ScientificScholar®
Knowledge is power
Publisher of Scientific Journals

www.surgicalneurologyint.com

Surgical Neurology International

Editor-in-Chief: Nancy E. Epstein, MD, Professor of Clinical Neurosurgery, School of Medicine, State U. of NY at Stony Brook.

SNI: Neurovascular

Editor
Kazuhiro Hongo, MD
Shinshu University, Matsumoto, Japan

SNI
Open Access

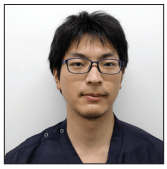
Technical Notes

The case of treatment for carotid web – Double-layer micromesh stent implantation in our hospital

Kaisei Kamatani[1], Shinichiro Yoshida[1], Noriaki Tashiro[2], Yoshiya Hashiguchi[2], Kousuke Takigawa[1], Masahiro Yasaka[2], Hiroshi Aikawa[1], Yoshinori Go[1], Kiyoshi Kazekawa[1]

Departments of [1]Neurosurgery and [2]Cerebrovascular Medicine, Fukuoka Neurosurgical Hospital, Fukuoka, Japan.

E-mail: *Kaisei Kamatani - kaisei.kamatani@gmail.com; Shinichiro Yoshida - fkewk902@gmail.com; Noriaki Tashiro - noriaki1983@hotmail.co.jp; Yoshiya Hashiguchi - yoshiyamihoko@yahoo.co.jp; Kousuke Takigawa - takigawa19841221@gmail.com; Masahiro Yasaka - yasakamasahiro@gmail.com; Hiroshi Aikawa - haikawa35@gmail.com; Yoshinori Go - go@kouchikukai.or.jp; Kiyoshi Kazekawa - kazekawa3426@gmail.com



***Corresponding author:**
Kaisei Kamatani,
Department of Neurosurgery,
Fukuoka Neurosurgical
Hospital, Fukuoka, Japan.

kaisei.kamatani@gmail.com

Received: 20 June 2023
Accepted: 26 August 2023
Published: 15 September 2023

DOI
10.25259/SNI_525_2023

Quick Response Code:

ABSTRACT

Background: A carotid web is a shelf-like structure on the posterior wall of the origin of the internal carotid artery, and it is believed to cause cerebral infarction due to thrombus formed by turbulent flow with stagnation of blood flow. Recently, it has been suggested that recurrent cerebral infarction cannot be prevented in patients with a symptomatic carotid web by conventional medical management alone. However, there is still no consensus on the treatment of carotid webs. Carotid artery stenting (CAS) with the CASPER stent (Microvention, Terumo, Tustin, CA, USA) was performed in six consecutive patients with symptomatic carotid webs, and the results are reported along with a review of the literature.

Methods: Six consecutive patients with a diagnosis of internal carotid artery stenosis due to a carotid web on magnetic resonance imaging and digital subtraction angiography (DSA) were included in this study. All patients underwent dual antiplatelet therapy approximately 10 days before surgery and after 6 months, and then, a CASPER stent was implanted under general anesthesia. All patients were evaluated postoperatively by DSA 6 months after treatment.

Results: In all patients, no in-stent stenosis was seen 6 months after the operation, and no symptomatic cerebral infarction occurred within 1 year after the procedure.

Conclusions: CASPER stent implantation may be effective for treating carotid webs.

Keywords: Carotid web, Stent, Stroke

INTRODUCTION

A carotid web is a shelf-like structure on the posterior wall of the origin of the internal carotid artery, and it is believed to cause cerebral infarction due to a thrombus formed by turbulent flow with stagnation of blood flow.[9] Although the carotid web was previously considered a fibrotic lesion, it has been reported that it may also have aspects of an ulcerative lesion.[6] Recently, it has been suggested that recurrent cerebral infarction cannot be prevented in patients with a symptomatic carotid web by conventional medical treatment alone.[13] However, a consensus on the treatment of carotid webs has not yet been established.

The CASPER stent is a self-expandable nitinol stent with a dual-layer structure of tubular mesh. The outer layer consists of a braided closed-cell structure with close vessel wall apposition and good conformability, and the inner layer has a closed-cell design with a very small micromesh

to limit plaque prolapse and embolic release. The dual-layer structure was considered to be effective against fibrotic and ulcerative lesions. Carotid artery stenting (CAS) was performed using the CASPER stent (Microvention, Terumo, Tustin, CA, USA) in six consecutive patients with symptomatic carotid webs. The results of the treatment at our hospital are reported along with a review of the literature.

METHODS

Of the patients diagnosed with cerebral infarction at our hospital between October 2020 and May 2022, six consecutive patients diagnosed with carotid artery stenosis on magnetic resonance imaging (MRI) and digital subtraction angiography (DSA) were included. The diagnosis of a carotid web in the lesion was made based on the previous literature[4] [Table 1]. A structure that satisfies all three is diagnosed as a carotid web: (1) shelf-like structures on the posterior wall at the origin of the internal carotid artery. Flattened structures rather than simple intimal thickening; (2) lesion must be presented within 20 mm of the internal carotid bifurcation; and (3) stagnation of blood flow and turbulence near the lesion. After dual antiplatelet therapy (DAPT) was performed for all patients for approximately 10 days before surgery, a CASPER stent, 10 mm × 20 mm, was deployed in the lesion using a Spider FX (Medtronic, Minneapolis, MN, USA) as distal protection under general anesthesia and an Rx-Genity 7 mm × 20 mm (Kaneka Inc., Osaka, Japan) at 6 atm for 10 s. All patients were evaluated postoperatively by DSA 6 months after treatment [Figure 1]. DAPT was continued for 6 months after the treatment. The procedure was performed under general anesthesia to reduce the reflex sensitivity of the baroreceptor and prevents complications.[1,10]

CASE PRESENTATION

The patient is an 80-year-old male. On the day of admission, he suddenly noticed dysphasia and weakness in the left upper and lower limbs and was transported to our hospital. Head MRI showed a new cerebral infarction at the right frontal lobe and wall irregularity of the right internal carotid artery. DSA showed a shelf-like lesion at the origin of the right internal carotid artery, so we diagnosed it as a carotid web. Echocardiography showed no abnormal findings that could be the source of the embolus, and a computed tomography scan of the thorax and abdomen denied malignant disease, so the cerebral infarction was thought to be caused by a carotid web**.** CAS was performed on the 17th day.

RESULTS

The mean age of this case group was 81.3 years. Five cases had hypertension and fur cases had hyperlipidemia [Table 2]. After the operation, no in-stent stenosis occurred within 6 months after the procedure, and no symptomatic stroke occurred within 1 year [Table 2 and Figure 2]. The modified Ranking Scale was not changed between pre- and post-operation in all cases [Figure 3].

DISCUSSION

A carotid web is defined as a shelf-like structure on the posterior wall of the origin of the internal carotid artery, and it has been reported to show fibromuscular dysplasia of the vascular intima, unrelated to atherosclerotic factors. It is not known why carotid webs occur at these sites.[13] The wall shear stress (WSS) is low at the vascular bifurcation, and there is a transitional zone from elastic to the muscular vascular wall, and the posterior wall of the carotid artery's bifurcation forms a recirculation zone. It is thought that a carotid web starts from a structural weakness such as a transitional zone and that several triggers, such as low WSS and endothelial cell dysfunction, may cause localized intimal fibrotic proliferation.[12] As a diagnostic criterion for a carotid web in our hospital, we consider the transitional zone and set the criterion for diagnosis to be

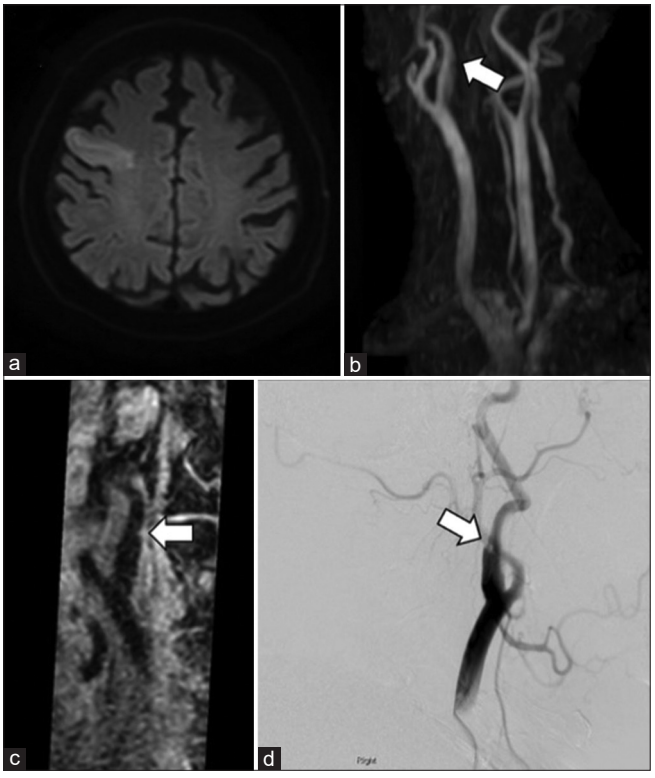


Figure 1: Images of a representative case. (a) MRI: Cerebral infarction of the right frontal lobe is observed; (b) MRA: A low-intensity linear structure protruding anteriorly from the posterior wall of the origin of the right internal carotid artery is observed (arrow). (c) T1 black-blood scan. Linear structures are visualized as slightly high-intensity lesions (arrow). (d) DSA. A linear shadow defect extending anteriorly from the posterior wall of the origin of the right internal carotid artery is observed (arrow).

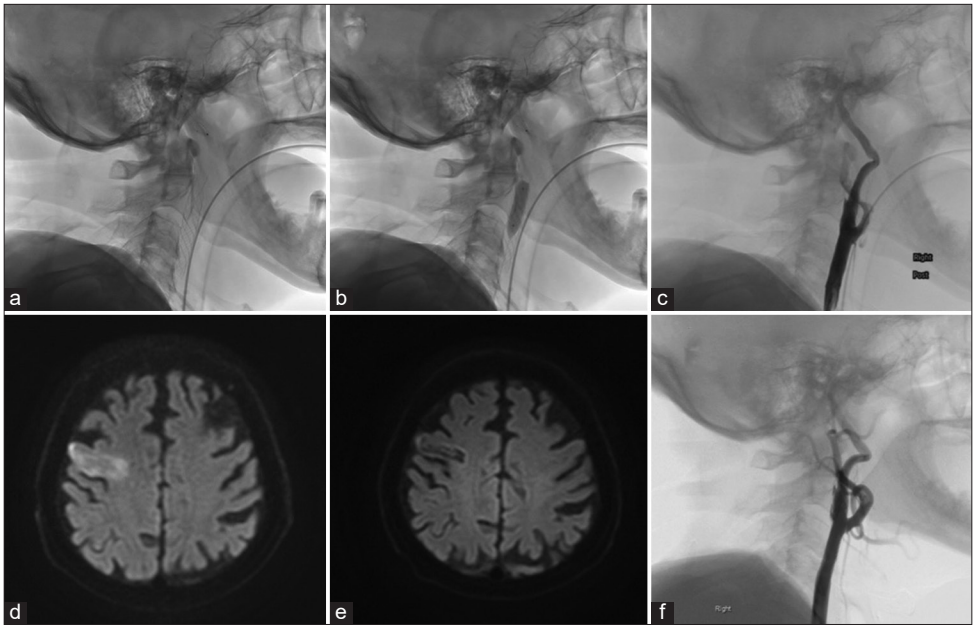


Figure 2: Intraoperative findings of CAS. (a) Full deployment of a CASPER stent. (b) Post dilation. (c) Postoperative DSA. No acute in-stent occlusion or plaque protrusion is observed. (d) Postoperative MRI. No ischemic complications are observed. (e) MRI 6 months after treatment. No new infarction is observed. (f) DSA 6 months after treatment. No in-stent stenosis is observed.

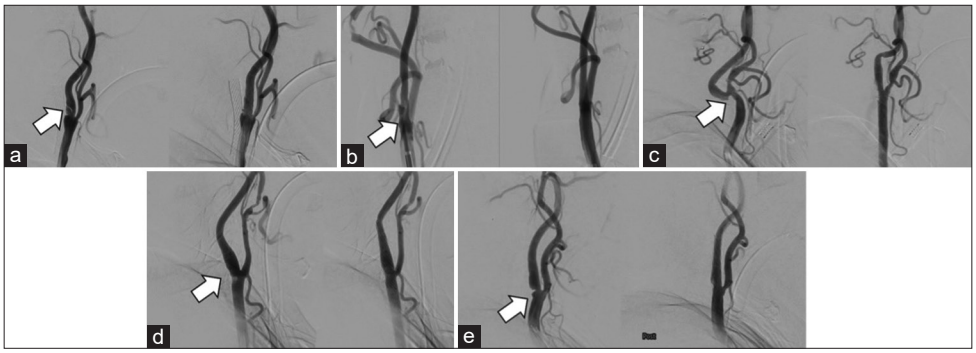


Figure 3: Images of the other CAS cases. (a-e) There was a stenotic lesion of carotid web (arrow). Left image: Previous operation. Right image: Postoperation.

Table 1: Diagnostic criteria for carotid web at our hospital.

1)	Shelf-like structures on the posterior wall at the origin of the internal carotid artery. Flattened structures rather than simple intimal thickening.
2)	Lesion must be presented within 20 mm of the internal carotid bifurcation.
3)	Stagnation of blood flow and turbulence near the lesion.

within 20 mm from the bifurcation of the internal carotid artery, referring to the report by Janzen[5] [Table 1].

A carotid web protrudes into the internal carotid artery, and its membranous structure causes turbulent flow with stagnant blood flow at the isthmus of the lesion, which increases the risk of platelet aggregation, and thrombus formed there is said to cause cerebral infarction.[9] Therefore, both thrombotic and embolic elements are thought to be involved. In addition, a case of a shelf-like lesion at the caudal side, in which turbulent flow with stagnation of blood flow can be formed,[6] relatively similar to an ulcer, has been reported.

The presence of stagnant blood flow near the lesion is also a criterion for the diagnosis of a carotid web in our hospital [Table 1].

Patients with cerebral infarction who have a carotid web are considered to be at high risk for recurrent infarction. In a study by Guglielmi *et al*., one in six patients with a symptomatic carotid web had recurrent cerebral infarction within 2 years, suggesting that conventional medical treatment alone may not be sufficient to prevent recurrence.[13]

Table 2: Patient's characteristics. All patients had symptomatic carotid artery stenosis with a carotid web. After the operation, no new neurological deficits were observed at 1 year.

	Age	Sex	Medical background	mRS (preoperation)	Medication (preoperation)	Percentage of stenosis (%)	Anesthesia	mRS (postoperation)	postoperative stroke
1	79	M	HT, HL	1	Aspirin+clopidogrel	80	General	1	None
2	80	M	HT, DM, HL	1	Aspirin+clopidogrel	60	General	1	None
3	93	F	HT, HL	1	Aspirin+clopidogrel	65	General	1	None
4	74	F	None	1	Aspirin+clopidogrel	70	General	1	None
5	79	F	HT, HL	1	Aspirin+clopidogrel	60	General	1	None
6	86	M	HT	1	Aspirin+plasugrel	60	General	1	None

DM: Diabetes mellitus, HL: Hyperlipemia, HT: Hypertension, M: Male F: Female mRS: Modified rankin scale

In a systematic review by Zhang *et al*., 54% of patients treated with antiplatelet therapy and 75% of patients treated with anticoagulation had a recurrence, whereas patients treated with surgical revascularization had no recurrence.[2] A carotid web is composed of fibrous tissue, and positive remodeling has not been reported. Therefore, aggressive surgical intervention should be considered.[7] In 2013, Lenck *et al*. reported the first CAS for the carotid web.[8] Regarding the technique of CAS for carotid webs, Haussen *et al*. reported 24 CAS cases, and closed-cell stents were used in 75% of them. No serious complications related to the procedure were reported.[3]

The CASPER stent was performed in this study. Kawahara *et al*.[6] showed that in addition to the typical finding of a thrombus adhering to the rostral side of a web lesion, some patients had lesions that could form turbulence with stagnant blood flow not only on the rostral side but also on the caudal side, which was considered to be relatively similar to an ulcer. The dual structure of the CASPER stent was thought to be effective for the carotid web, which has both fibrotic and ulcerative lesions. Fibrotic lesions may benefit from a laser cut with high radial force, while ulcerative lesions may benefit from the braided stent to prevent plaque protrusions. The CASPER stent has a dual-layer structure, with a soft braided nitinol outer layer that adheres closely to the vessel wall, a high mesh density in the inner layer, and a micromesh with pores, reducing the risk of plaque protrusion from the stent strut, and the incidence of associated ischemic complications has been reported to be lower than that of conventional stents.[4,11] The dual-layer structure of the CASPER stent was considered to be effective against fibrotic and ulcerative lesions. In fact, no postoperative cerebral infarction occurred in the present cases with symptomatic carotid webs using the CASPER stent [Table 2]. However, the CASPER stent may have less radial force than the laser-cut stent. Therefore, a larger balloon catheter is used to expand the stent and firmly adhere it to the vessel wall.

To improve treatment safety, general anesthesia was performed in all CAS cases in this study. Nagata *et al*. have shown that general anesthesia using sevoflurane and nitrous oxide in oxygen-depressed baroreceptor reflex sensitivity, induced hemodynamic stability under CAS, and may decrease the rate of occurrence of complications.[1,10]

CONCLUSION

Although this was a single-center study with a small number of cases, it showed that CAS with a CASPER stent for symptomatic carotid webs did not cause ischemic complications. Thus, CAS with a CASPER stent may be an effective treatment for a symptomatic carotid web. We hope that this paper will be useful for future studies of the treatment of symptomatic carotid webs.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The author(s) confirms that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

REFERENCES

1. Gekka M, Osanai T, Aoki T, Nakayama N, Kazumata K, Houkin K, *et al.* Efficacy of carotid artery stenting performed under general anesthesia with somatosensory evoked potential monitoring. J Stroke Cerebrovasc Dis 2021;30:106007.
2. Guglielmi V, Compagne KC, Sarrami AH, Sluis WM, van den

Berg LA, van der Sluijs PM, *et al.* Assessment of recurrent stroke risk in patients with a carotid web. JAMA Neurol 2021;78:826-33.
3. Haussen DC, Grossberg JA, Koch S, Malik A, Yavagal D, Gory B, *et al.* Multicenter experience with stenting for symptomatic carotid web. Interv Neurol 2018;7:413-8.
4. Imamura H, Sakai N, Matsumoto Y, Yamagami H, Terada T, Fujinaka T, *et al.* Clinical trial of carotid artery stenting using dual-layer CASPER stent for carotid endarterectomy in patients at high and normal risk in the Japanese population. J Neurointerv Surg 2021;13:524-9.
5. Janzen J. The microscopic transitional zone between elastic and muscular arteries. Arch Mal Coeur Vaiss 2004;97:909-14.
6. Kawahara I, Hiu T, Ono T, Haraguchi W, Ushijima R, Tsutsumi K. Reconsideration of carotid web and the therapeutic strategy. No Shinkei Geka 2019;47:659-66.
7. Krasteva MP, Diamantaras AA, Siller T, Mordasini P, Heldner MR. Symptomatic carotid web in a female patient. SAGE Open Med Case Rep 2020;8.
8. Lenck S, Labeyrie MA, Mosimann PJ, Saint-Maurice JP, Houdart E. Diaphragm of the internal carotid artery: A novel cause of pulsatile tinnitus. J Neurol 2013;260:2185-7.
9. Mac Grory B, Emmer BJ, Roosendaal SD, Zagzag D, Yaghi S, Nossek E. Carotid web: An occult mechanism of embolic stroke. J Neurol Neurosurg Psychiatry 2020;91:1283-9.
10. Nagata S, Kazekawa K, Aikawa H, Tsutsumi M, Kodama T, Iko M, *et al.* Hemodynamic stability under general anesthesia in carotid artery stenting. Radiat Med 2005;23:427-31.
11. Yamada K, Yoshimura S, Miura M, Kanamaru T, Shindo S, Uchida K, *et al.* Potential of new-generation double-layer micromesh stent for carotid artery stenting in patients with unstable plaque: A preliminary result using OFDI analysis. World Neurosurg 2017;105:321-6.
12. Yang T, Yoshida K, Maki T, Fushimi Y, Yamada K, Okawa M, *et al.* Prevalence and site of predilection of carotid webs focusing on symptomatic and asymptomatic Japanese patients. J Neurosurg 2021;135:1370-6.
13. Zhang AJ, Dhruv P, Choi P, Bakker C, Koffel J, Anderson D, *et al.* A systematic literature review of patients with carotid web and acute ischemic stroke. Stroke 2018;49:2872-6.

How to cite this article: Kamatani K, Yoshida S, Tashiro N, Hashiguchi Y, Takigawa K, Yasaka M, *et al.* The case of treatment for carotid web – Double-layer micromesh stent implantation in our hospital. Surg Neurol Int 2023;14:339.