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Technical Note

Successful Retrieval of the Distal Anti-embolic Device after Carotid Stenting Using the Balloon Bridge Technique

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Background: During carotid artery stenting (CAS), retrieval of the distal umbrella portion of the anti-embolic device (AED) could be difficult. Herein, we report a case of left CAS managed with balloon angioplasty and stent placement with successful retrieval of the umbrella portion of the AED using the balloon bridge technique after failure of retrieval with the standard technique.

Case Presentation: After successful revascularization of the asymptomatic severe carotid bulb stenosis in a 62-year-old woman, we could not pass the re-sheathing catheter over the deployed stent because of the ledge effect between the guidewire of the AED and the stent mesh. However, using the balloon bridge technique, which helped minimize the ledge effect, we could advance the guiding catheter beyond the stented segment over the partially inflated balloon. The umbrella portion of the AED could be easily retrieved through the guiding catheter without complications.

Conclusion: During CAS, the balloon bridge technique could be used to retrieve the AED after failure of retrieval with the standard techniques.

Keywords ▶ balloon bridging method, distal anti-embolic device, carotid artery stenting, complication

Introduction

Carotid angioplasty and stenting are standard treatment modalities for symptomatic or asymptomatic significant carotid artery stenosis (CAS). Currently, the use of anti-embolic devices (AEDs) is regarded as the prerequisite to a safe procedure.[1–3] After successful implementation of a stent for revascularization, we need to access beyond the deployed stent to retrieve the umbrella portion of the AED. Regardless of the type of AED, it is commonly difficult to retrieve this umbrella, which might cause severe procedural complications.[4] Herein, we report a case of left CAS managed with balloon angioplasty and stent placement with successful retrieval of the umbrella portion of the AED using the balloon bridge technique.

Case Presentation

A 62-year-old woman presented with an asymptomatic left CAS. Revascularization was planned, and digital subtraction angiography revealed an eccentric severe stenosis in the carotid bulb. We decided to perform balloon angioplasty and stent insertion with an AED. A 6-French (Fr) guiding catheter (Envoy Neurovascular, Raynham, MA, USA) was placed in the left common carotid artery via the right femoral artery, and an AED (Emboshield Embolic Protection System; Abbott Vascular, Santa Clara, CA, USA), which opened up like an umbrella, was implanted successfully in the left distal cervical internal carotid artery. We performed angioplasty using a balloon catheter of 5-mm length (Aviator; Cordis, Miami Lakes, FL, USA) and successfully

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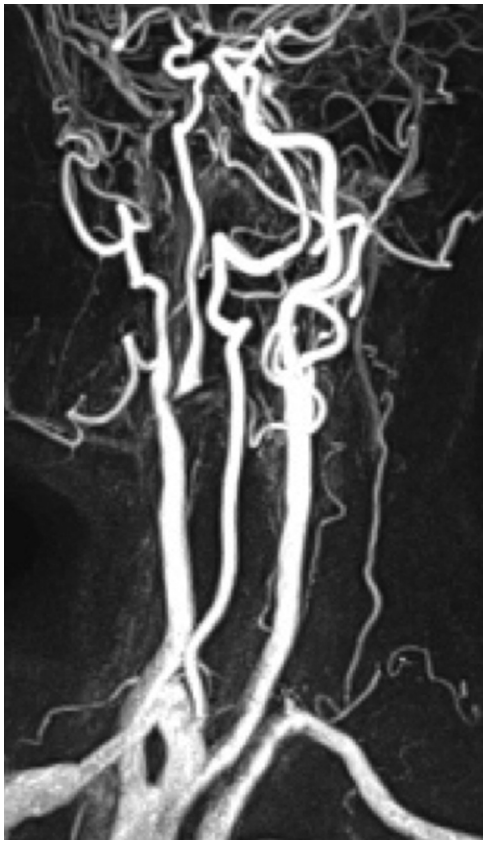

Fig. 1 In the oblique view, contrast-enhanced magnetic resonance angiography reveals a focal severe stenosis of the bulb of the right proximal internal carotid artery.

placed a self-expanding stent of 7-mm diameter and 40-mm length (Precise; Cordis, Miami Lakes, FL, USA) at the desired location. The stent was dilated using the same balloon as that used for angioplasty. Despite some residual stenosis, we decided not to use a larger balloon for dilation since the luminal gain was significant.

However, the distal tip portion of the re-sheathing catheter failed to pass beyond the stented segment, particularly because of the ledge effect between the wire of the AED and the protruded stent mesh at the residual stenosis **(Fig. 1)**. After several unsuccessful attempts to pass the re-sheathing catheter through the stent, we decided to apply the balloon bridge technique. After removal of the re-sheathing catheter, we advanced the balloon catheter that had been placed for angioplasty. Since there was no significant gap between the tip of the nose cone of the balloon catheter and the wire of the AED, we did not experience any difficulty in advancing the deflated balloon catheter beyond the jammed site in the stent lumen. Partial inflation of the balloon at a pressure of <1 atm was enough to separate the wire from the protruded stent mesh. The ledge effect was removed by the partially inflated balloon, and therefore, we had no difficulty in advancing the 6-Fr guiding catheter beyond the balloon and even the stented segment. Finally, the umbrella portion of the AED could be easily removed via the guiding catheter without complications (**Figs. 2** and **3**).

Discussion

Every stage of the CAS procedure, such as crossing the lesion, pre-dilatation, stent deployment, and post-dilatation, increases the risks of cerebral microembolism and associated stroke.[5–8] Proximal protection devices reduce microembolic signals more compared to AED because of the plaque tear and rupture while crossing a vulnerable lesion. However, there were no significant differences in the periprocedural and 30-day rates of cardiac events between proximal and distal AEDs.[7]

Although the routine use of AED for CAS is controversial, it is mandatory to ensure a safe procedure. The use of AED makes the procedure more complex and difficult. Acute arterial occlusion could occur as a side effect of using embolic protection devices. It is related with flow arrest, arterial dissection, vasospasm, and the accordion effect.[9–11]

In addition, retrieval of the filter after a successful procedure is commonly difficult. After the carotid stent has been deployed, a steep angle to the longitudinal axis of the carotid artery could appear. This angle could lead to a proximal ledge between the arterial lumen and the stent, resulting in complications, such as displacement and migration of the stent, mechanical stenosis, or occlusion, or even rupture of the carotid vessel.[6,12] The ledge effect is exaggerated when the stent is bigger in size, particularly at the side of the internal carotid artery, used for the accordion effect of the stent or in cases of presence of a curvature requiring bending of the stent.[6,12]

To overcome this hurdle, turning the neck, swallowing, and external pressure may be useful. The neck can be turned laterally or vertically to manipulate the external carotid artery manually. The AED wire can be manipulated with the guiding catheter, or another type of catheter, such as an angled-tip diagnostic catheter, can be used to detangle the locked AED wire from the stent mesh. However, it is difficult in cases in which an AED wire of regular length is used. A coronary guiding catheter extension system or vertebral angiographic catheter can be used.[10,11,13]

Other reports of the novel balloon bridge technique have been published. This technique helps in the efficient and atraumatic positioning of a guiding catheter in patients

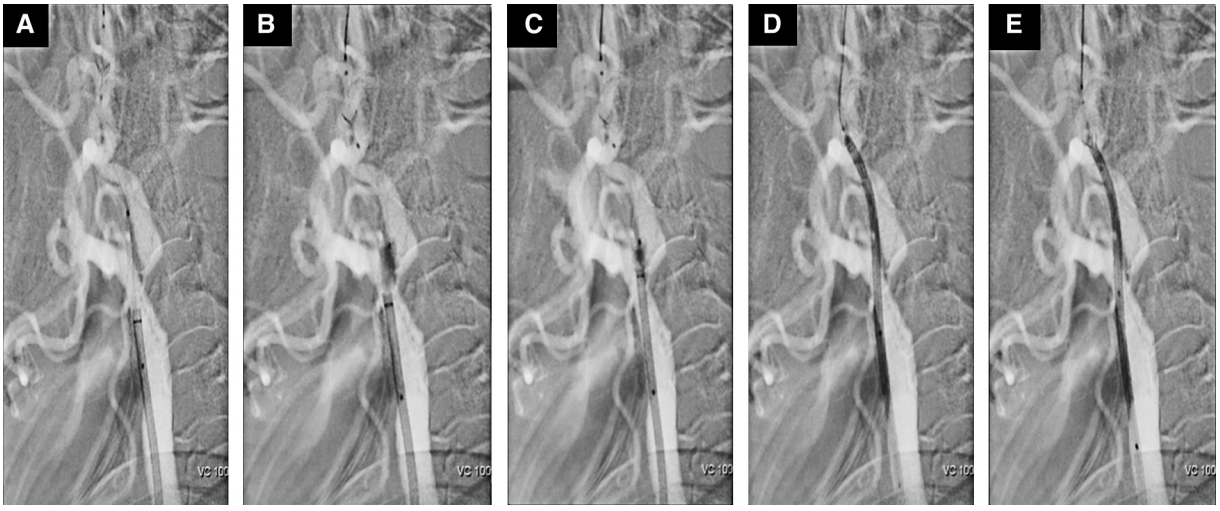

Fig. 2 Serial fluoroscopic images acquired during the application of the balloon bridge technique. (**A**) After failure of passing the re-sheathing catheter, we attempted to manipulate the wire using the guiding catheter; however, it was unsuccessful. (**B**) The balloon used before the dilatation of the lesion was re-introduced and partially inflated with the proximal portion within the guiding catheter lumen. The guidewire and stent mesh separated, which prevented passage of the re-sheathing catheter. (**C**) While advancing the guiding catheter over the partially inflated balloon, the balloon could easily collapse within the guiding catheter lumen. (**D**) Once the guiding catheter was successfully advanced beyond the jammed site, it was easily pushed beyond the distal segment of the stent. (**E**) After removal of the balloon catheter, we could re-sheath the umbrella using the guiding catheter since we used a 6-Fr catheter for stenting. If it is difficult, the re-sheathing catheter can be used.

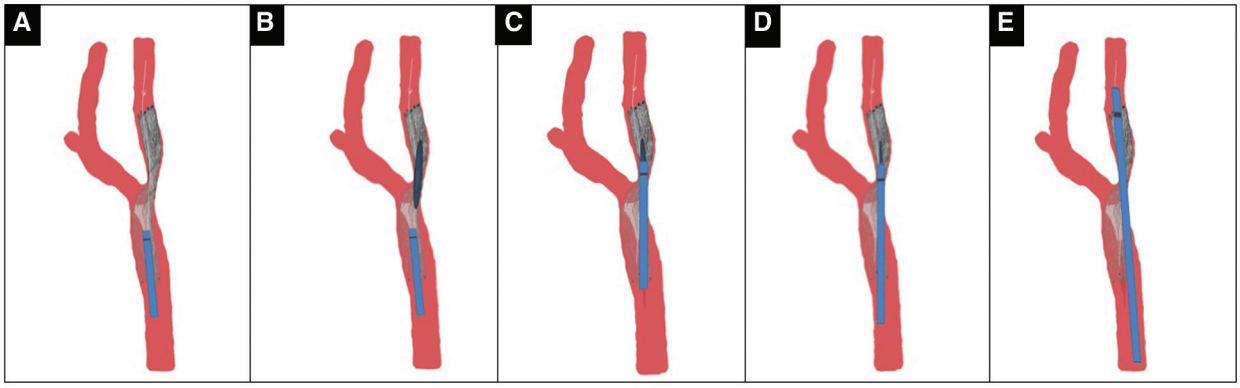

Fig. 3. Serial illustrations images during the application of the balloon bridge technique. (**A**) After failure of passing the re-sheathing catheter, we attempted to manipulate the wire using the guiding catheter; but were unsuccessful. (**B**) The balloon used before the dilatation of the lesion was re-introduced and partially inflated with the proximal portion within the guiding catheter lumen. The guidewire and stent mesh separated, which prevented passage of the re-sheathing catheter. (**C**) While advancing the guiding catheter over the partially inflated balloon, the balloon could easily collapse within the guiding catheter lumen. (**D**) Once the guiding catheter was successfully advanced beyond the jammed site, it was easily pushed beyond the distal segment of the stent. (**E**) After removal of the balloon catheter, we could re-sheath the umbrella using the guiding catheter since we used a 6-F.

with a tangential angle to the long axis of a carotid artery stent. A report suggested the use of a small balloon with a diameter of 2 mm. A small balloon is easier to manipulate and can reduce the operation time and incidence of postoperative complications.[6,12] In our experience, we prefer using a 6-Fr guiding system since it enables swift passage of the guiding catheter through the stent lumen during application of the balloon bridge technique.

The balloon bridge technique is useful in two kinds of situations: balloon angioplasty and retrieval of AED. When the balloon cannot be advanced across the proximal CAS ledge, the balloon is positioned outside the site of CAS, and partially inflated to 30%–50% capacity. Furthermore, it is concurrently advanced during deflation of the balloon. When the re-sheathing catheter cannot be advanced at the jammed site in CAS, it is removed, and the balloon catheter

is reintroduced and inflated across the jammed site of the distal tip of the guiding catheter and proximal CAS.[6]

The balloon bridge technique can cause the tip of the guiding catheter to be placed at the center of the lumen of the vessel and CAS, which can avoid the ledge effect. The expanded balloon provides support and dilation, which makes the steep angle shallower or even close to straight.[6,12] During the deflation of the balloon, the 6-Fr guiding catheter is sequentially advanced across the proximal stent. It would be plausible if the re-sheathing catheter poses no difficulties during the passage by modification of the tip portion. It is also possible to use bigger catheter size in this method, but using bigger size would be more difficult to drive and also easier destructed the stent mesh. This method also can be used to overcome difficulties in cases of extreme cervical carotid tortuosity and be beneficial for stenting of the vertebral artery ostium (Movie 1; This is available online).[5]

Conclusion

The balloon bridge technique is safer, simpler, and more effective for advancing both balloon catheters and guiding catheters across a steep-angle carotid stent without significant complications. The method could also be beneficial for stenting of other lesions, such as vertebral artery ostial stenosis.

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Disclosure Statement

None of the authors reports any financial disclosure relevant to this paper.

Supplementary Information

Movie 1 is available online.

Movie 1

Step-by-step procedure balloon bridge technique. After the carotid stent had been deployed, a steep angle to the longitudinal axis of the carotid artery appeared. We fail to pass and the re-sheathing the umbrella filter, we attempted to manipulate the wire using the guiding catheter; however, it was unsuccessful. The balloon that we used before for the dilatation of the lesion was re-introduced again and partially inflated with the proximal portion within the guiding catheter lumen. The guidewire and stent mesh separated, which prevented passage of the re-sheathing catheter. While advancing the guiding catheter over the partially inflated balloon, the balloon could easily collapse within the guiding catheter lumen. After the guiding catheter was successfully advanced beyond the jammed site, it was easily getting through to the distal segment of the stent. After removal of the balloon catheter, we re-sheath the umbrella filter using the guiding catheter since we used a 6-French guiding catheter.

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