however, a thick branch of parietal artery running from M2 superior trunk was still occluded (**Fig. 2b** and **2c**). This occluded artery was voluminous, so it represented a wide area of perfusion, thereby the additional M2 thrombectomy was conducted. Using a CHIKAI 0.014 inch 200 cm as a microguidewire, a Marksman microcatheter was advanced over it through the thrombosed segment to the distal portion of M2. The angiography through the microcatheter placed at the distal M2 portion showed the recanalization of whole M2 length; however, distal to the M3 proximal segment, the parietal artery, was still occluded, as a result of the distal migration of thrombus during the cannulation of the Marksman microcatheter (**Fig. 3a**). Nearby the central sulcus as an eloquent area, avascular area was detected without leptomeningeal collateral blood flow on the angiography; therefore, thrombectomy was decided to be tried. A marksman microcatheter was advanced up more distally and a smaller stent retriever, Trevo XP ProVue 3.0–20 mm, was deployed from M3 to

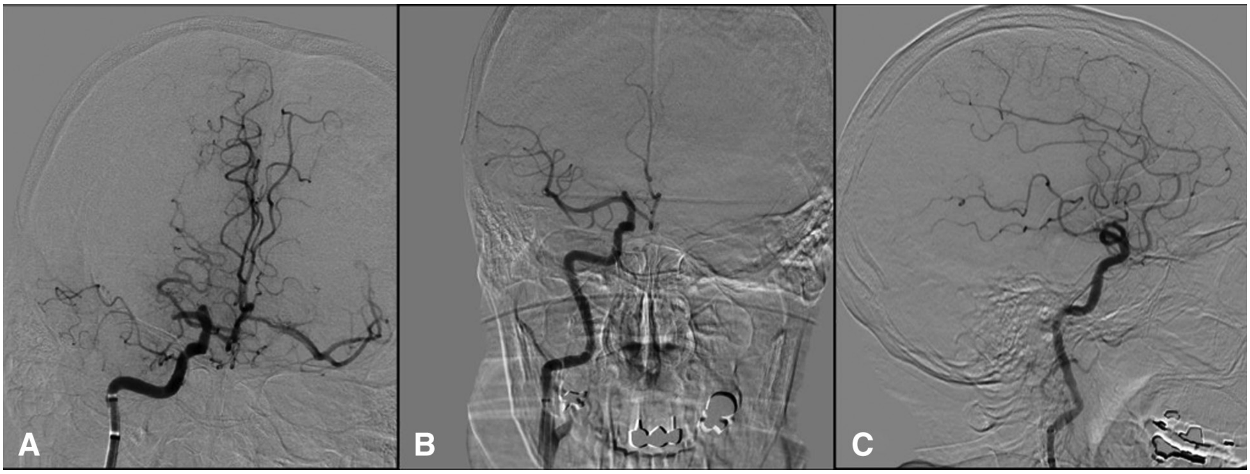

Fig. 2 (**A**) Initial angiography demonstrated the right proximal M1 occlusion. (**B**) Eventually, after the third pass, reperfusion of whole M1 segment and M2 inferior trunk area was achieved. (**C**) M2 superior trunk and central artery were recanalized; however, thick branch of parietal artery running from M2 superior trunk was still occluded.

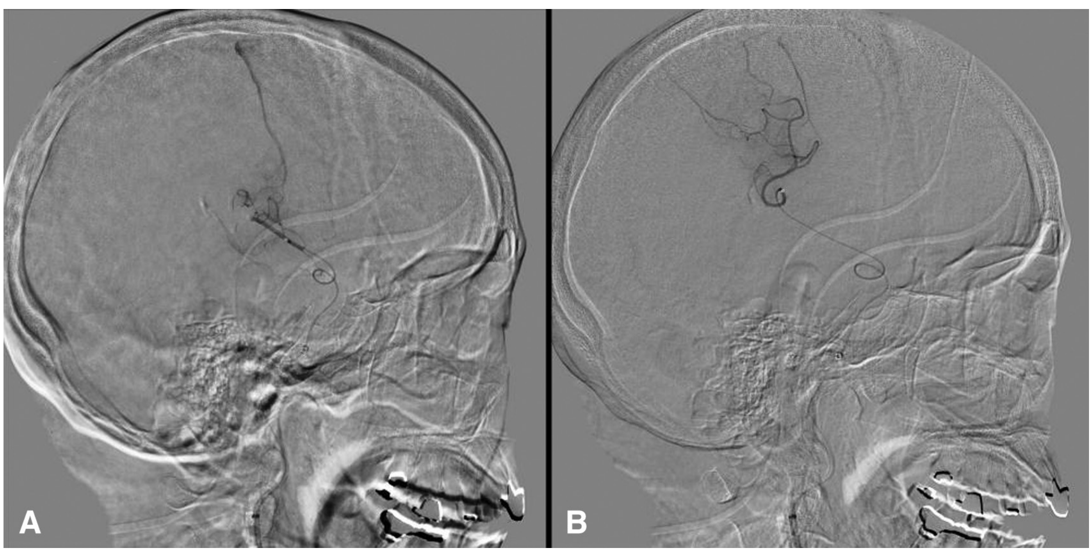

Fig. 3 (**A**) The angiography through the microcatheter placed at distal M2 portion showed the recanalization of whole M2 length; however, distal from M3 of the parietal artery was still occluded, resulted from distal migration of thrombus. (**B**) During the cannulation by microcatheter, using a 0.014 inch 200 cm microwire was stuck at M3 strong looping site and the operator felt moderate resistance.

proximal M2. During the cannulation of Marksman microcatheter using a CHIKAI 0.014 inch 200 cm, microguidewire was stuck at a M3 strong looping site and the operator felt moderate resistance (**Fig. 3b**). The wire's deviation is expected to be showed as the possible cause of arterioles' avulsion; however, due to the single-plane use of angio-machine (bi-plane machine was employed by cardiologist for another treatment), anterior–posterior view as another view was not recorded, unfortunately. Two different times of the procedure were performed with the stent retriever, despite this, reperfusion was not achieved. Then, the procedure was finished. Three passes from proximal M2 to M1 and two passes from M3 to M2, totally five passes of combined stent retriever (Trevo) and aspiration (Sofia) technique were carried out. Throughout the approach, contrast extravasation was not confirmed. The puncture to recanalization TICI 2b time was 69 minutes.

Post-thrombectomy course

Immediate post-thrombectomy MRI-DWI, on 4 hours later after onset, showed no spreading of HIAs, even so, computed tomography (CT) imaging displayed subarachnoid hematoma (SAH) along the right sylvian fissure (**Fig. 4a**). The consciousness level had overcome stupor so that spontaneous

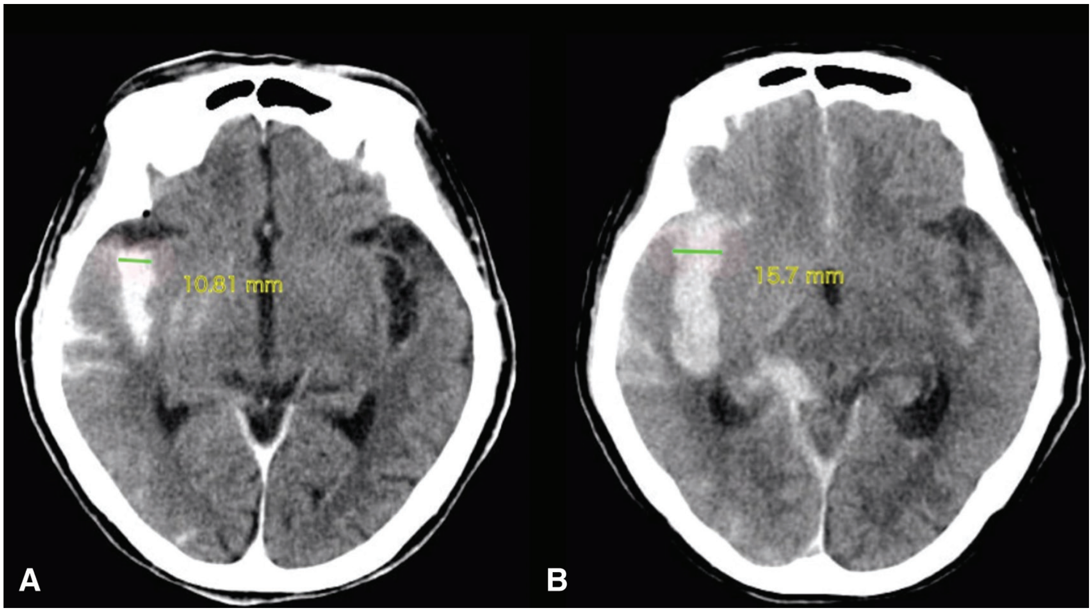

Fig. 4 (**A**) CT imaging displayed SAH along the right sylvian fissure. The CTILS is 10.8 mm. (**B**) The growth of SAH, which became the sylvian hematoma, was detected with computed tomography, on 14 hours later from postoperative first CT imaging. The CTILS is 15.7 mm. CT: computed tomography; CTILS: clot thickness in the inferior limiting sulcus; SAH: subarachnoid hematoma

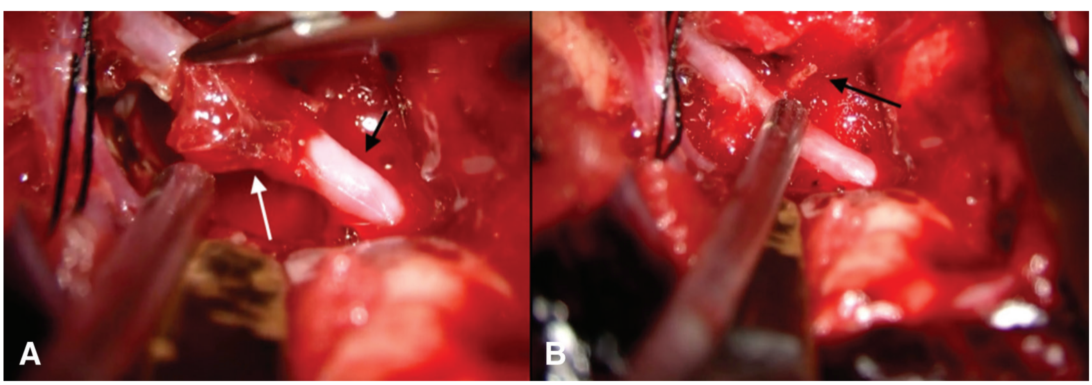

Fig. 5 (**A**) At the posterior rim of sylvian fissure, parietal artery (black arrow) from M2 superior trunk was exposed and solid hematoma (white arrow) fixed to the vessel wall was confirmed. (**B**) As this hematoma was disentangled, an abrupt arteriole (black arrow) which was considered as the bleeding point caused by avulsion was appeared.

eye opening was possible, and no detectable bleeding point estimated by the presence of extravasation, which led us to observe the CT imaging exhaustively. Due to the occurrence of the SAH, embolus preventing anticoagulant therapy had to be refrained. After14 hours from postoperative first CT imaging, however, the growth of the SAH, something that became the sylvian hematoma, was detected with CT imaging (**Fig. 4b**). CT angiography demonstrated the whole recanalization of the occluded parietal artery: pseudoaneurysm, presence of dissection, and contrast extravasations were not detected. The patient's consciousness level deteriorated to semi-coma; therefore, removal of the sylvian hematoma, which led to determine the bleeding etiology, was planned immediately.

Sylvian hematoma removal (Video)

(The video is available online.)

17 hours later from the administration of t-PA, removal of the sylvian hematoma started. After right extended fronto-to-parieto-temporal craniotomy, the sylvian, carotid-basal, pre-pontine, interpeduncular, pre-chiasma, and contralateral carotid-basal cistern were exposed and irrigated with 0.9% saline solution including urokinase (60000 units/500 mL), removing almost all SAH. Irrigation and clot removal were

Fig. 6 Postoperative CT showed disappearance of the sylvian hematoma. CT: computed tomography

carried out with a Suction Plus device (Johnson and Johnson, Tokyo, Japan). The expected bleeding point was not detectable along the entire M1 and proximal M2 segments, neither in their branches. Then, irrigation was extended to distal sylvian fissure. After removing subarachnoid clot, parietal artery from M2 superior trunk was dissected and solid hematoma fixed to the vessel wall was confirmed at the posterior rim of sylvian fissure. As this hematoma was disentangled and removed subpial hematoma, an abrupt arteriole tear, which was considered as bleeding point caused by avulsion, appeared (**Fig. 5a** and **5b**). The bleeding was stopped by electrical coagulation of those teared arteriole's stumps and then almost all the subpial hematoma was removed. Near this site, some other arterioles were entangled into the hematoma and those vessels were coagulated considering them as a possibility of secondary injured bleeding points. Throughout the operation, hemorrhagic diathesis due to t-PA was not confirmed.

Post-sylvian hematoma removal course

Postoperative CT showed disappearance of the sylvian hematoma (**Fig. 6**), also MRI showed no extension of DWI-HIAs and the patency of recanalization at whole occluded arteries. Slight edema at the insular cortex was confirmed. Without recurrent SAH, gradually, the patient's consciousness level was improved.

Discussion

PTSAH could have been caused by vessel perforation, dissection, and arteriole avulsion, which are likely to be detectable, if angiographical extravasation of the contrast is showed. In our case, persistent occlusion of the parietal artery might be a reason that the extravasation was not at all visualized during the whole thrombectomy. Therefore, just from the operative findings of sylvian hematoma removal, arteriole avulsion could be identified distinctly as the etiology of PTSAH. Under the circumstance of proximal antegrade blood flow occlusion, even though the distal arteriole originated from occluded parent artery is avulsed, retrograde bleeding from the avulsed arteriole might be difficult to be contrasted in angiography. First, retrieval force from the retrieval stent should be mentioned as the cause of arterioles' avulsion. Regardless of that, in our case, no resistance was felt in stent retrieve, which gives us the impression that deviation force from microguidewire during micro-cannulation into the distal M2 segment, the parietal artery, is more likely to be the cause of the arterioles' avulsion than retrieval force from the stent. From only the lateral view, no deviation of microguidewire, but the wire's stuck condition was detected; however, it was anticipated that wire's deviation could be visible from the anterior–posterior view so that arterioles' avulsion might be prevented. For more secured safety of precise manipulations, under bi-plane condition should be more recommended than single-plane condition. Needless to say, possibility of stent retrieval force may exist as a cause of arterioles' avulsion; therefore, a smaller stent retriever like a Tron FX 2.0mm-15mm (Terumo) or solely aspiration technique using a smaller catheter like a 3MAX reperfusion catheter (Penumbra, Alameda, CA, USA) should be applied, especially in more distal artery than distal M2 portion.

Immediately after the thrombectomy, the degree of SAH was slight, although spontaneous recanalization of the parietal artery might lead to critical sylvian hematoma. As the hematoma was growing, nearby arterioles were entangled in the hematoma, leading to additional arteriole avulsions and acceleration of the hematoma's growth. Besides, heparin use and t-PA administration might enhance the growth of the hematoma. Yang et al.[6] indicated the increased risk of symptomatic intracranial hemorrhage associated with heparinization during mechanical thrombectomy.[6]

For the purpose of releasing from the mass effect and preventing the hematoma growth by certain hemostasis of bleeding points, in our case of right side as non-dominant side, the removal of the sylvian hematoma was indicated. Even though the sylvian hematoma exists at dominant hemisphere, the hematoma removal should be indicated to release from the mass effect, improving the functional and vital prognosis.

In the intra-cranial hematoma removal, after the intravenous t-PA, alteplase administration, the hemorrhagic diathesis should be considered to treat. The t-PA, alteplase, has a peak time of 55 minutes, a half-long time of 6 minutes and life-long time of 84 minutes; therefore, at least 2 hours later from the administration of t-PA, the intra-cranial hematoma removal prior to be avoid to reduce operative bleeding.

Aggressive sylvian hematoma removal has been reported as distinct effective method for the prevention of the symptomatic cerebral vasospasm after an aneurysmal subarachnoid hemorrhage.[7] Başkaya et al.[8] reported that the only significant prognostic factor in those patients who had intra-sylvian hematoma was early surgery within 12 hours of the bleeding. Matsukawa et al.[9] showed that the clot thickness in the inferior limiting sulcus (TCILS) on CT could be a marker of sylvian subpial hematoma which induce cerebral vasospasm and 12-month poor outcome. They analyzed that the TCILS threshold of ≥6 mm was associated with sylvian subpial hematoma.[9] In our case, the first TCILS of 10.8 mm grew up to 15.7 mm, 14 hours later. Additionally, to confirm the bleeding site and to manipulate against the re-bleeding, sylvian hematoma removal should be indicated promptly without hesitation; however at least 2 hours later from the intravenous t-PA administration, if needed, and especially in the TCILS ≥6 mm cases.

Conclusions

- The PTSAH is possible even if in invisible-extravasation cases.
- The sylvian hematoma removal is effective to elucidate the etiology of the PTSAH, is a reliable method to prevent the re-bleeding, and is anticipated to improve the prognosis. Craniotomy is required for medically resistant PTSAH after thrombectomy, and avulsion of the pial artery can be the cause.
- Under the single-plane condition, closer attention not to injure the arterioles by invisible device motion, is needed than under the bi-plane condition.

Patient Consent

Obtained.

Disclosure Statement

All authors have declared that they have no financial relationships that might have an interest in the submitted work.

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