Online September 3, 2020
Journal of Neuroendovascular Therapy 2020; 14: 495–500 DOI: 10.5797/jnet.cr.2019-0045

Case Report

A Patient with Carotid Mobile Plaques Treated by Carotid Artery Stenting Using a Double-layer Micromesh Stent

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Objective: We report a case of carotid mobile plaques treated by carotid artery stenting (CAS) using a double-layer micromesh stent (CASPER stent).

Case Presentation: An 86-year-old male presented with lightheadedness. Carotid artery ultrasound revealed mobile plaques in the right internal carotid artery (ICA). Head and neck MRI demonstrated concomitant left ICA occlusion. We first started medical treatment, but it could not reduce the plaque size. Then, we performed CAS using a CASPER stent in addition to medical treatment. The procedure was finished without complications, and there was no plaque protrusion. The postoperative course was uneventful during 3 years of follow-up.

Conclusion: A mobile plaque of the carotid artery may be treated less-invasively with a micromesh stent.

Keywords ▶ mobile plaque, carotid artery stenting, double layer micromesh stent, vulnerable plaque

Introduction

Carotid mobile plaques are frequently discovered by carotid artery ultrasound. Many points remain to be clarified regarding their natural course, but they are handled as a type of vulnerable plaque caused by plaque rupture.[1)] They are considered a risk factor for ischemic stroke recurrence, but no treatment strategy has been established.[1)] A few cases treated by carotid endarterectomy (CEA)[2–5)] or carotid artery stenting (CAS) using an existing stent[6,7)] have been reported, but mobile plaques are pathologically fragile and embolic complication caused by plaque protrusion (PP) is problematic; therefore, CAS is considered as a high-risk treatment.[8)] On the other hand, new stents such as CASPER stent (MicroVention, Terumo, Tustin, CA, USA), a double-layer micromesh stent (**Fig. 1**), has been clinically applied, and favorable clinical results have been reported in several clinical studies.[9,10)]

We report a patient with carotid mobile plaques accompanied by contralateral internal carotid artery (ICA) occlusion treated by CAS using a double-layer micromesh stent in whom a favorable treatment outcome was achieved.

Case Presentation

Patient: The patient was an 86-year-old male.

Chief complaint: The chief complaint of the patient was dizziness.

Past medical history: The patient had a past medical history of hypertension and dyslipidemia.

Life history: The patient was an ex-smoker of 30 cigarettes/day for 60 years with no habitual alcohol drinking.

History of present illness: The patient presented to another hospital complaining dizziness. Head and neck MRI/MRA and carotid artery ultrasound showed left ICA occlusion and mobile plaques in the right ICA (**Fig. 2a–2d**). The patient was referred and admitted to our department for further examination and treatment.

Neurological findings on admission: No abnormal neurological findings were observed.

Neuroradiological findings: Right ICA stenosis was mild on neck MRI, but a mild T1 high-intensity lesion was

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Received: June 12, 2019; Accepted: June 8, 2020
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Fig. 1 Image of the CASPER (provided by Terumo, Tustin, CA, USA), a double-layer micromesh stent. It has a 2-layer structure comprising a lateral coarse lattice and an inner fine lattice.

present in the plaques (plaque/sternocleidomastoid intensity ratio: 1.2) (**Fig. 2e**). No acute cerebral infarction was noted on diffusion-weighted head MRI (**Fig. 2f**).

Treatment course after admission: Medical treatment with antiplatelet drugs (aspirin 100 mg/day, clopidogrel 75 mg/day) and statin (atorvastatin 5 mg/day) was performed, but the mobile plaques remained without changes in shape or size. Four days after admission, sufficient inhibition of platelet aggregation was confirmed using a 12-channel platelet aggregometer (IMI PRP313M; TAIYO Instruments Inc., Osaka, Japan) based on the light transmission method (platelet aggregation test: ADP 3, collagen 4). Because of concomitant contralateral ICA occlusion, both medical treatment and CAS were considered to be treatment options and proposed to the patient. Then, the patient and his family strongly requested CAS, which was performed 4 days after admission.

Endovascular treatment: The procedure was carried out under local anesthesia. A 9Fr 25-cm sheath was inserted into the right femoral artery, and a 9Fr Optimo (Tokai Medical Products, Aichi, Japan) was guided to the right common carotid artery (**Fig. 3a**). Under proximal balloon protection, a FilterWire EZ (Boston Scientific, Natick, MA, USA) was guided to the distal region of stenosis while carefully avoiding the plaque using a load map. Under concomitant distal filter protection, intravascular ultrasound (IVUS) using Volcano (Volcano, San Diego, CA, USA) and optimal frequency domain imaging (OFDI) using the Lunawave OFDI system (Terumo, Tokyo, Japan) were performed to confirm the lesion (**Fig. 3b**), and a double-layer micromesh stent (CASPER 8 × 30 mm) was placed (**Fig. 3c**). Post dilatation was not performed because favorable dilatation was acquired. After stent placement, IVUS and OFDI were repeated. Incomplete stent apposition was noted in a part of the stenosis region, but the absence of PP from the stent strut was confirmed (**Fig. 3d**) and the procedure was completed.

Postoperative course: After treatment, no neurological abnormality was noted, and disappearance of the mobile plaque was confirmed by carotid artery ultrasound (**Fig. 4a**). On head MRI, an asymptomatic high-intensity spot was present in the right caudate nucleus (**Fig. 4b**), but the postoperative course was favorable and the patient was discharged to home with a modified Rankin Scale score of 0 at 10 days after treatment. The patient has been followed for 3 years as an outpatient. Mild stenosis in the stent (the degree of stenosis according to North American Symptomatic Carotid Endarterectomy Trial [NASCET] criteria was 38%) was observed (**Fig. 5**), but no novel ischemic stroke has developed.

Discussion

Carotid mobile plaques are frequently discovered on carotid artery ultrasound, and the detection rate is approximately 1/2000.[11] In general, they are handled as a type of vulnerable plaque and considered to be related to recurrent cerebral infarction.[1] Mobile plaques were noted in 12.8% of patients with carotid artery stenosis-induced atherothrombotic brain infarction, and cerebral infarction recurred in 33% of patients.[1] Ogata et al. classified mobile plaques into the following types based on the morphological characteristics on carotid artery ultrasound: 1) jellyfish type: a part of the fibrous cap is mobile, 2) streaming-band type: a part of the ruptured fibrous cap is fluttering, 3) mobile thrombus type: a tethered thrombus caused by plaque rupture is mobile, and 4) fluctuating ulcer type: a part of the ulcer is pulsating. They clarified that the incidence of recurrence of stroke was often high with the jellyfish type.[1] The mechanism of each type is unclear, but the following hypothesis has been proposed: jellyfish-type mobile plaques are produced by fibrous cap rupture and types 2–4 mobile plaques are formed. In the present patient, the mobile plaques may have been the streaming-band type. Many points in the

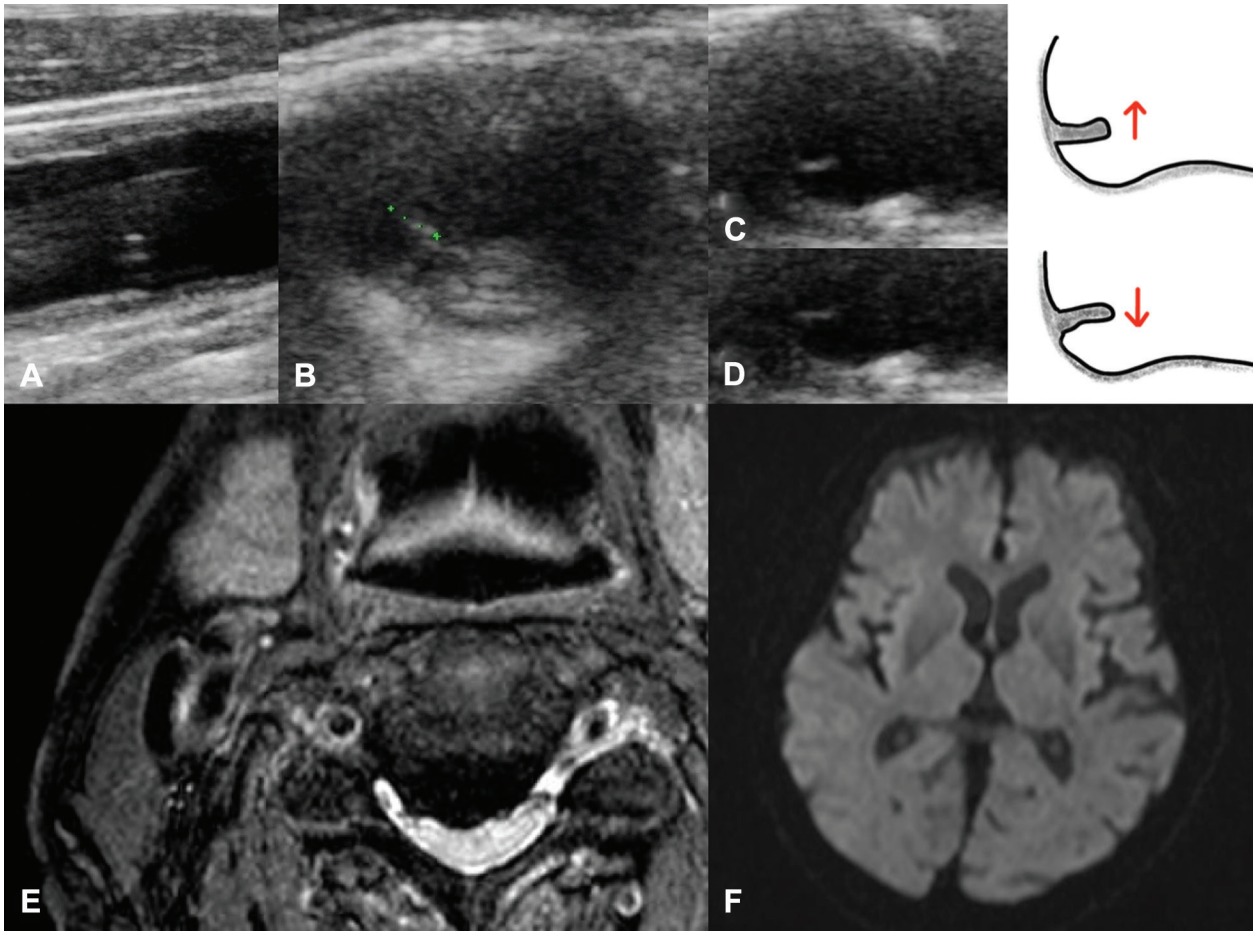

Fig. 2 Preoperative images (carotid artery ultrasound, and head and neck MRI). On carotid artery ultrasound, mobile plaques with a maximum diameter of 2.0 mm were observed (**A**–**D**), and a T1WI high-intensity lesion suggesting vulnerable plaques was present in the same region on neck MRI (**E**). No ischemic change was noted on head MRI (**F**).

spontaneous course have not been clarified, and no treatment strategy has been established at present. Several cases of plaque regression achieved by medical treatment alone including oral antithrombotic drugs have been reported[12,13]; however, mobile plaques are accompanied by a pathologically degenerated arteriosclerotic flap, and ruptured plaques are accompanied by a mobile thrombus, intimal dissection, thin or defective fibrous capsule, lipid-rich necrotic core, and hemorrhage, and have been treated by CEA in many cases.[2–5,14,15]

However, CAS may be a treatment choice for carotid artery stenosis patients with a past medical history specified as a risk factor for CEA in the stenting and angioplasty with protection in patients at a high risk for endarterectomy,[16] mobile plaques accompanied by clinically significant cardiac disease, severe pulmonary disease, contralateral carotid artery occlusion, contralateral laryngeal nerve palsy, previous radical neck surgery or radiation therapy to the neck, recurrent stenosis after endarterectomy, and age of 80 years or older. The present patient had carotid artery stenosis with contralateral carotid artery occlusion, making CEA a high-risk procedure. Moreover, medical treatment with antiplatelet drugs and statin was performed as early treatment, but the mobile plaques did not recess and CAS was selected at the strong request of the patient and his family. In previous studies, "plaque prolapse" or "PP" in which a plaque protrudes from the stent cell was considered as a cause of major embolic complications after CAS.[17–19] Mobile plaques and vulnerable plaques have previously been treated by CAS using a conventional closed-cell stent, embolic protection devices, and a stent-in-stent technique in several reports,[6,7,20] and reduction of the risk for CAS-induced PP applied to mobile plaques, which are vulnerable plaques, was difficult. According to Kotsugi et al., the frequency of observation of PP by IVUS was 2.6%[21] and the use of an open-cell stent with a larger cell size was considered to increase the risk.[21] Thus, the GORE Carotid Stent (W. L. Gore & Associates, Inc., Flagstaff, AZ, USA),

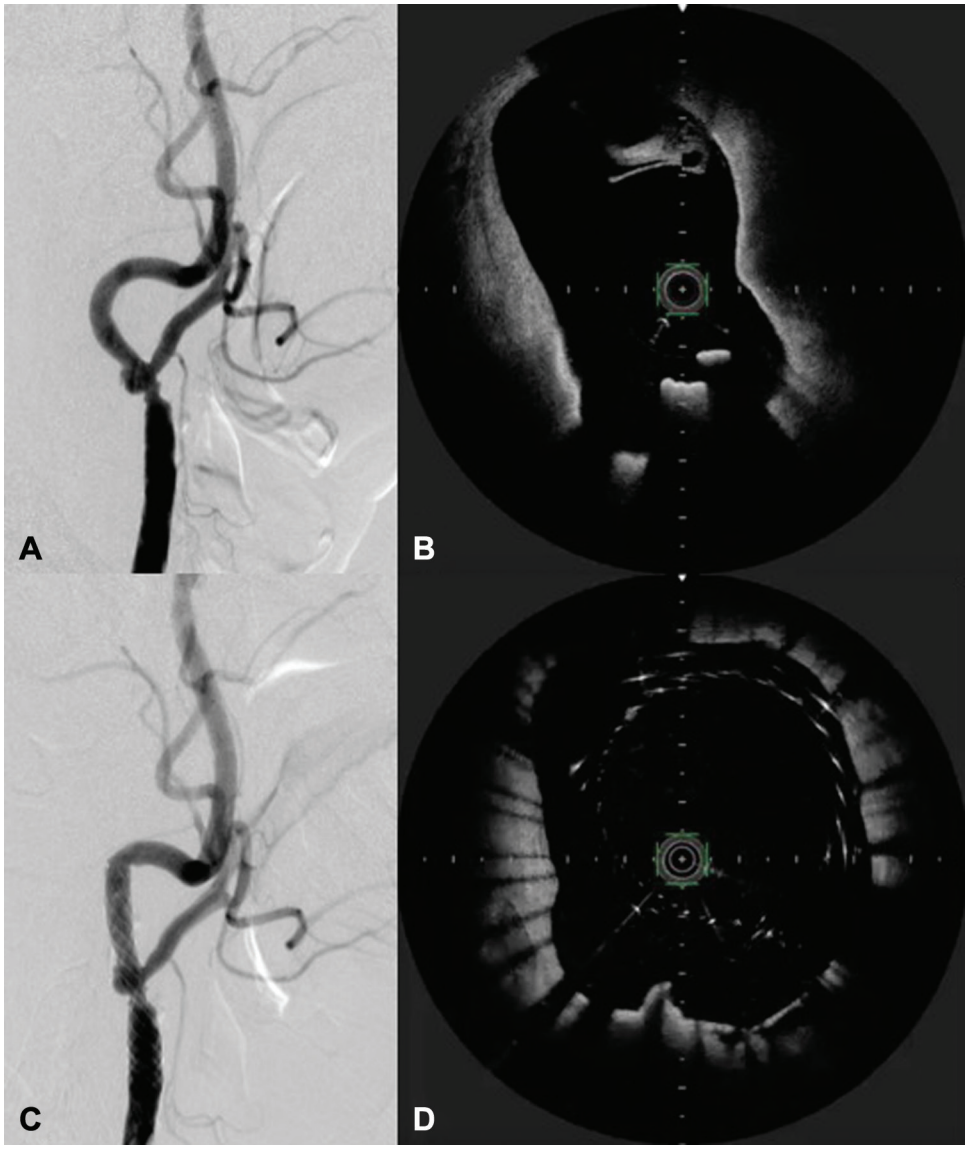

Fig. 3 Intraoperative images (pre/post DSA and pre/post OFDI). Stenosis accompanied by NASCET 21% wall irregularity was present at the root of the right ICA in the lateral view on DSA (**A**). A plaque protruding into the lumen was present in the same region on OFDI (**B**). After stent placement, no in-stent stenosis was noted, although apposition was noted in some stents (**C**), and no in-stent protrusion was noted on OFDI (**D**). ICA: internal carotid artery; NASCET: North American Symptomatic Carotid Endarterectomy Trial; OFDI: optimal frequency domain imaging

CGuard (InspireMD Ltd., Tel Aviv, Israel), and CASPER stents with a cell size smaller than that of the conventional stents have been clinically applied mainly in Western countries. The pore sizes of the stents were 500, 150–180, and 375 μm, respectively, and the free cell area was smaller than that in conventional stents. The CASPER stent used in our patient is a double-layer micromesh stent in which nitinol mesh and nitinol wire having an expansion force are combined (**Fig. 5**). Yamada et al. compared the incidence of PP between the CASPER stent and conventional stent in CAS of vulnerable plaques using optical coherence tomography, and confirmed that the CASPER stent significantly reduced the incidence and volume of PP, suggesting it to prevent embolic complications of vulnerable plaques.[22] The CASPER stent, GORE Carotid Stent, and CGuard have achieved favorable early treatment outcomes in clinical studies performed in Western countries.[9,23,24] On the other hand, it has been reported that the incidences of ipsilateral ischemic stroke and restenosis requiring treatment were higher in cases in which the CASPER stent was used than

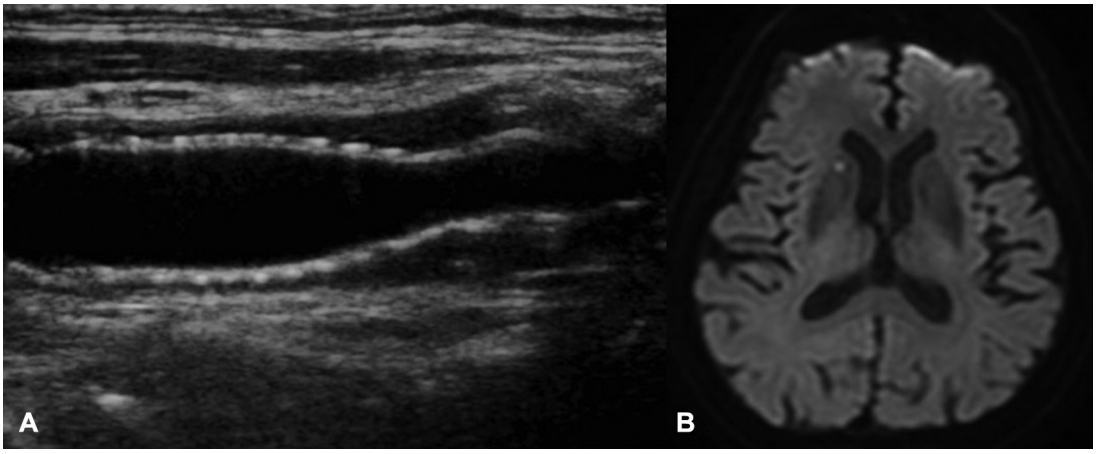

Fig. 4 Postoperative images (head MRI and carotid artery ultrasound). No mobile plaques were detected by carotid artery ultrasound (**A**). On head MRI, an asymptomatic DWI high-intensity spot was present in the right caudate nucleus (**B**). DWI: diffusion-weighted imaging

in those in which the CGuard was used at the 1-year follow-up (4.2% vs. 0.5% and 2.1% vs. 0.5%, respectively),[10,25] suggesting that appropriate case selection is necessary when any stents are applicable.

Complete prevention of PP is difficult. As the combination of OFDI, we can closely evaluate the necessity of additional treatment, such as balloon dilatation or another stent deployment. Because OFDI is capable of confirming the presence of PP at a higher detection rate than that by previously used IVUS, it is considered effective auxiliary diagnostic device for preventing embolic complications.[26,27]

Regarding the timing of therapeutic intervention for mobile plaques, there is no clear criterion. Previous studies reported that medical treatment with antithrombotic therapies should be prioritized[14]; reduction of the mobility of mobile plaques by statin administration was suggested by others.[7] Therefore, medical treatment was performed first for our patient, but it was ineffective. After approval by the ethics committee of our facility, we used the CASPER stent (receipt number: 1859) for inhibition of mobile PP from the stent strut[22] and OFDI for its high PP-visualizing ability. Regarding the CASPER stent, clinical trials have been completed in Japan and it is expected to become clinically available in the near future. As CAS using the CASPER stent may be useful to treat mobile plaques due to the possibility of reducing PP compared with conventional stents, a comparative study of treatments using novel devices, such as the CASPER stent, is expected. In addition, although it was not used in the present study, detection of PP using 3D rotational angiography has been reported[28] and its use may be considered.

Fig. 5 Postoperative images (cerebral angiography). On cerebral angiography 2 years after treatment, mild in-stent stenosis (NASCET 38%) was observed. NASCET: North American Symptomatic Carotid Endarterectomy Trial

Conclusion

To our knowledge, the present case is the first case report in whom a carotid mobile plaque was successfully treated by CAS using the CASPER stent. A micromesh stent may be useful to treat mobile plaques of the carotid artery.

Disclosure Statement

The authors declare no conflicts of interest.

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