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CASE REPORT

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Entrapment of an embolic protection device within stent during carotid artery stenting: a case report

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Abstract

Background Distal embolic protection devices have been widely used to reduce the incidence of embolic events during carotid artery stenting. Entrapment of an embolic protection device is an extremely rare complication, and most cases are resolved by surgical removal.

Case presentation A 67-year-old male underwent carotid artery stenting with an embolic protection device. During the procedure, the embolic protection filter became entrapped within the stent. The complication was resolved endovascularly without sequelae.

Conclusion The most important step in stenting is to be careful until the procedure is completed. However, if complications occur during the operation, in-depth knowledge of the catheters, wires, and devices will help the operator resolve the problem using endovascular techniques.

Keywords Carotid stenosis, Angioplasty, Stent, Embolic protection device, Complication

Introduction

Carotid artery stenting (CAS) with an embolic protection device (EPD) is an effective alternative to carotid endarterectomy for treating carotid artery stenosis [1, 2]. The use of EPD reduces the embolic complication rate during CAS [3, 4]. However, the use of an EPD may induce various complications, including filter occlusion, internal carotid artery (ICA) dissection, difficult retrieval or entrapment of protection devices, and spasms [5, 6]. These complications may result in catastrophic outcomes; for example, the entrapment of an embolic protection filter in a carotid stent requires open surgical retrieval [7]. Herein, we present a case of EPD entrapment within the stent during a CAS procedure, which was safely corrected by an endovascular maneuver.

Case report

A 67-year-old male being treated for ICA stenosis detected during a medical examination visited our neurology outpatient clinic with right leg weakness. He had transient right leg weakness and numbness that lasted for approximately 5 min for 2 weeks before the visit. Neurological examination at the time of admission demonstrated no abnormalities. He had a history of hypertension and dyslipidemia.

Diffusion-weighted magnetic resonance (MR) images showed multifocal border zone infarcts at the junction of the left anterior cerebral artery and middle cerebral artery territories. A catheter angiogram was performed for further evaluation, revealing 85% stenosis in the left proximal ICA. The clinician decided to perform CAS for symptomatic stenosis. Written informed consent was obtained from the patient prior to the procedure.

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The procedure was performed under local anesthesia. A 6-Fr guiding sheath (Flexor shuttle; Cook, Bloomington, IN, USA) was positioned at the left common carotid artery (CCA) via a transfemoral approach. An Emboshield NAV6 filter (Abbott Vascular, IL, USA) was advanced across the stenosis and deployed at the ICA cervical segment, located distal to the lesion. Following deployment of the EPD, a 5×40 mm Submarine Rapido balloon catheter (Medtronic Minneapolis, MN, USA) was inflated across the lesion. Then, an Acculink 6–8×40 mm stent (Abbott Vascular, IL, USA) was deployed over the proximal left cervical ICA into the distal left CCA. After stent deployment, the relatively inexperienced interventionalist assumed that the procedure was successful. While advancing the retrieval catheter to remove the filter device, the operator was unaware that the filter wire had exited the side hole of the catheter. The retrieval catheter continued to advance, resulting in the filter being abruptly pulled back and entrapped within the placed stent (Fig. 1). Gentle traction on the filter wire met with resistance within the stent. Attempts were made to retrieve the filter basket with a retrieval catheter within the stent. However, the filter wire ring did not fold. Several unsuccessful attempts were made to push the filter with the headhunter catheter. Therefore, we decided to use a shuttle sheath to push the filter distally out of the stent. The filter was slowly pushed with the shuttle sheath and moved out of the stent (Fig. 2). Then, the filter was removed without difficulty by using a retrieval catheter.

DWI obtained 2 days after CAS did not show a newly developed infarct. Follow-up Doppler ultrasound 2 days after the procedure showed no evidence of in-stent restenosis or thrombosis.

The patient was discharged without neurologic deficits. The patient had good clinical outcomes at the 8-month follow-up.

This case report was approved by our Institutional Review Board (No. DAUHIRB-22-072) with a waiver of the requirement for written informed consent because of the retrospective nature of this study.

Discussion

The main concern regarding CAS is the risk of distal embolic stroke caused by migration of plaque fragments. Distal protection devices have been used for intraprocedural embolic protection. Nazari et al. [8] reported that patients treated without EPD were associated with a fourfold increase in perioperative stroke in an interrogation of the American College of Surgeons National Surgical Quality Improvement Program database (2011–2018). Garg et al. [9] reported a relative risk reduction of 0.59 (95% CI 0.47–0.73) compared to the risk with unprotected CAS in 24 studies. However, EPD is related to

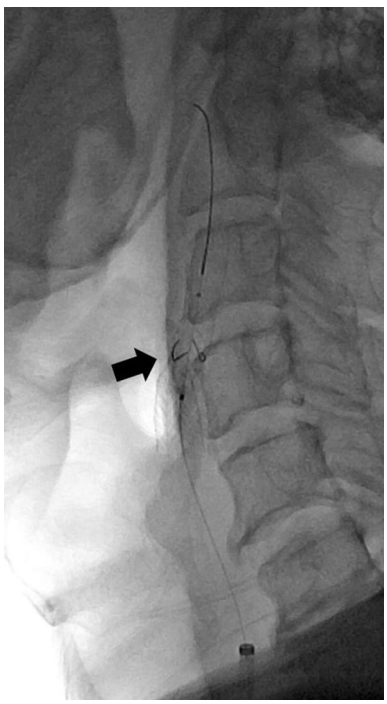

Fig. 1 Left common carotid angiography shows entrapment of the filter basket (arrow) within the stent

Fig. 2 An angiogram performed after advancing the shuttle sheath into the stent to push the filter shows that the filter has moved out of the stent (arrow)

periprocedural complications during CAS. Entrapment of EPD in stents is a very rare complication, and most cases are resolved by surgical removal [10–12]. Page et al. [12] reported a case of a retained EPD during CAS necessitating open surgical removal. In this case, numerous attempts were made to retrieve the Spider Fx EPD with an angioplasty balloon, diagnostic catheter, or dilator sheath. However, all attempts were filed and required open surgical removal of the retained device and stent.

Our case was resolved endovascularly without sequelae. To solve this problem, we first attempted to recapture the filter basket within the stent. However, this is not a well-considered exit strategy. The Emboshield NAV6 filter basket diameter is 7.2 mm, larger than the Acculink stent diameter of 6–8 mm. Attempts to retrieve the filter basket within the stent can produce tangling with the stent strut, which could aggravate the locking between the filter wire ring and stent strut. Continuous tension on the wire may cause it to detach from the filter basket, resulting in catastrophic consequences. Thus, when the filter basket is stuck within the stent, the only solution is to push the filter out of it.

The Emboshield NAV6 filter basket is not fixed to the guidewire. Traction on the wire causes the distal 0.019-inch bead to caudally pull the 0.014-inch filter basket. However, pushing the wire allows only the wire to advance and does not allow the filter basket to move forward, unlike the situation with the SpiderFxTM EPD (Covidien, Mansfield, MA, USA) [13, 14]. Therefore, the only way to distally push an entrapped filter basket is to use another device.

Although we used a shuttle sheath, we suggest that it is better to push the filter basket using the balloon catheter first. There may be concerns about engagement between the inner surface of the balloon catheter tip and the outer surface of the filter anchorage. Campbell et al. [15] reported a case of locking between the tip of the Aviator Rx balloon catheter (Cordis, Johnson & Johnson, Miami Lakes, FL, USA) and the anchorage of the AccuNet filter (Guidant Corporation, St. Paul, MN, USA), while the balloon catheter was advanced over the wire. We simulated a procedure in which the Submarine Rapido balloon catheter was advanced over the wire of the Emboshield NAV6 filter and forcefully pushed the filter basket while holding the wire. However, there was no balloon catheter engagement with the filter (Fig. 3). Further evaluations using several different filters and balloon catheters are required.

Dauherty et al. [16] reported two similar cases with failed retrieval of an Emboshield NAV 6 embolic protection in which they used a 5 French vertebral catheter to recapture and remove a trapped EPD. However, we tried to push the filter with a 5 French Headhunter catheter, but this was unsuccessful. In our case, a shuttle sheath was used to push the filter distally, and the results were very successful. When using the shuttle sheath, as opposed to the balloon catheter, the tip of the shuttle sheath contacted the outer side of the wire ring (Fig. 4). Therefore, the characteristics of the force transmitted to the filter basket may also differ. The shuttle should be pushed forward using a gentle and quick wrist-snap motion so that the pushing force can be transmitted to the filter well.

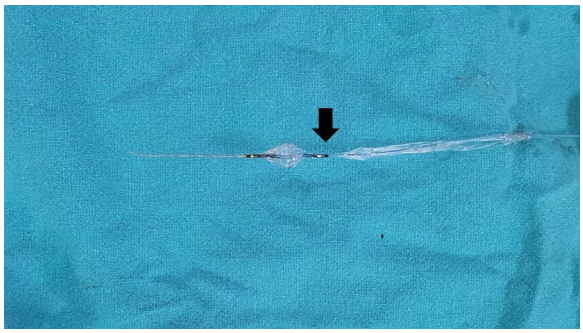

Fig. 3 A photograph of the Emboshield NAV6 filter and Submarine Rapido balloon catheter shows no engagement between the filter and balloon catheter tip (arrow)

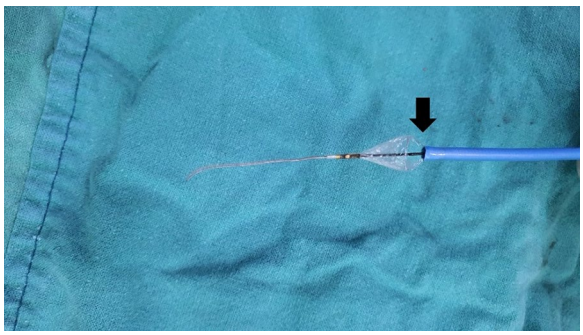

Fig. 4 A photograph of the Emboshield NAV6 filter and shuttle sheath demonstrates that, in contrast with the balloon catheter tip, the tip of the shuttle sheath (arrow) contacts the outer side of the wire ring

It is not appropriate to leave a retained filter in situ. However, there are no clear guidelines for its management. Myrcha et al. [17] reported a case of an accidentally retained filter after stenting of the ICA. The patient did not consent to surgical removal of the filter. There were no observable flow disturbances in the filter, and the patient remained asymptomatic during the 10-year follow-up. The authors proposed that in cases of a poor general condition of the patient, a watch-and-wait approach could be reasonable if there is no flow

restriction by the filter. In the present case, the retained filter caused a flow restriction and had to be removed.

Conclusions

The use of an EPD during CAS is essential, and the potential risks associated with its use should be minimized. The most important step in CAS is to be careful until the operation is completed. However, if complications occur during the procedure, in-depth knowledge of the catheters, wires, and devices will help the operator resolve the problem using endovascular techniques. Here, we reported a case of filter entrapment within a carotid stent, which was resolved using an endovascular maneuver.

Abbreviations

CAS	Carotid artery stenting
EPD	Embolic protection device
ICA	Internal carotid artery
CCA	Common carotid artery

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Not applicable.

Author contributions
All authors contributed equally in the development of this case report. All authors read and approved the final manuscript.

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Availability of data and materials
Not applicable.

Declarations

Ethics approval and consent to participate
This case report was approved by our Institutional Review Board.

Consent for publication
This case report was approved by our Institutional Review Board, and the requirement for written informed consent for publication of the case report was waived.

Competing interests
The authors declare no competing interests.

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