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Case Report

A Case of Mechanical Thrombectomy with Stent-retriever Avoiding Vessel Linearization for Occluded Tortuous Distal Branch of Middle Cerebral Artery (M2)

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Objective: We report a case of mechanical thrombectomy with stent-retriever for the insular segment of the middle cerebral artery (M2). Stent was deployed on a relatively linear vessel, which was not the culprit lesion for hemiparesis, with avoidance of excessive straightening of the culprit vessel.

Case Presentations: A 66-year-old man presented with sudden onset of left hemiparesis. MRI showed no ischemic changes and intravenous administration of t-PA was started. Cerebral angiography showed occlusion at the M2 bifurcation. Recanalization was unsuccessful using mechanical thrombectomy with a Penumbra Reperfusion Catheter 3-MAX. Therefore, thrombectomy with a Solitaire FR 4.0/15 mm stent-retriever was then performed. Stent was deployed to the other straight running culprit branch to avoid linearization of morbid vessel. Flow restoration occurred immediately after stent deployment and there was no reocclusion at 10 min after deployment. The stent-retriever was then drawn back via the guiding catheter, and clots were retrieved outside the stent struts. Immediately, angiography showed complete recanalization of the parietal and central arteries, which resulted in neurological improvement.

Conclusion: In thrombectomy with a stent-retriever for acute occlusion due to a clot at the M2 bifurcation, the site at which the stent is deployed should be determined based on efficacy, with deployment in the active zone, and safety, with avoidance of excessive vessel linearization. This should result in clot retrieval outside the stent struts, as in this case.

Keywords ▶ acute ischemic stroke, mechanical thrombectomy, stent-retriever, Solitaire FR, M2 occlusion

Introduction

For mechanical thrombectomy for acute ischemic stroke, the use of special devices became possible in 2010, and stent-retrievers were introduced in May 2014, in Japan. Mechanical thrombectomy, primarily using stent-retrievers, has been confirmed by meta-analysis of randomized trials in various foreign countries to be useful for the treatment of occlusion of the internal carotid artery (ICA) and horizontal segment of the middle cerebral artery (M1),[1)] and their use is also recommended by the AHA/ASA Guidelines.[2)] However, the usefulness of the procedure for the treatment of occlusion of the insular segment of the middle cerebral artery (M2) has not been demonstrated.

In this report, we present a case in which occlusion of the M2 bifurcation that did not respond to intravenous administration of t-PA (IVtPA) could be completely recanalized by deploying a stent-retriever on the linear parietal artery rather than the hairpin-shaped central artery, which was the culprit vessel of left hemiplegia. Since this case has rich implications for the determination of the site of stent-retriever deployment for M2 occlusion, it is reported with a review of the literature.

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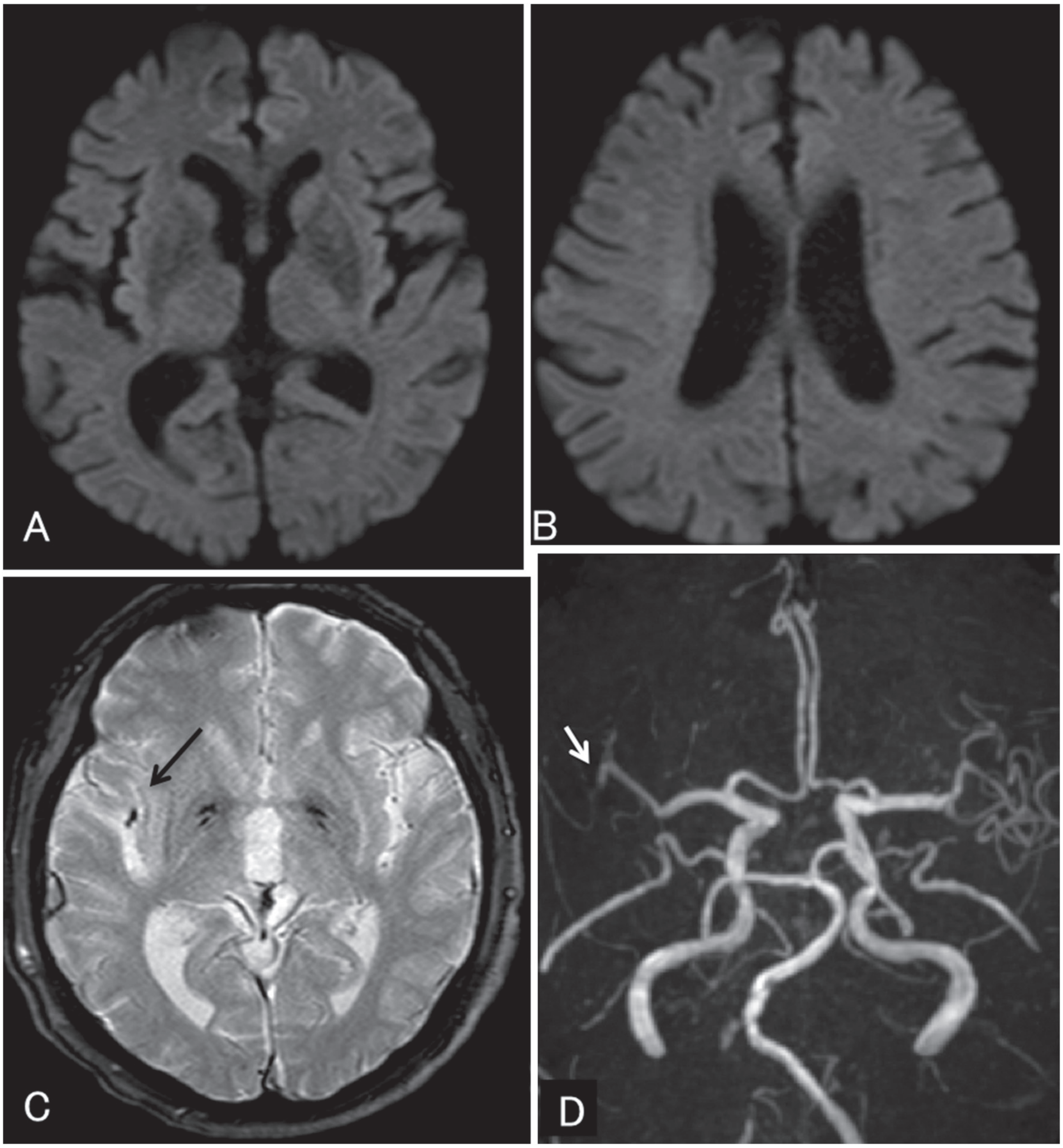

Fig. 1 Preprocedural MRI/MRA. (A, B) MRI-DWI displayed normal findings. (C) MRI-T2* showed a vessel susceptibility sign (arrow) in the right M2. (D) MRA disclosed right M2 occlusion (arrow). DWI: diffusion-weighted image

Case Presentation

The patient was a 66-year-old male with weakness of the left side of the body. He was orally medicated for hypertension and diabetes, showed no arrhythmia, smoked 50 cigarettes/day for 41 years, and drank 1500 cc/day of beer. He had no familial history of stroke.

The patient suddenly noted weakness of the left half of the body after lunch in August 2014 and was transported by ambulance to our hospital (onset to door time: 60 min). On admission, he had nearly clear consciousness, showed left facial paralysis, dysarthria, left hemiparesis (Manual Mascle Test: 3-/5, 3-/5 in both the arm and leg muscles), and reduced touch sensation (National Institutes of Health Stroke Scale: 5).

Concerning laboratory tests, peripheral hematology, blood chemistry, and clotting test results were normal. While ECG (electrocardiogram) showed atrial fibrillation, no cardiomegaly was noted by chest radiography. On head CT, there was no high-density area or early infarct sign (ASPECT: 10), and no clear high-signal area was noted on diffusion-weighted head MRI (**Figs. 1A–1B**). T2*-weighted imaging showed a susceptibility vessel sign (SVS) at the site of the right M2

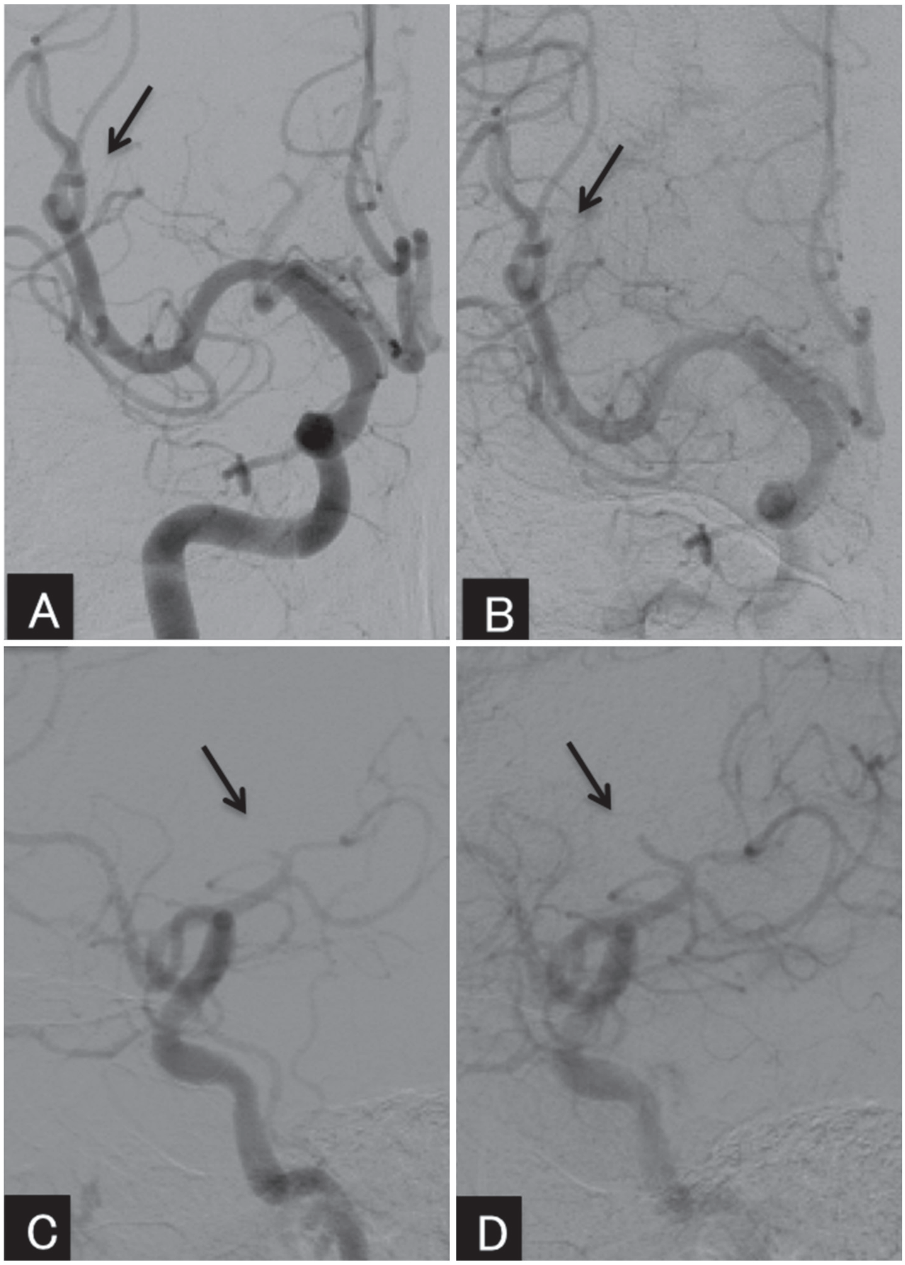

Fig. 2 Angiograms before endovascular thrombectomy. (A, B) Anterior-posterior views in the early (A) and delayed (B) phases showed M2 occlusion (arrows). (C, D) Lateral views in the early (C) and delayed (D) phases showed occlusion (arrows) of the superior trunk of M2.

occlusion (Fig. 1C), which was also suspected by head MRA (Fig. 1D). On cervical vascular ultrasonography, there was no finding of cervical arterial stenosis or dissection.

Drip infusion of edaravone at 30 mg was initiated immediately after head CT, and IVtPA was started immediately after head MRI/MRA (door to needle time: 136 min), but the symptoms did not respond, and the addition of endovascular surgery was determined. Since a diagnosis of occlusion of the anterior branch of the right M2 was made by cerebral angiography via the right femoral artery (Fig. 2), a 6Fr system was selected. Envoy MPD 6F (Cardis, Miami, FL, USA) was placed in the right cervical ICA (Internal carotid artery), and the thrombus was aspirated by advancing the thrombectomy catheter Penumbra Reperfusion catheter 3-MAX (Penumbra, Alameda, CA, USA) to the site of right M2 occlusion using Traxcess 0.012–0.014/200 cm (Terumo, Tokyo), but recanalization could not be achieved. Moreover, at this point, while no migration of the thrombus was observed, the symptoms were exacerbated, causing left complete hemiplegia, and the device was changed to a stent-retriever. Traxcess 0.012–0.014/200 cm

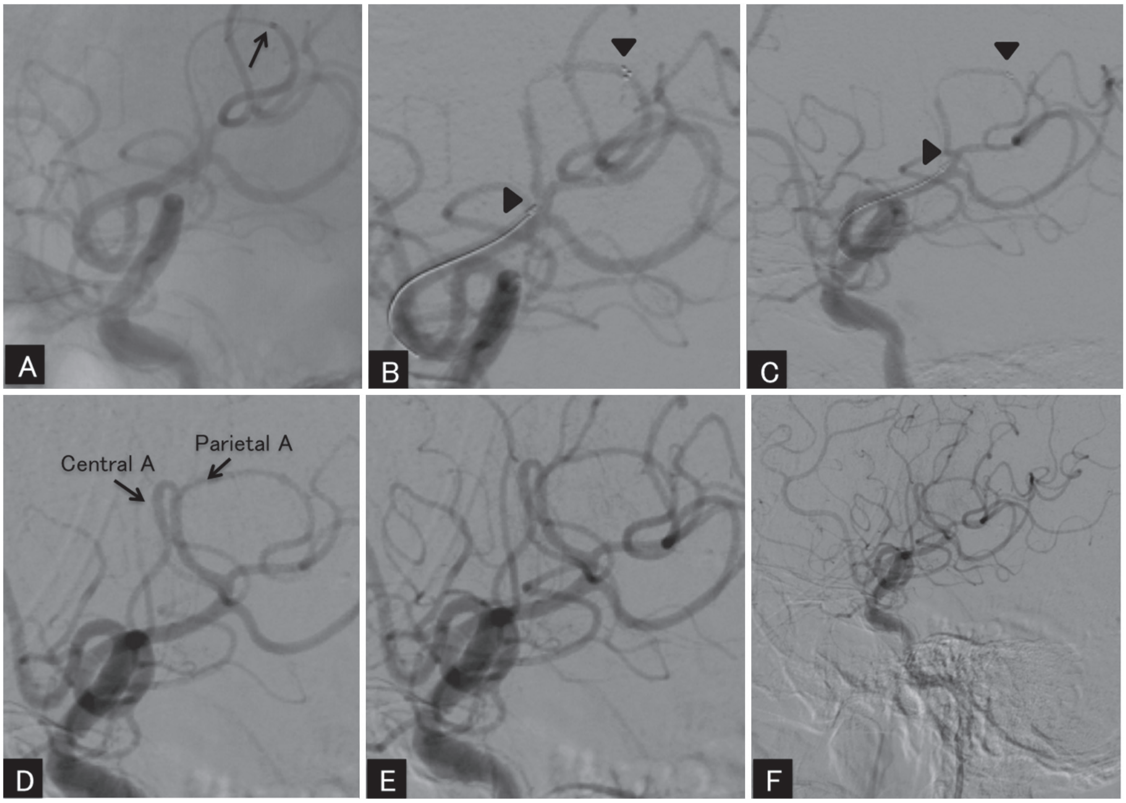

Fig. 3 Angiograms during and after endovascular thrombectomy. (A) Dual injection via a guiding catheter and microcatheter (arrow) showed relatively linear anatomy of the parietal branch. (B, C) Flow restoration was seen immediately after deployment of the stent-retriever (B, arrowheads), with no reocclusion at 10 minutes after deployment (C, arrowheads). (D–F) Complete recanalization was achieved immediately after one pass by drawing back the stent-retriever, based on angiograms in the early (D) and delayed (E) phases and on a 12-inch image (F) taken with an enlarged range for estimation of patency of the entire right MCA. MCA: middle cerebral artery

was passed through the site of occlusion to the central artery, resistance by thrombus was felt, and the vessel was estimated to be markedly tortuous with hairpin curves. Therefore, the wire was repositioned in the parietal artery, which was relatively linear, and Marksman (Medtronic, Minneapolis, MN, USA) was carefully guided. The wire was withdrawn, the size and location of the thrombus and blood vessel routes were checked by dual injection (**Fig. 3A**), and Solitaire FR 4.0/15 mm (Medtronic, Minneapolis, MN, USA) was deployed. Immediately after deployment, flow restoration (FR) was confirmed in the parietal artery (**Fig. 3B**), and no reocclusion was observed after 10 min (**Fig. 3C**). When the stent was carefully recovered, a hard thrombus was retrieved outside the struts (**Fig. 4A**), and not only the parietal artery but also the central artery were completely recanalized (**Figs. 3D–3F**). Therefore, the procedure was ended after 1 pass (TICI3; procedure time: 119 min). Pathological examination of the thrombus by HE stain showed no organized clots (**Fig. 4B**), and the thrombus was confirmed to contain platelets and fibrin by immunological staining for PTAH (**Fig. 4C**) and CD61 (**Fig. 4D**), respectively. No extravasation was demonstrated by head CT immediately after the procedure. Left hemiplegia was gradually resolved from immediately after the procedure, and the patient became able to keep the left upper and lower extremities lifted. Since paroxysmal atrial fibrillation was detected by ECG on admission, continuous intravenous infusion of heparin at 10000 units was initiated on the 2nd hospital day and was replaced by oral administration of dabigatran at 300 mg on the 8th hospital day. On the 15th hospital day, the patient was discharged to home with only mild impairment of skilled movements persisting. The modified Rankin scale (mRS) score after 3 months was 0.

Discussion

In acute ischemic stroke, mechanical thrombectomy was confirmed to be useful for the treatment of ICA and M1 occlusion by meta-analysis of randomized trials carried out from the end of 2014 through 2015[1] and is also recommended by the AHA/ASA Guidelines.[2] Reports of its use

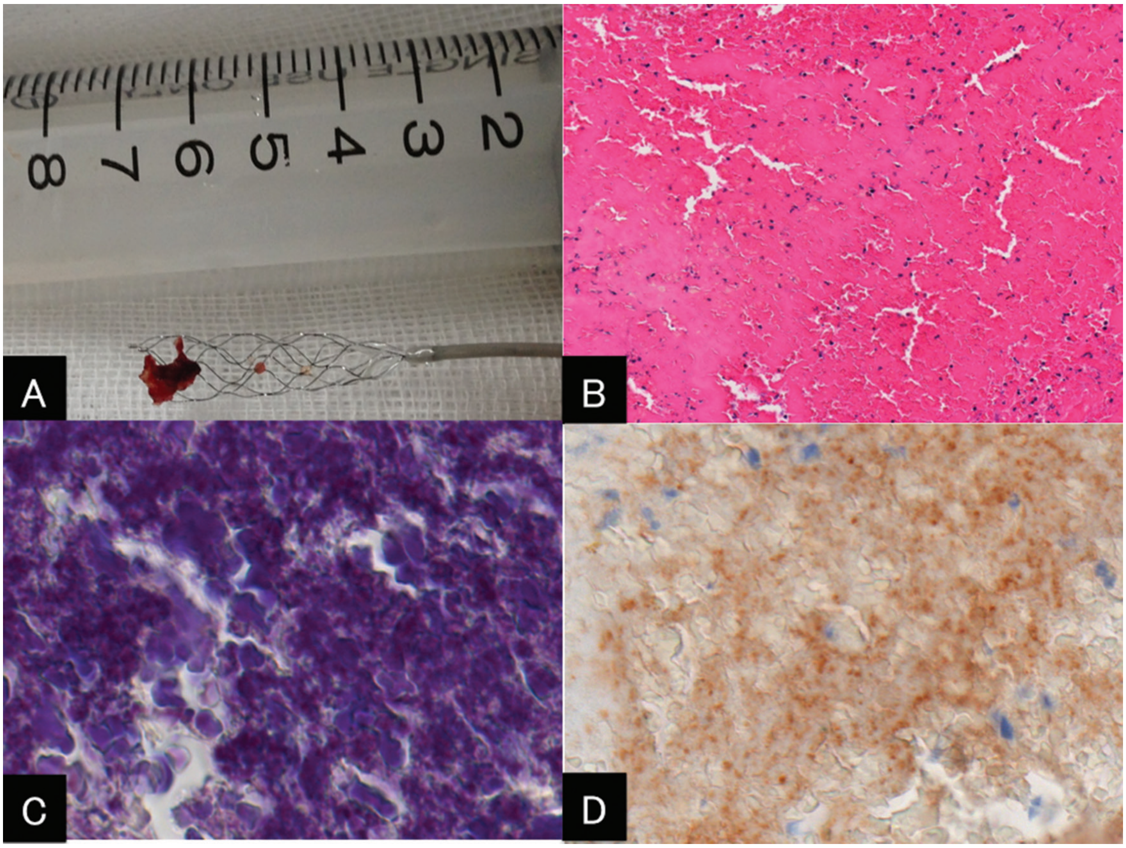

Fig. 4 Macrographic and micrographic findings for the retrieved clot. (A) The clot was retrieved outside the stent struts in the macrographic image. (B–D) The clot composition was shown pathologically to be fibrin and platelet without an organized composition using staining with HE (B), PTAH (fibrin staining dark purple) (C), and CD61 (megakaryocyte staining brown) (D).

for M2 occlusion have also appeared sporadically in series of patients treated with stent-retrievers[3–6] and Penumbra reperfusion catheter.[7] In M2 occlusion, the reperfusion rate has been reported to be high by IVtPA alone.[8] However, the early reperfusion rate after ICA and M1 occlusion has been reported to decrease by IVtPA alone when an SVS is noted by T2*-weighted head MRI,[9] and this also applies to M2 occlusion. In the present case, an SVS was observed in M2 by preprocedural T2*-weighted head MRI. Considering also the exacerbation of the symptoms during the procedure despite the absence of migration of the thrombus, the condition of this case is judged to have been an indication for mechanical thrombectomy.

Vascular endothelial damage due to stent-retrievers has been pathologically confirmed in experimental models,[10,11] and there is concern over its occurrence particularly when it is applied to relatively tortuous M2. In the RESCUE Japan Registry, also, the incidence of symptomatic intracranial hemorrhage has been reported to increase in M2 occlusions by catheterization following IVtPA.[12] In the present case with occlusion of the M2 bifurcation, the stent was initially planned to be placed in the central artery, which was the culprit vessel of motor paralysis. However, the central artery was found to be markedly tortuous by intraprocedural wire manipulation, and stenting at this site was judged to increase the risk of vascular damage by excessively straightening the vessel. For this reason, the stent was decided to be deployed in the parietal artery, which was relatively linear. Fortunately, the thrombus located over the M2 bifurcation could be retrieved en bloc by one pass of the stent deployed at this site, and complete reperfusion of the region including the central as well as parietal artery could be achieved. In foreign countries, capture and retrieval of thrombi located over vascular bifurcations using two stent-retrievers have been proposed for ICA and M1 occlusions,[13] but this procedure should not be selected for M2 occlusion to avoid vascular damage. Therefore, concerning treatment for occlusion of the M2 bifurcation using a stent-retriever[14] the selection of the site of stent deployment that minimizes linearization of the vessel as well as the introduction of safer devices are considered

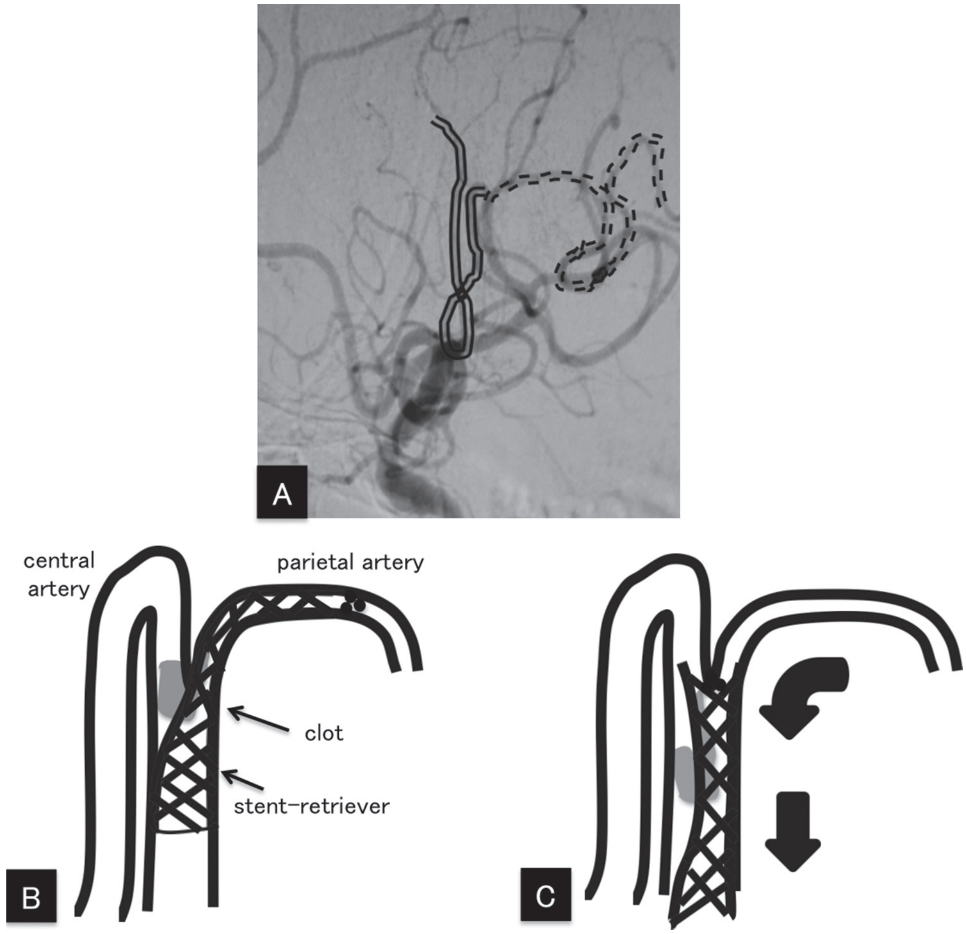

Fig. 5 Pattern diagram illustrating the probable mechanism of capture and retrieval of the clot. (A) Black and dotted lines indicate the central and parietal arteries, respectively. (B) The firm clot at the M2 bifurcation dividing the central and parietal arteries was captured outside the stent-struts. (C) The clot was retrieved with retention of the positional relationship of the stent struts.

to be important. From the same viewpoint, a method of deploying stent-retrievers only in the patent vessel before the thrombus and in the proximal part of the thrombus has also been proposed.[15)]

One of the reasons that the thrombus at the M2 bifurcation could be retrieved en bloc with a stent-retriever without fragmenting it is that the thrombus was relatively firm. In the *in-vivo* model of Mordasini et al., it was confirmed that FR occurred as the sham thrombus in the vessel was displaced by the stent and that the vessel was then reoccluded as the thrombus was cut into the stent-struts.[16)] When FR was achieved after stent deployment without reocclusion, as in our case, the thrombus was estimated to have been relatively firm. Indeed, the retrieved thrombus, which was 4 mm in diameter, was hard and could not be completely crushed by compression between the fingers. Pathologically, however, it was a relatively fresh thrombus consisting of fibrin and platelets, and the findings by HE staining did not support an organized thrombus including calcification. When the manner of capturing of the thrombus by the stent-struts is classified into capturing primarily inside the struts and capturing primarily outside the struts, the present case is considered to be the latter (**Fig. 5**). Macroscopically, also, the retrieved thrombus attached outside the struts, but this remains a reference finding, because there is the possibility that the thrombus was initially captured primarily on the inside of the struts but moved to the outside of the struts during its passage through Envoy MPD 6F. There is a report that the reperfusion rate rose when FR did not occur, or a slow flow was observed, at stent deployment.[17)] Conversely, the reperfusion rate may fall when FR is achieved, and there is no subsequent reocclusion, and, in this case, the possibility that the thrombus at the bifurcation is hard and can be retrieved en bloc as it is captured primarily on the outside of the struts may increase. There is also a report that the complete reperfusion rate by stent-retriever treatment increased when occlusion was caused by a thrombus with a high CT value (Hounsfield unit) on plain CT.[18] Therefore, it is speculated that each device can effectively capture and retrieve thrombi with a particular level of hardness.

Conclusion

This report presented a case in which occlusion of the M2 bifurcation could be successfully treated by deployment of a stent-retriever by avoiding linearization of the vessel. For thrombi located over the M2 bifurcation, deployment of a stent at a safer site should be considered with the possibility of capturing the thrombus primarily on the outside of the struts in mind.

Disclosure Statement

There are no conflicts of interest regarding this paper for any of the authors.

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