

Embolectomy of acute embolic stroke associated with ipsilateral carotid web: a case report and literature review

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Abstract

A carotid web is a thin intraluminal protrusion located in the posterolateral wall of the carotid bulb, which might be a risk factor for cryptogenic stroke. The mechanism of ischemic stroke caused by carotid web is still unclear, but it might be related to hemodynamic changes distal to the web, resulting in flow forces and remote embolization of fibrin-based clots. The diagnosis of a carotid web mainly depends on carotid artery imaging examinations. The main therapeutic strategies include medical treatment with oral antiplatelet agents and anticoagulants, and operative treatment, such as carotid endarterectomy and carotid artery stenting. Few cases of acute large-vessel occlusion undergoing mechanical thrombectomy in the setting of carotid web as the etiology have been reported. We report here a case of a 37-year-old woman who underwent stent retriever embolectomy after acute ischemic stroke. Carotid artery imaging examinations, including digital subtraction angiography and magnetic resonance imaging, and pathology showed that a carotid web was located at the proximal right internal carotid artery. We also discuss the clinical pathophysiological and imaging features, and the treatment of carotid web as described in the currently available literature.

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Keywords

Carotid web, cryptogenic stroke, embolectomy, arterial embolism, computed tomography angiography, stent

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Introduction

Although the etiology of ischemic stroke is crucial for secondary prevention, the underlying mechanisms are unknown. Recent studies have shown that a carotid web is a novel risk factor for cryptogenic ischemic stroke.^{1,2} A carotid web is often misdiagnosed or missed because of the lack of relevant experience of radiologists or clinicians, especially in patients in a precarious situation. The pathogenesis of ischemic stroke caused by a carotid web is not fully understood, but it could be attributed to the morphological characteristics and regional hemodynamic changes in a carotid web.¹ Some studies have corroborated the proposed mechanism of flow stasis, thrombosis, and clot fragmentation with resultant cerebral embolism in the formation of a carotid web.¹ Endovascular therapy for an ipsilateral carotid web inducing large-vessel occlusion has rarely been reported.³ We report a young female patient with ipsilateral carotid web associated with acute right middle cerebral artery occlusion who was successfully treated by stent retriever embolectomy. Moreover, we summarize the imaging features of carotid web to hopefully improve its diagnosis.

Case report

A 37-year-old woman who did not have a previous medical history or known cerebrovascular risk factors was admitted to a local hospital for suddenly developed left hemiparesis. A dose of 1,000,000 IU urokinase

was administered intravenously in the local hospital before arriving at our hospital. On emergency admission, the symptoms were aggravated with severe left hemiplegia, somnolence, and gaze paralysis 240 minutes after onset, and the National Institutes of Health Stroke Scale score was 14. No obvious abnormal changes were detected on brain computed tomography (CT). Digital subtraction angiography (DSA) showed that the right middle cerebral artery M1 was occluded (Figure 1a), and it was recanalized (Figure 1b) after performing stent retriever embolectomy. Additionally, a small triangular filling defect in the posterior wall was found at the proximal right internal carotid artery (Figure 1c). Cerebral magnetic resonance imaging (MRI) showed acute ischemic lesions in the territory of the right middle cerebral artery (Figure 1e, f). Laboratory investigations and 24-hour Holter monitoring results were normal. A carotid web at the proximal right internal carotid artery was identified by computed tomographic angiography (CTA) (Figure 1g, h) and high-resolution magnetic resonance imaging (HRMRI) (Figure 2a, b). Additionally, Doppler ultrasound showed a reticular structure extending into the right carotid bifurcation with thrombosis (Figure 2e). DSA (Figure 1d) and HRMRI (Figure 2c, d) showed small protruding lesions at the proximal left internal carotid artery. She was treated with aspirin 100 mg/day, clopidogrel 75 mg/day, and atorvastatin 40 mg/day in our stroke unit. The National Institutes of Health

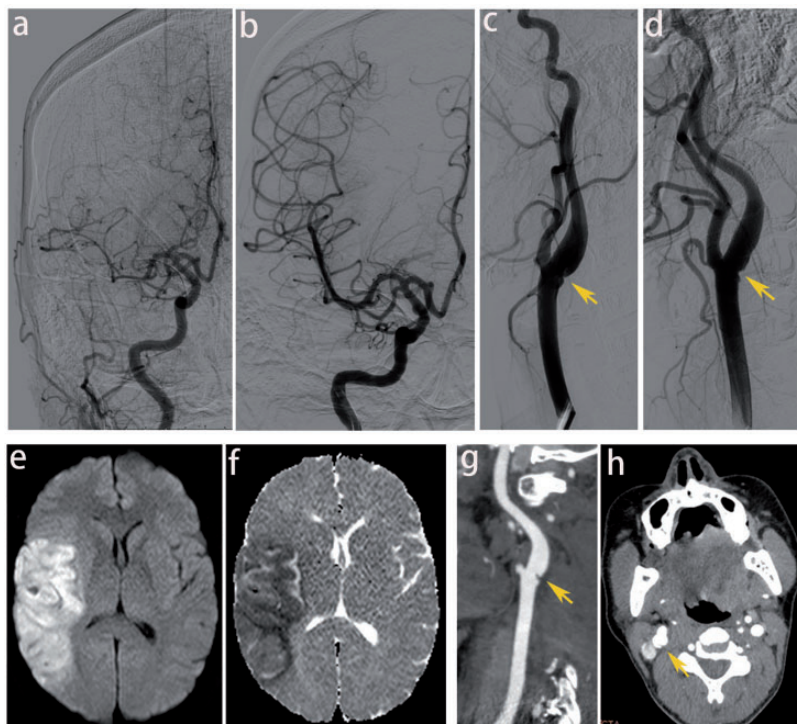


Figure 1. Digital subtraction angiography at presentation showing that the right middle cerebral artery M1 is occluded (a) and it is recanalized after embolectomy (b). (c) A small triangular filling defect (yellow arrow) along the posterior wall of the right carotid bulb can be seen. (d) A small protruding lesion (yellow arrow) along the posterior wall of the left carotid bulb can be seen. Axial magnetic resonance imaging shows restricted diffusion (e) and a low apparent diffusion coefficient (f) in the right hemisphere. (g) The oblique lateral plane of computed tomography angiography shows a shelf-like filling defect (yellow arrow) along the posterior wall of the right carotid bulb consistent with a carotid web. (h) Computed tomography angiography in the axial plane shows partition dependent on the posterolateral wall (yellow arrow).

Stroke Scale score was 2 after 7 days of treatment. Carotid endarterectomy was performed 20 days post-stroke because of the high recurrence rate of stroke in patients with symptomatic carotid web that has not yet received surgical treatment. The histopathology (Figure 2f, g) showed fibrous intimal thickening with an adherent thrombus. The patient did not experience any cerebrovascular ischemic events over 3 months of follow-up. The reporting of this study conforms to the CARE guidelines.⁴

Discussion

The potential association of a carotid web and ischemic stroke was not recognized until the first case was reported in 1968.⁵ Rainer et al. described a young woman with transient right-sided hemiparesis events, and a diaphragm-like intraluminal filling defect was found at the posterior aspect of the internal carotid artery bulb.⁵ A carotid web is a specific type of myofibrous dysplasia mainly involving the inner

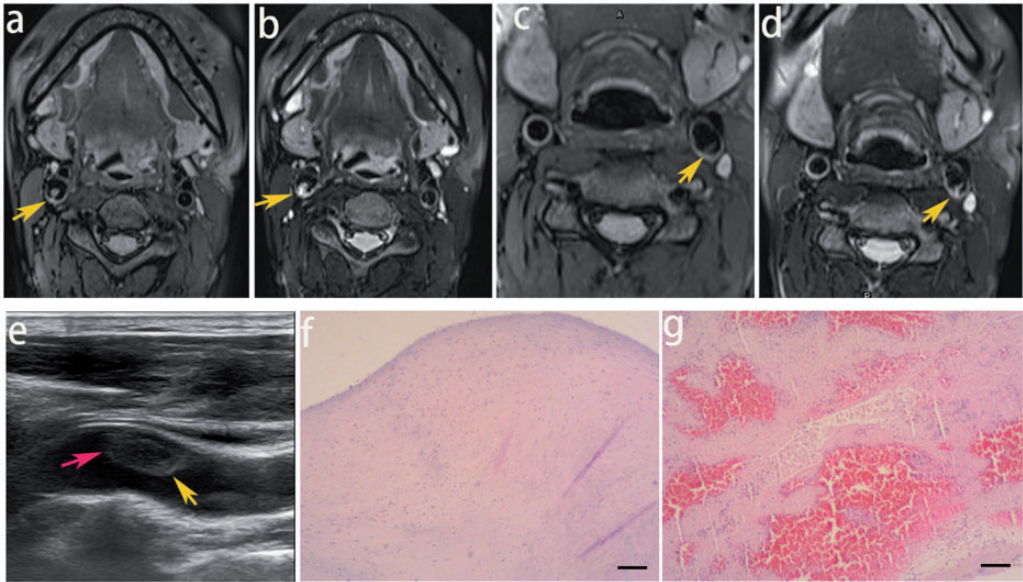


Figure 2. Precontrast (a) and postcontrast (b) magnetic resonance vessel wall imaging of the right carotid bulb shows a shelf-like protrusion (yellow arrow) slightly T1 hypointense relative to the normal vessel wall with enhancement. Precontrast (c) and postcontrast (d) magnetic resonance vessel wall imaging of the left carotid bulb shows a shelf-like protrusion (yellow arrow) slightly T1 hypointense relative to the normal vessel wall with peripheral enhancement. (e) Doppler ultrasound showing thrombosis formation (red arrow) and the septum projecting (yellow arrow) into the right carotid bifurcation. (f) Hematoxylin–eosin staining shows that the carotid web consists of extensive fibromuscular proliferation. Scale bar, 100 μm . (g) Hematoxylin–eosin staining shows that the attached thrombus is a mixed thrombus. Scale bar, 100 μm .

layer of the arterial wall. Although data are not available on the prevalence of a carotid web, it accounts for a common cause of ischemic stroke among young patients, especially women, and the median age of its pathological evidence is 40.5 years.⁶ A recent study provided evidence on the correlation between a carotid web and ischemic stroke in patients in whom alternative causes of stroke are not identified.⁷ A carotid web may be an underrated risk factor for stroke. Sajedi et al. found that patients with a carotid web accounted for 21.2% of cryptogenic stroke cases.⁸ Nevertheless, the exact mechanism of a carotid web has not yet been clarified. A patient-based, computational, fluid dynamics study showed that carotid webs were associated with increased recirculation

zones and regional increased wall shear stress metrics that were associated with disturbed flow.⁹ The pathology of endarterectomy specimens from some patients with a carotid web showed focal fibrous intimal thickening with an adherent thrombus.¹ Additionally, the rate of superimposed thrombosis has been described in 12% to 29% of patients with stroke attributable to a carotid web.⁶ Turbulence and stasis in the cul-de-sac upstream of the web may create a thrombogenic milieu, and embolic stroke may occur when the size of the thrombus is sufficiently large.¹ This theory is supported by the appearance of thrombus superposed along the upper surface of the diaphragm on vascular imaging and the pathological specimens in some patients with a carotid web.^{1,2,8} We report a young

female patient without any known cerebrovascular risk factors and thrombosis in the upper part of a carotid web, which was detected by Doppler ultrasound and pathology. The underlying pathogenesis of ischemic stroke could be that a right carotid web causes local hemodynamic changes, thrombosis, and thrombus shedding, leading to right middle artery occlusion.

A carotid web may be unilateral or bilateral. Haussen et al. found that 58% of patients with a carotid web had contralateral carotid webs, which could remain asymptomatic during a median follow-up of longer than 10 months.¹⁰ An asymptomatic carotid web presents with a more benign course compared with a symptomatic carotid web. A recent case series reported small protruding lesions, as described in our case, and they may have the same pathology as carotid webs.² However, whether these lesions would cause thrombogenesis similar to carotid webs is yet to be determined.

Doppler ultrasound is a widely used examination tool for the carotid artery without any radiation injury. The representative ultrasonographic manifestation of carotid webs is a membranous structure protruding from the carotid sinus or the initial segment of the internal carotid artery that fluctuates with blood flow. Additionally, hemodynamic changes near the carotid web can also be observed by Doppler ultrasound, which is superior to CTA in showing morphological and hemodynamic evidence of thrombus formation. However, a carotid web is often misdiagnosed as an atherosclerotic plaque by the operator because of a lack of clinical experience and skills.^{2,6}

CTA allows detailed anatomical imaging of the craniocervical vessels with multiplane reconstruction in a short period, and has a high sensitivity and specificity for diagnosing a carotid web. CTA also differentiates between a carotid web and atherosclerosis

and other lesions. However, CTA cannot provide information about flow dynamics and the composition of the lesion. Additional disadvantages of exposure to radiation and iodinated contrast agent have also been found.^{1,2,6,7,9,10} In our case, Doppler ultrasound showed a carotid web with thrombosis in the right internal carotid artery, while craniocervical CTA failed to identify thrombosis.

MRI has the advantages of non-radiation and non-invasiveness. A sagittal image shows the shape and position of a carotid web, and an axial image shows the characteristics of the luminal structure. Only a few studies have shown the application of HRMRI in the diagnosis of a carotid web. A small-sample study by Zhu et al. suggested that carotid ultrasound combined with CTA and HRMRI is an effective and reliable method for diagnosing a carotid web.¹¹ Therefore, HRMRI could also be considered as a useful diagnostic method to detect carotid webs.

DSA is an imaging tool with high temporal and spatial resolution, and it is the criterion standard for craniocervical angiography in carotid imaging. DSA is characterized by a remnant of contrast that can be observed over a carotid web.⁶ However, a disadvantage of DSA is that it has a risk of losing the carotid web in the invasive operation by standard posteroanterior and lateral projections. A misdiagnosis usually occurs during emergency endovascular treatment. In the current case, the carotid web presented as a small triangular filling defect on DSA was initially not identified by the radiologist.

The epidemiology of an acute anterior circulation large-vessel occlusion in ipsilateral carotid web is unclear. Baseline data of 3439 adult patients with anterior circulation large-vessel occlusion stroke who underwent endovascular treatment showed that 30 (0.9%) of them were complicated by ipsilateral symptomatic carotid web.¹²

Semerano et al. found that, in 1430 patients with large-vessel occlusion stroke treated by endovascular thrombectomy, 11 (0.7%) had a symptomatic carotid web.¹³ All of them achieved successful angiographic reperfusion (modified Thrombolysis in Cerebral Infarction 2b-3) after endovascular thrombectomy. Endovascular thrombectomy appears to be a feasible treatment in large-vessel occlusion stroke related to symptomatic carotid web, similar to our case.

Presently, there is no unified standard for treating a carotid web because of the lack of high-quality, clinical trials. The main treatments include anticoagulation, antiplatelets, stents, and carotid endarterectomy. Some studies have shown a high recurrence rate of ischemic stroke in patients with conservative treatments.¹⁰ Thrombosis secondary to a carotid web is similar to mural thrombosis of the left atrium. Therefore, anticoagulant therapy appears to be the most effective for secondary prevention, but relevant data are lacking. The histopathological manifestation of a carotid web is atypical myofibrous dysplasia, and a carotid stent or carotid endarterectomy is the optimal treatment.⁸ Some studies have shown that carotid endarterectomy or carotid stenting is safe and effective in the treatment of carotid webs.^{2,6,10,14,15} A recent review of 70 patients showed that 60% of them had a symptomatic carotid web, and they underwent carotid endarterectomy or carotid artery stenting without any complications or stroke recurrence for a median follow-up of 14 months.¹⁴ In our case, the patient was treated by carotid endarterectomy and remained stable during 3 months of follow-up.

In conclusion, we report a case of acute middle cerebral artery occlusion in a female patient in whom a carotid web at the proximal right internal carotid artery was found on Doppler ultrasound, HRMRI, CTA, and DSA. We also summarized the imaging

characteristics and therapeutic strategy of carotid webs by reviewing the literature. The findings of our case may help us to understand the possible pathogenesis of arterial-to-arterial embolism caused by carotid webs. Currently, high-quality research is still limited, and the epidemiology, diagnosis, pathogenesis, and treatment of symptomatic or asymptomatic carotid webs need to be further investigated.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

Ethics statement

This study was approved by the Ethics Committee of Xingtai Third Hospital (approval number: 2021-KY-28). Written informed consent was obtained from the patient for publication of this report.

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