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Case Report

Overlapped Double-Layer Micromesh Stents for Giant Extracranial Internal Carotid Artery Aneurysm

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Objective: Extracranial internal carotid artery aneurysms (ECAAs) are rare. We herein describe a case of overlapped stenting with two double-layer micromesh stents for a giant ECAA.

Case Presentation: A 73-year-old man presented to our hospital with an enlarged right posterior cervical mass. A right internal carotid artery (ICA) angiogram revealed a giant aneurysm of 50 × 60 mm. We chose a carotid double-layer micromesh stent for stenting. With the patient under general anesthesia, the first double-layer micromesh stent (CASPER Rx, 10 × 30 mm; Terumo, Tokyo, Japan) was deployed between the ICA distal to the aneurysm and the common carotid artery (CCA). The second stent was also deployed from a site more proximal than the first one. Ten coils were then placed from a microcatheter that had been placed in the aneurysm. A right CCA angiogram after the procedure revealed a flow-diversion effect for the aneurysm. The patient was discharged with no complications. At the 6-month follow-up angiogram, blood flow into the aneurysm had completely disappeared.

Conclusion: A flow-diversion effect using overlapped double-layer micromesh stents can result in thrombosis and healing of giant ECAAs.

Keywords overlapped stent, extracranial carotid aneurysm, giant aneurysm

Introduction

Extracranial internal carotid artery aneurysms (ECAAs) are rare, accounting for 0.4% to 4.0% of all arterial aneurysms.[1–3] The most frequent causes are atherosclerosis (80%), trauma, dissection, and fibromuscular dysplasia.[4] Treatment is necessary in some patients because of the possibility of rapid growth, rupture, and ischemic stroke.[5] Although open surgery is a common treatment and has been reported to be effective,[6–8] recent advances in endovascular devices and techniques have led to an increase in endovascular treatment using stents and covered stents for ECAA.[9–11]

We herein describe a case of stenting with overlapped double-layer micromesh stents for a giant ECAA.

Case Presentation

A 73-year-old man presented to our hospital with a chief complaint of an enlarged right posterior cervical mass. On admission, neck contrast-enhanced computed tomography revealed a 55-mm right cervical internal carotid artery (ICA) aneurysm and fracture of the styloid process (**Fig. 1A**). The length of the styloid process was 50 mm. In the right ICA angiogram, a giant aneurysm of 50 × 60 mm was diagnosed, with the inflow portion of the aneurysm slightly distal to the ICA bifurcation (**Fig. 1B** and **1C**). On the maximum intensity projection image reconstructed from rotational DSA, the ICA diameter was 7.94 mm and the common carotid artery (CCA) diameter was 7.29 mm (**Fig. 1D**). Because the diameters were not compatible with flow diverter (FD) stent implantation, we decided to perform stenting with overlapped double-layer micromesh stents and coiling. Aspirin and clopidogrel were started 2 weeks

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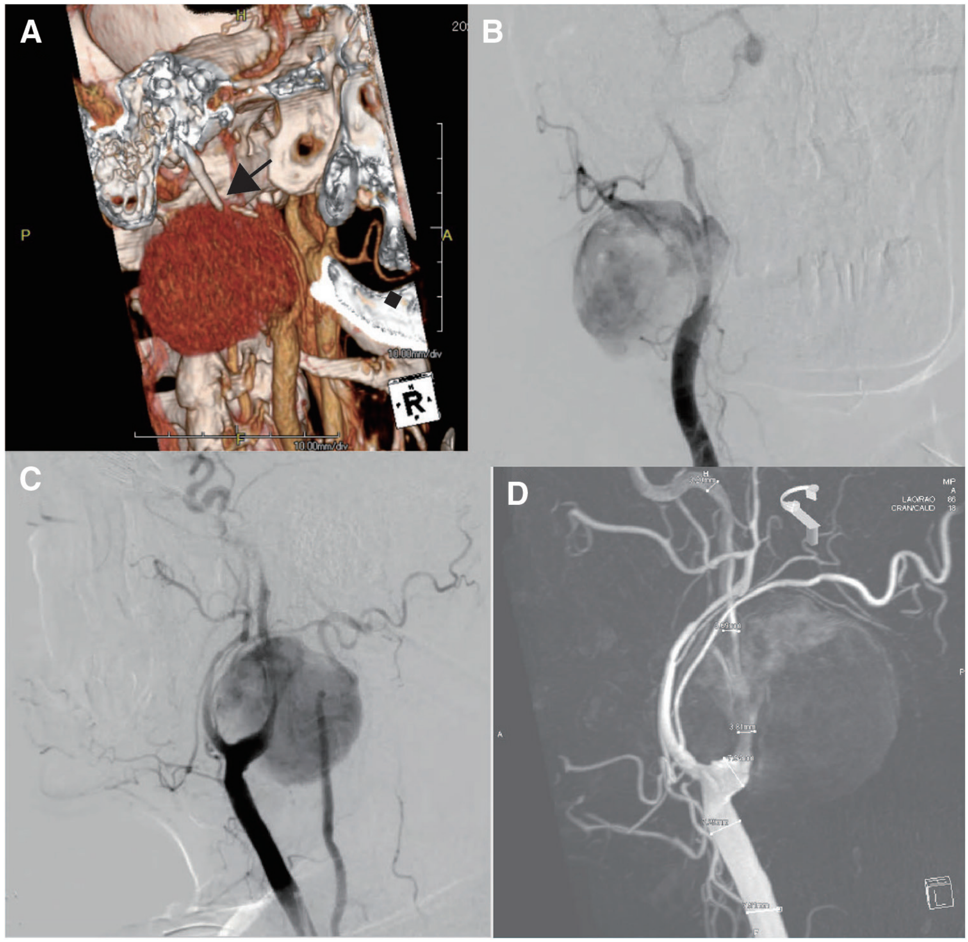

Fig. 1 CTA and diagnostic angiogram. (**A**) Neck contrast-enhanced CT scan revealed a 55-mm right cervical ICA aneurysm and fracture of the elongated styloid process (55 mm) (arrow). (**B** and **C**) In the right ICA angiogram, a giant aneurysm of 50 × 60 mm was diagnosed, with the inflow portion of the aneurysm slightly distal to the ICA bifurcation. (**B**) Frontal view. (**C**) Lateral view. (**D**) On the maximum intensity projection image reconstructed from rotational DSA, the ICA diameter was 7.94 mm, the CCA diameter was 7.29 mm, and the minimum diameter of the ICA was 3.61 mm. CCA: common carotid artery; ICA: internal carotid artery

before the treatment, and a platelet aggregation test confirmed its effectiveness.

The research within our submission has been approved by the Ethics Institutional Review Board of Kansai Rosai Hospital. Written informed consent for publication of the patient's information and images was provided by the patient.

Treatment

With the patient under general anesthesia, an 8-Fr long sheath was placed in the right femoral artery, a 6-Fr long sheath was placed in the left femoral artery, and an 8-Fr guiding catheter (80 cm, Asahi Fubuki; Asahi Intecc, Aichi, Japan) was placed in the right CCA. We decided to use a triple coaxial system, which consists of a distal access catheter (DAC), a microcatheter, and a microcatheter with better introduction, considering that it was difficult to advance into the ICA immediately distal to the giant fusiform aneurysm. A 5-Fr intermediate catheter (115 cm, Sofia Select; Terumo, Tokyo, Japan) was introduced into the ICA distal to the aneurysm with a microcatheter (150 cm, SL10-STR; Stryker, Freemont, CA, USA) and microguidewire (200 cm, Asahi Chikai 0.014-inch; Asahi Intecc) (**Fig. 2A**). A 5-Fr guiding catheter (90 cm, ENVOY; Cerenovus, Fremont, CA, USA) was also placed in the right CCA from the left femoral sheath. A microcatheter (Lantern 45°; Penumbra, Alameda, CA, USA) was placed in the aneurysm using a microguidewire (Asahi Chikai 0.014-inch) from a 5-Fr guiding catheter (90 cm, Envoy) (**Fig. 2B**). A FilterWire EZ was guided from the Sofia Select into the distal ICA and deployed, because the presence of a thrombus in the aneurysm required the use of FilterWire EZ for distal protection. A CASPER Rx 10- × 30-mm stent (Terumo) was deployed between the ICA distal to the aneurysm and CCA (**Fig. 2C**). The second CASPER Rx 10- × 30-mm

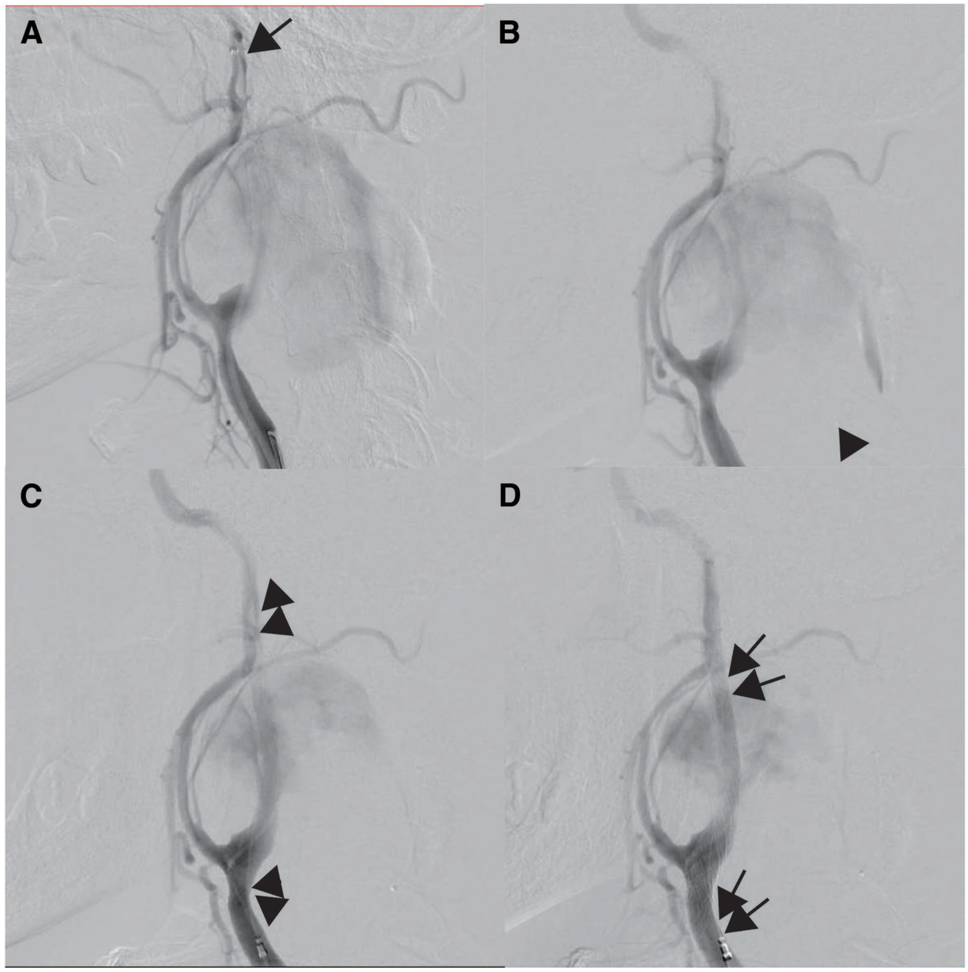

Fig. 2 Lateral view of right CCA angiogram during the treatment. (**A**) An 8-Fr guiding catheter (80 cm, Asahi Fubuki; Asahi Intecc, Aichi, Japan) was placed into the right CCA, and a 5-Fr intermediate catheter (115 cm, Sofia Select; Terumo, Tokyo, Japan) was introduced into the ICA distal to the aneurysm with a microcatheter (150 cm, SL10-STR; Stryker, Freemont, CA, USA) (arrow) and microguidewire (200 cm, Asahi Chikai 0.014-inch; Asahi Intecc). (**B**) After deployment of a FilterWire EZ (Stryker), a 5-Fr guiding catheter (90 cm, ENVOY; Cerenovus, Fremont, CA, USA) was also placed into the right CCA from the left femoral sheath. A microcatheter (Lantern 45°; Penumbra, Alameda, CA, USA) was placed in the aneurysm using a microguidewire (Asahi Chikai 0.014-inch) from the 5-Fr guiding catheter (90 cm, ENVOY) (arrowhead). (**C**) A CASPER Rx 10- × 30-mm stent (Terumo) was deployed between the ICA distal to the aneurysm and CCA (double arrowheads). (**D**) A second CASPER Rx 10- × 30-mm stent was also deployed from a site more proximal than the first one (double arrows). CCA: common carotid artery; ICA: internal carotid artery

stent was also deployed from a site more proximal than the first one (**Fig. 2D**). Ten coils were placed from the microcatheter (Lantern 45°), which had been placed in the aneurysm. A right CCA angiogram after the procedure showed markedly decreased blood flow into the aneurysm and blood flow stasis in the aneurysm (**Fig. 3A**). The patient was discharged with no complications. At the 6-month follow-up angiogram, blood flow into the aneurysm had completely disappeared (**Fig. 3B**). Moreover, the size of aneurysm was reduced from a maximum diameter of 6 cm to 4.8 cm in 6 months (**Fig. 3C**). Then, clopidogrel was stopped based on these results.

Discussion

Several reports of stent placement for ECAAs have been published.[6,9,10] However, only one report has described treatment with two double-layer micromesh stents.[11] In that case, overlapped double-layer micromesh stents induced complete occlusion of the aneurysm, while parent artery patency was preserved as our case. In contrast to our case, however, the aneurysm was located on the CCA and its pathogenesis was iatrogenic.[11] This is the first report describing the treatment with two double-layer micromesh stents for a non-iatrogenic aneurysm. The pathogenesis of

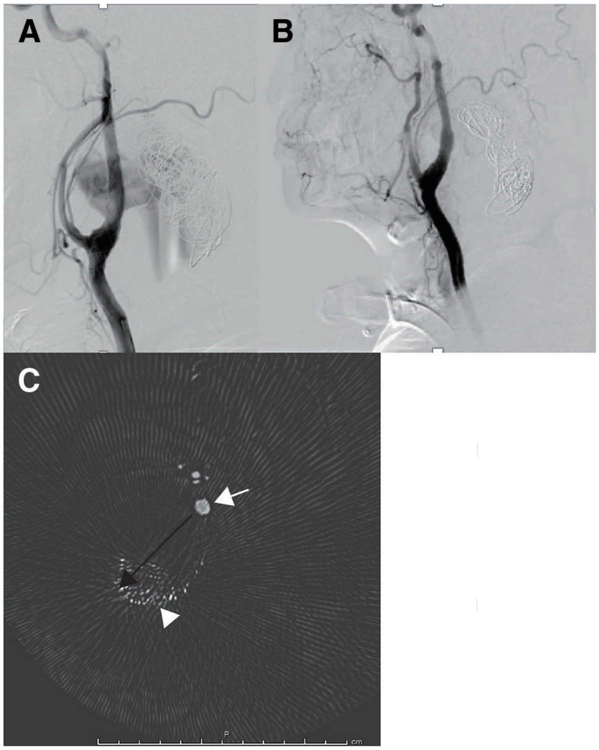

Fig. 3 Postprocedural right CCA angiogram (lateral view). (**A**) After the procedure, a marked decrease in blood flow into the aneurysm and blood flow stasis in the aneurysm were observed. (**B**) At the 6-month follow-up angiogram, blood flow into the aneurysm had completely disappeared. (**C**) At the 6-month follow-up angiogram, the axial plane of 3D-DSA reconstruction showed no blood flow into the aneurysm and the size of aneurysm was reduced from a maximum diameter of 6 cm to 4.8 cm in 6 months (black arrow). White arrow shows ICA, and arrowhead indicates coil mass. CCA: common carotid artery; ICA: internal carotid artery

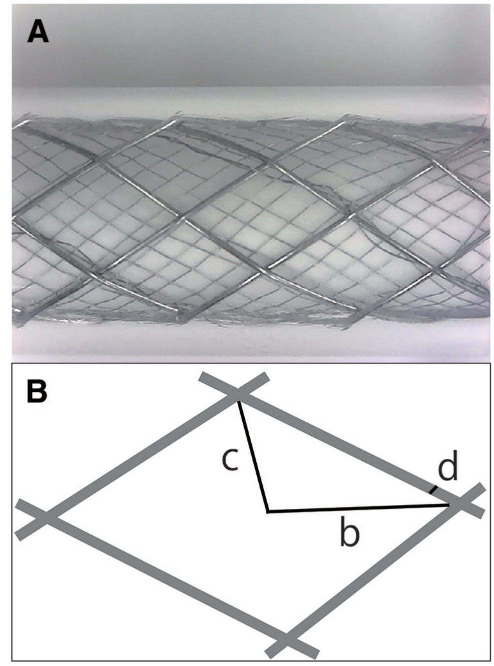

Fig. 4 Experimental placement of CASPER Rx stent (Terumo, Tokyo, Japan) into a 6-mm tube model. (**A**) We placed a 10- × 30-mm CASPER Rx stent into a tube model with a 6-mm inner lumen diameter. (**B**) We measured the required values and calculated by substituting these values into the formula. Outer layer b = 3.4 mm, c = 2.5 mm, d = 0.1778 mm. Inner layer b = 0.45 mm, c = 0.3 mm, d = 0.04064 mm. The metal coverage (%) of the CASPER Rx stent was estimated to be approximately 24.5%.

ECAA includes atherosclerosis, trauma, and infection.[4] Although the pathogenesis of the ECAA in the present case was not clear, the patient had an elongated styloid process. Moreover, the styloid process was fractured and in contact with the aneurysm. Although the pathogenesis of the aneurysm was undetermined, we considered that enlargement of the aneurysm had resulted in the fracture of the styloid process.

ECAAs are often treated because of their rapid growth with subsequent rupture and ischemic stroke.[5] Surgical treatments include aneurysmectomy with or without revascularization, carotid artery ligation with or without extracranial–intracranial bypass, and aneurysm clipping.[6–8,12] Coil embolization and stenting (bare stent, FD stent, and covered stent) have recently been reported as minimally invasive endovascular treatments made possible by technological developments, and their outcomes for ECAAs are reportedly superior to those of surgical treatment.[9,10,13] Covered stents are not currently approved in Japan, and bare stents cannot directly block blood flow into an aneurysm. Therefore, FD stents are desirable. However, the ICA and CCA diameters were >7 mm in the present case. Because the diameters were not compatible with FD stent implantation, we decided to perform stenting with two double-layer micromesh stents.

A CASPER Rx stent is a double-layer micromesh stent. The inner layer is constructed with a higher mesh density and smaller pore size to firmly suppress plaque, while the outer layer is an open-cell design that has strong expansion force and can be firmly adhered to the vessel wall. In the present case, the CASPER Rx stent was considered suitable because of the need to firmly adhere the stent to the parent vessel at the neck of the aneurysm and to attain a flow-diversion effect. However, the flow-diversion effect of the CASPER Rx stent remains unclear.

The metal coverage ratio has a significant effect on the hemodynamics of aneurysms, and a higher metal coverage ratio is associated with earlier aneurysm occlusion.[14] Although the vessel diameter differs from that of the carotid artery, it has been reported that a stent with 30% to 35% metal coverage can occlude more than 90% of cerebral aneurysms after 6 months regardless of the size of the cerebral aneurysm.[15] The metal coverage (%) of an FD stent when placed into a parent artery is estimated to be 30% to

35%.[15] By contrast, the metal coverage (%) of the CASPER Rx stent has not been published. Therefore, we measured the metal coverage (%) of the CASPER Rx stent. The methods of measuring metal coverage (%) of a stent have been previously reported.[14,16,17] We applied a previously described method for measurement of the metal coverage (%) of a stent because of its simplicity.[16] By substituting numerical values into this formulation, the percentage of metal coverage (%) of a stent was derived.[16] Experimentally, we placed a 10- × 30-mm CASPER Rx stent into a tube model with a 6-mm inner lumen diameter (**Fig. 4A**). Furthermore, we measured required values and calculated by substituting these values into the formula. The metal coverage (%) of the CASPER Rx stent (Terumo) was then estimated to be approximately 24.5% (**Fig. 4B**). Previous reports have indicated that the metal coverage of two overlapping low-profile visualized intraluminal support device (LVIS) stents (22%–28% metal coverage per LVIS stent) is 36.6%, which is higher than that of FD stent implantation.[18] Therefore, using double CASPER Rx stents, the metal coverage is estimated to be approximately 36% because the metal coverage per stent is comparable to that of the LVIS stent. From the above, it is considered that a sufficient flow-diversion effect can be achieved with overlapping CASPER Rx stents.

This study has several limitations. First, coils were used; if a double CASPER Rx stent provides a sufficient metal coverage rate and a high rate of occlusion, coils may not be necessary. Regarding the use of coils, we placed coils just in case the aneurysm did not heal after using a double CASPER Rx stent and the only next procedure would be to place an additional stent. Second, we did not measure the metal coverage rate of two overlapping CASPER Rx stents in the present study. If the same stent is overlapped in exactly the same position, it is presumed that the metal coverage is not much different than when a single stent is implanted. If the second stent was intentionally displaced from the first stent, as in the present case, the metal coverage rate was expected to increase. However, calculation of the metal coverage rate is considered difficult because the overlap between the first and second stents varies depending on the position where the second stent is placed, and thus was not evaluated in this study. Further case accumulation is desirable.

Conclusion

A flow-diversion effect can be sufficiently achieved with overlapping double-layer micromesh stents, resulting in thrombosis and healing of the ECAA. This method can be an alternative treatment to FD stents when they are unavailable.

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Disclosure Statement

The authors declare that there are no conflicts of interest.

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