CASE REPORT doi: 10.2176/nmc.cr.2017-0151

Neurol Med Chir (Tokyo) 58, 219–224, 2018 Online May 1, 2018

Tied Pipeline: A Case of Rare Complication

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Abstract

A 48-year-old female with a symptomatic giant carotid cavernous aneurysm underwent endovascular treatment with multiple Pipeline Flex embolic devices (PED). The delivery catheter had to take a complicated course of multiple turns to cross the aneurysm, and its loop was tied in the aneurysm. When the catheter was to be withdrawn, it was apparent that the tied catheter had made a tight knot that bound the tail of the previous PED together. We successfully retrieved all of the system including the tied PED, and we used telescoping stents with five PEDs in the next operation. Although this is a rare complication, it is worth noting and checking to make sure that there is no knot before deploying the stent.

Key words: aneurysm, flow diverter, complication

Introduction

Flow diverters are the most attractive device to induce spontaneous aneurysm occlusion and shrinkage while preserving the parent artery.[1,2] This breakthrough can dispel the problems of massive coil embolization or sacrifice of the parent artery in the treatment of large or giant skull-base carotid aneurysms.[3] Pipeline Flex embolic device (PED, Medtronic-Covidien, Irvine, California, USA) is the most widely used flow diverter globally. However, this device requires not only a high level of skill for adequate deployment, but also meticulous and empirical strategizing and size selection considering its foreshortening and elongation.[4] Particularly, it is very difficult to deploy a PED across a giant carotid cavernous aneurysm (CCA) whose neck is completely involved in the sac. In such aneurysm, we must rotate the micro-guidewire around the aneurysm to insert it into the distal exit and then straighten the loop to a natural and stable course by pulling the microcatheter. In some cases, telescoping stents are needed.[5] Although the loop is usually simple S or α shape, it sometimes makes a very complicated three-dimensional turn in the aneurysm. We experienced a very rare complication in which multiple PEDs were accidentally knotted in the aneurysm. The mechanism of this accident and measures to avoid such a complication are discussed.

Received September 14, 2017; Accepted November 16, 2017

Case Report

A 48-year-old female had suffered from progressive double vision and headache for 4 years. She presented with total abducens nerve palsy on the left side without impairment of visual acuity or field. Magnetic resonance imaging showed a large mass in the left skull base. Conventional angiogram disclosed a giant aneurysm without identifiable neck at the left cavernous portion of the left internal carotid artery (ICA) and another tandem aneurysm on the near proximal side. The size of distal aneurysm was 28.8 × 19.8 mm, and the proximal one was 10.9 × 8.8 mm. In the distal giant aneurysm, the parent artery lost its course, and the orifice of the distal ICA was located in a different direction three-dimensionally, with a twisted relationship from the entry of ICA (Fig. 1). The diameter of the ICA was 3.1 × 2.7 mm in the directions of distal and proximal to the aneurysms, respectively. As the minimum course from the distal to landing point was more than 65 mm, telescoping stents were presumed to be necessary.

Treatment

First operation

Double anti-platelet agents (clopidogrel 75 mg/day and aspirin 100 mg/day) were given from

Fig. 1 The left internal carotid angiogram (*lateral view*) showed a giant aneurysm at the cavernous portion and another medium fusiform aneurysm located proximal to it (A). The three-dimensional angiogram (*left oblique view*) demonstrated no traceable relationship between the entry and exit of the parent artery (B). The first Pipeline Flex embolic devices was successfully deployed (*arrow*) without arranging the course of the microcatheter (C).

7 days prior to the intervention. The anti-platelet effect was within the adequate level on verify-now. The procedure was performed under general anesthesia and general heparinization. A Navien 6-Fr. guide catheter (Medtronic/Covidien, Irvine, CA, USA) was navigated into the petrous portion of the left ICA through a Flexor Shuttle 6-Fr. guiding sheath (Cook Medical, Bloomington, IN, USA). As it was difficult to advance a Marksman micro-catheter (Medtronic-Covidien) even using various shaped micro-guidewires, we used an Excelsior SL-10 microcatheter (Stryler, Kalamazoo, MI, USA.) with a Chikai 14 Black micro-guidewire (ASAHI INTECC, Nagoya) and finally succeeded in advancing it into the M2 portion of the middle cerebral artery (MCA) after assembling triple loops within the aneurysm.

After the exchange to the Marksman, we inserted the Solitaire FR 4 × 20 mm (Medtronic-Covidien) to anchor the distal end at M2 portion, and tried to correct the loops by pulling back the catheter. However, the tip of the microcatheter tended to fall down because the loops interfered with each other. We stopped to correct the catheter course, and a PED 3.5 × 35 mm was deployed from the origin of the posterior communicating artery into the aneurysm and tried to arrange the course afterwards. The Marksman was repositioned, and a 2nd PED (3.75 × 35 mm) was partially deployed. Although we tried to straighten the microcatheter course again with the anchoring aids of the PED, this maneuver showed the same tendency of falling the catheter, so we deployed this second PED with the unsheathed method alone. It was very difficult to manipulate the catheter because of the interference of the multiple loops; ultimately, the catheter accidentally fell out from the proximal end of the PED. Thus, we lost the purchase needed to connect the subsequent PED (Fig. 2).

We tried to insert the microcatheter again into the free end of the stent using various types and shapes of micro-guidewire, but multiple attempts to regain access failed. We used a Hyperform balloon (Medtronic-Covidien) inflated inside the aneurysm and changed the direction of the stent. Finally, the Marksman was passed into the stent with two loops as in the previous fashion thanks to the navigation and arrangement of the position of the previous stent by manipulating the inflation. After starting to deploy the tip of the third PED (4.25 × 35 mm), we tried to arrange the course of the catheter in expectation of the anchoring effect of the expanded stent head. At this moment, we found that the loop was tied. The maneuver of pulling back the catheter showed no possibility of spontaneous release and tended to make a knot. We had no choice but to withdraw the catheter together with the partially opened third PED. In this procedure, the tied catheter made a tight knot which bound the tail of the proximal PED together. We slowly dragged down the knotted Marksman holding the PED. We could successfully retrieve all the systems including Navien and guide sheath from the femoral artery with the cut-down method. One PED was left without migration in spite of this accident, but its proximal end was free in the aneurysmal sac (Fig. 2).

Postoperatively, the patient presented mild aphasia and right hemiparesis due to scattered ischemic lesions at left cerebral hemisphere due to showered small clots provided in the repeated and complicated procedures, but they improved within three days.

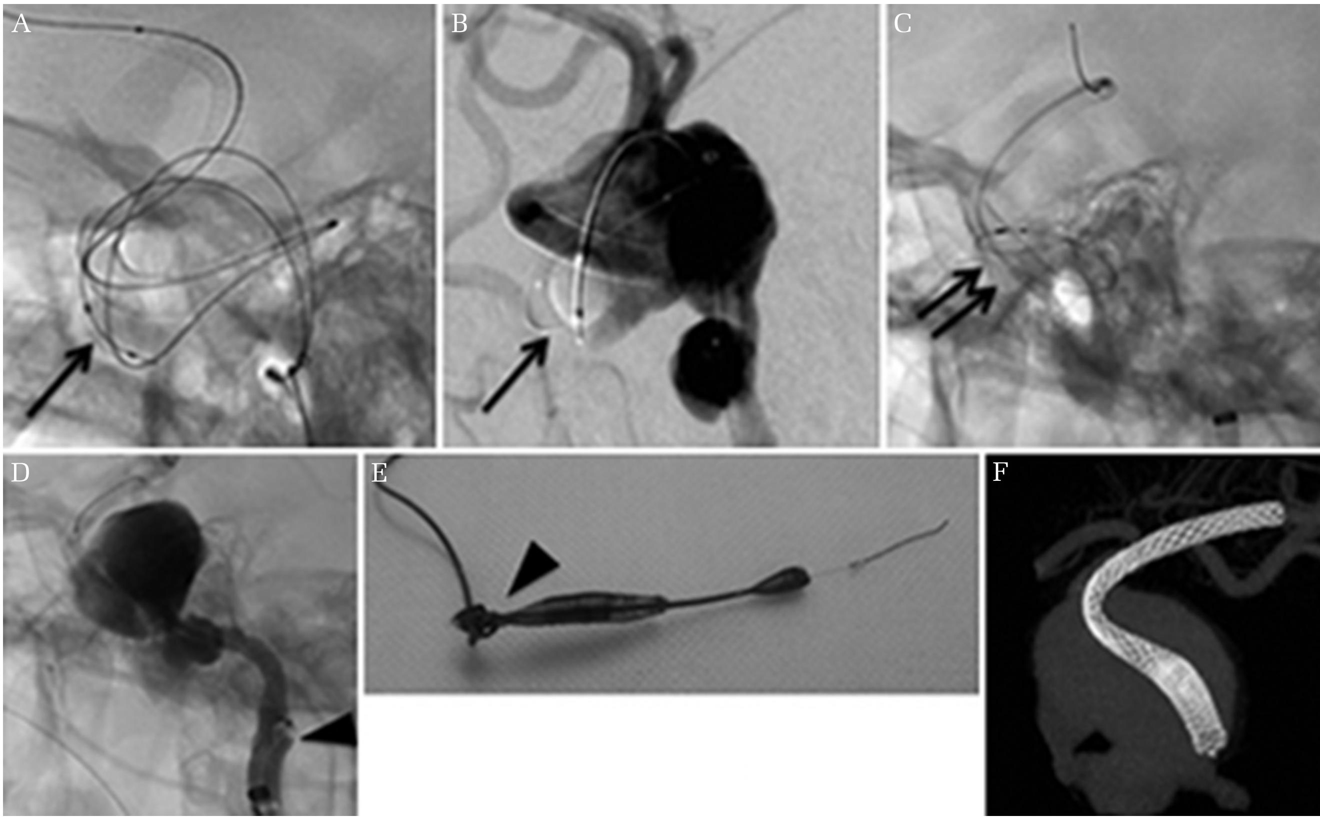

Fig. 2 Although the microcatheter accidentally fell down and lost course after deployment of two Pipeline Flex embolic devices (PEDs), it was successfully reinserted into the previously placed PED (A) with the assistance of a balloon catheter (*arrow*), making two intra-aneurysmal turns (B). However, the microcatheter was found to form a knot upon deployment of the third stent (C: *double arrow*). Since the end of the proximal PED was bound together with a tight knot of the catheter (*arrowhead*), this PED was withdrawn with the associated microcatheter (D). The retrieved microcatheter showed a knot with binding of the PED (E: *arrowhead*). One PED remained, but its proximal end was free in the aneurysmal sac (F).

Second operation

One week after the first operation, a second procedure was performed under general anesthesia and general heparinization. A Cerulean 5-Fr. guide catheter (MEDIKIT, Tokyo) with a J-shaped tip was placed in the distal giant aneurysm through a Flexor Shuttle 7-Fr. guiding sheath (Cook Medical, Bloomington, IN, USA) because previously used catheter (Navien) was difficult to be reshaped. An Excelsior SL-10 microcatheter (Stryker, Kalamazoo, MI, USA) with large reshaped curved tip was easily inserted into the lumen of the previously placed stent and successfully navigated to the MCA because the direction of the tip of the Cerulean catheter was fortunately directed to the end of the stent. This time the course of microcatheter was found to form simple S-curve and not a complicated loop. The microcatheter was exchanged to a Marksman and PED 4.25 × 35 mm was deployed following the previous stent with sufficient overlapping parts. Three Pipelines, 4.5 × 35 mm, 4.75 × 35 mm, and 5.0 × 35 mm, were uneventfully connected with partial overlapping to cover the neck of both aneurysms. The final angiogram showed a significant flow diversion effect with typical eclipse sign (Fig. 3).

The patient developed no new neurological symptoms postoperatively. Although the abducens nerve palsy has not improved yet, hemiparesis and aphasia has recovered at 1 month. She complained of strong left ocular pain 3 weeks later, but over 1 week of steroid administration it gradually receded, and she was discharged in the same neurological state as on admission.

In 6 months follow-up, the angiogram showed complete occlusion of the aneurysm and remodeling pathway formed with telescoping PEDs (Fig. 3).

Discussion

When large or giant aneurysms without obvious neck undergo endovascular treatment, it is usually very difficult to insert the microcatheter into the distal

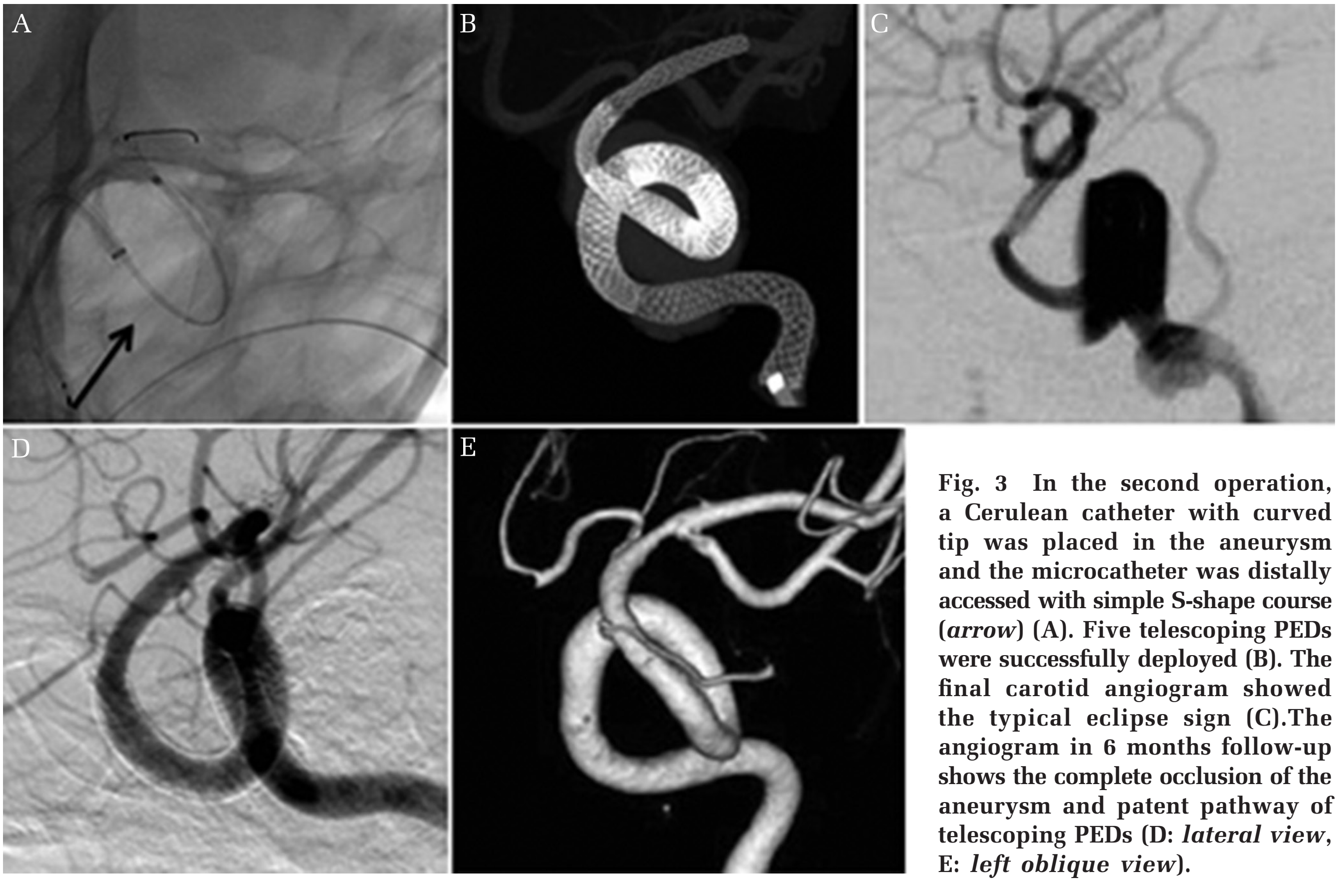

Fig. 3 In the second operation, a Cerulean catheter with curved tip was placed in the aneurysm and the microcatheter was distally accessed with simple S-shape course (*arrow*) (A). Five telescoping PEDs were successfully deployed (B). The final carotid angiogram showed the typical eclipse sign (C).The angiogram in 6 months follow-up shows the complete occlusion of the aneurysm and patent pathway of telescoping PEDs (D: *lateral view*, E: *left oblique view*).

orifice of the aneurysm. The "catheter-rounding method" in the aneurysm is an essential method to trace and perform the neck-bridging.[3] After successful navigation of the microcatheter to the distal portion, it is usually exchanged to a balloon catheter for anchoring. In our case, we used Solitaire stent for this purpose not to loose the course during catheter exchange maneuver. Then, the inflated balloon catheter is pulled back to create the shortest and most direct course. In our case, the decision to apply "catheter-rounding method" resulted in a serious accident.

In our case, there was no traceable neck continuity and three-dimensionally there was a different position between the distal and proximal orifice. Therefore, the microcatheter was required to turn three times with shifted loop-phases by turns. This complicated course may have a high risk of getting tangled. Particularly, the cause of our incident of a knot can be explained as follows: the microcatheter turned around the prolapsed PED column two times, and the final turn may have passed the center of these two loops from the end of the stent (Fig. 4). This course was the same as that used to form a knot at the end of a sewing thread. When the microcatheter cannot be straightened after it is successfully advanced to the distal artery, the possibility that such an irreversible knot will be formed should be considered.

Fig. 4 The mechanism by which the microcatheter became knotted.

To avoid this complication the microcatheter should not be coursed more than two turns in the aneurysm. Intra-aneurysmal placement of a soft distal access catheter with reshaped curving tip will be helpful in allowing easy access of the Marksman to the distal ICA as in the second treatment attempted in this case. Another preventive measure may be to deploy giant coils with another parallel microcatheter to buttress marksman in place.

After we lost the connection due to the falling catheter during the first procedure, it was very difficult to reinsert the catheter because the free proximal end of the stent vertically attached the aneurysmal wall and closed its orifice. In this situation, a Hyperform™ balloon was useful for moving the stent and changing its direction.[6] The over-length stent might also induce this situation. On planning the telescoping stents, we tend to select the longest stent to save the number of stents. However, the edge of the previously deployed stent may end at the bottom of the aneurysm, and may disturb the distal delivery of the subsequent stent due to the ledge effect. It will be important to design the layout of connecting stents using an image of virtual stents or a calculation to predict the foreshortening. Also, while planning, it is also very important to estimate a sufficient overlapping margin between stents so as not to break the connection.[7]

As for another discussion, we could consider the other strategy of sacrificing the ICA after the accident of the first operation. However, this patient had to undergo the external-ICA bypass surgery to realize the trapping because of small collateral flow with communicating artery, and she strongly desired to preserve the parent artery. Also, the non-inferiority of flow diverter treatment to conventional trapping has been already certified in some reports.[3,8] Therefore, we decided to perform the second operation to realize the original strategy.

In this case, thromboembolic complication was encountered in the first treatment. This might have been due to the complicated procedure and reckless withdrawal of the knotted stent system. Although the insertion of the distal access catheter into the aneurysm adopted in the second procedure also seems to risk injury to the vessel wall[9] and promote thrombus,[10] this support may be essential for successful access in difficult giant aneurysms without identifiable neck.

Conclusion

When we attempted to guide a Marksman from the proximal to distal parent artery crossing a giant aneurysm in order to deploy a Pipeline embolic device, a complicated course of multiple turns caused knotting of the catheter. Although it is a rare complication, it is worth noting and checking to make sure there is no knot before deploying the stent.

Ethics Approval

Obtained.

Acknowledgment

The authors wish to acknowledge and appreciation to Prof. Hidenori Oishi, Prof. Satoshi Tateshima, and Prof. Vitor Mendes Pereira who gave the valuable advises for the strategy of this difficult case.

Conflicts of Interest Disclosure

None.

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