

Ultrasound Imaging of Carotid Web with Atherosclerosis Plaque: A Case Report

Bin Ning¹, Dong Zhang², Binbin Sui³ and Wen He^{1*}

¹Department of Ultrasound, Beijing Tiantan Hospital, Capital Medical University, Fengtai District, Beijing, China

²Department of Neurosurgery, Beijing Tiantan Hospital, Capital Medical University, Fengtai District, Beijing, China

³Department of Neuroradiology, Beijing Tiantan Hospital, Capital Medical University, Fengtai District, Beijing, China

***Corresponding Author:** Wen He, Department of Ultrasound, Beijing Tiantan Hospital, Capital Medical University, Fengtai District, Beijing, China.

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Abstract

To the best of our knowledge, no previous studies on carotid webs with atherosclerosis plaque have been conducted. Thus, both radiologists and clinicians have insufficient knowledge on this disease, which could lead to misdiagnosis and missed diagnosis. An accurate diagnosis is beneficial to clinical management and prevention of stroke. Here, we present a case of a carotid web with an atherosclerotic plaque, which was confirmed by histopathology and was treated at the Department of Neurosurgery, Beijing Tiantan Hospital.

Keywords: *Ultrasound Imaging; Carotid Web; Atherosclerosis Plaque*

Abbreviations

CEA: Carotid Endarterectomy; CTA: Computed Tomography Angiography; DUS: Doppler Ultrasound

Introduction

Carotid web was known as a membranous structure of the carotid bulb protrudes into the lumen, and was a cause of cryptogenic stroke, the image representation has certain characteristics [1-7], but carotid web with atherosclerosis have no known etiological factors and are rarely reported. Thus, imaging characteristics of carotid webs with atherosclerosis could be unknown and easily ignored by radiologist and sonographer. The diagnosis could be difficult and effective management remains indeterminate. Moreover, prompt recognition of this disease is key to correct treatment and management. Hence, this case report and the relevant data in the literature could contribute to the improvement of the diagnosis and treatment of this disease.

Case Presentation

A 61-year-old man was admitted to the hospital with intermittent dizziness and slurred speech for 1.5 years and numbness of both upper limbs for 4 months. After resting, the patient showed improvement and had intermittent attacks without any treatment. Computed

tomography angiography (CTA) examination indicated stenosis at the beginning of the left internal carotid artery. Because of recurrent symptoms, he sought admission to the hospital for further treatment. Moreover, the patient had diabetes for 17 years and was treated with an oral antidiabetic medication. He also had hypertension for 10 months (blood pressure up to 220/120 mmHg) and was treated with an oral antihypertensive drug. He had 20-pack years of smoking history.

DUS and CTA examination

Routine examination with CTA and Doppler ultrasound (DUS) before surgery was performed. CTA indicated a small niche shadow in the left internal carotid artery on sagittal view (Figure 1) and no significant stenosis was found. The diagnosis based on CTA was atherosclerosis plaque surface ulceration. In the preoperative ultrasound examination, a membrane-like structure protruding into the lumen from the lateral posterior wall at the beginning of the left internal carotid artery on gray scale was noted, and an isoechoic plaque could be seen at the basilar part of the membrane-like structure (Figure 2). Moreover, the membrane-like structure projected into the lumen in a certain curve and was not floating in the blood. We adjusted the scanning angle for a better view of the whole length of the membrane-like structure; we observed a huge hollow space between the membrane-like structure and the plaque, which was similar to a large ulcer; however, the plaque surface was smooth and flat (Figure 3). In addition, Color Doppler Flow Image (CDFI) showed a whirlpool at the level of the carotid web (Figure 4) and super micro flow imaging (SMI) demonstrated a membrane-like filling defect with a small, broad base in the longitudinal (Figure 5) and transverse (Figure 6) views. A diagnosis of a carotid web with an atherosclerotic plaque was made based on the aforementioned image characteristics.



Figure 1: CTA indicated a small niche shadow in the left internal carotid artery on sagittal view (red arrow).

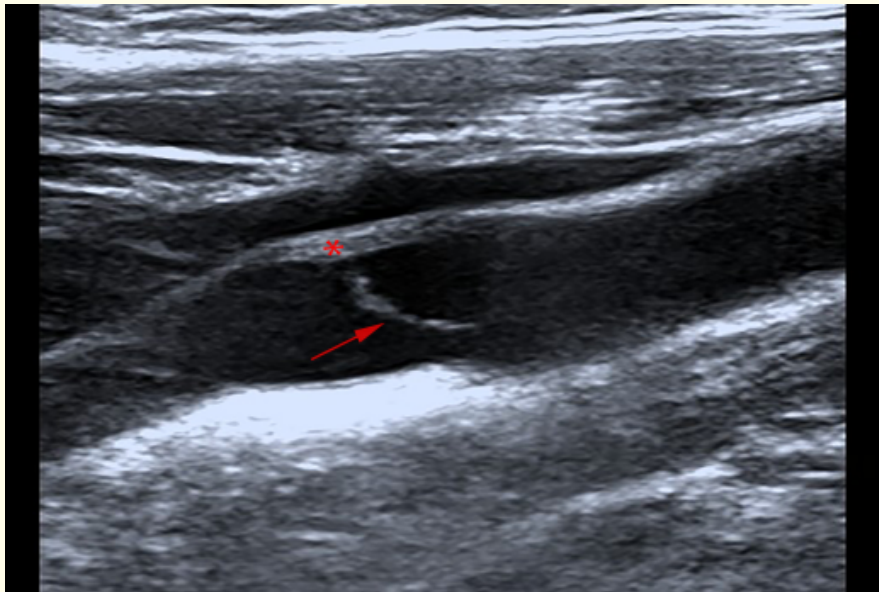


Figure 2: DUS showing membrane-like structure protruded into the lumen (arrow). The isoechoic plaque (star) on the artery wall was attached to the basilar part of the membrane-like structure.

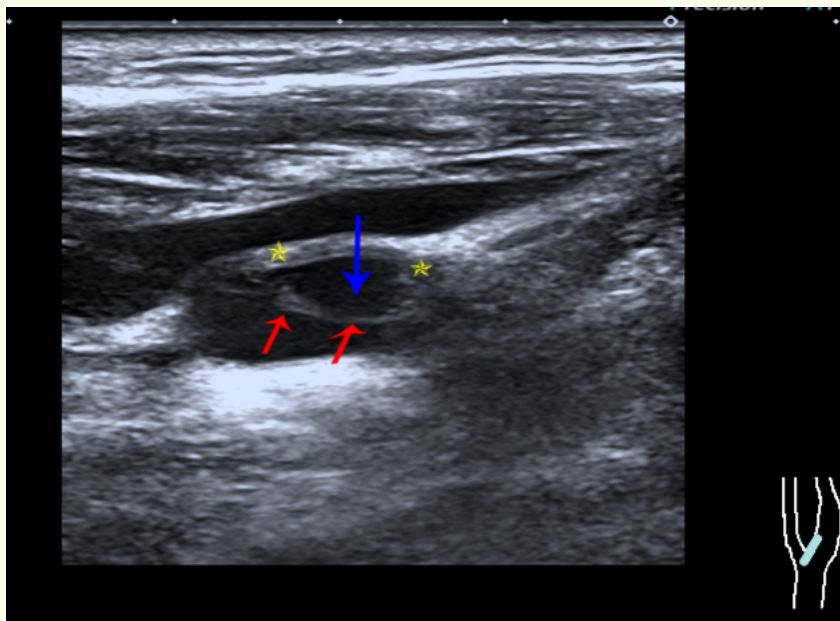


Figure 3: DUS showing carotid web (red arrow), plaque (yellow star), and huge cavity (blue arrow).

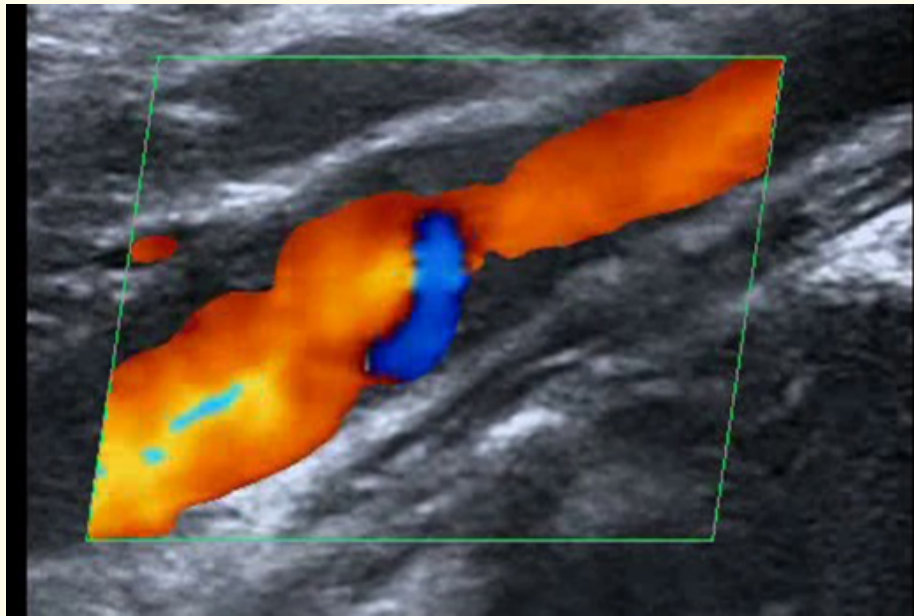


Figure 4: Color Doppler flow image showing whirlpool at the level of the carotid web on the longitudinal section.

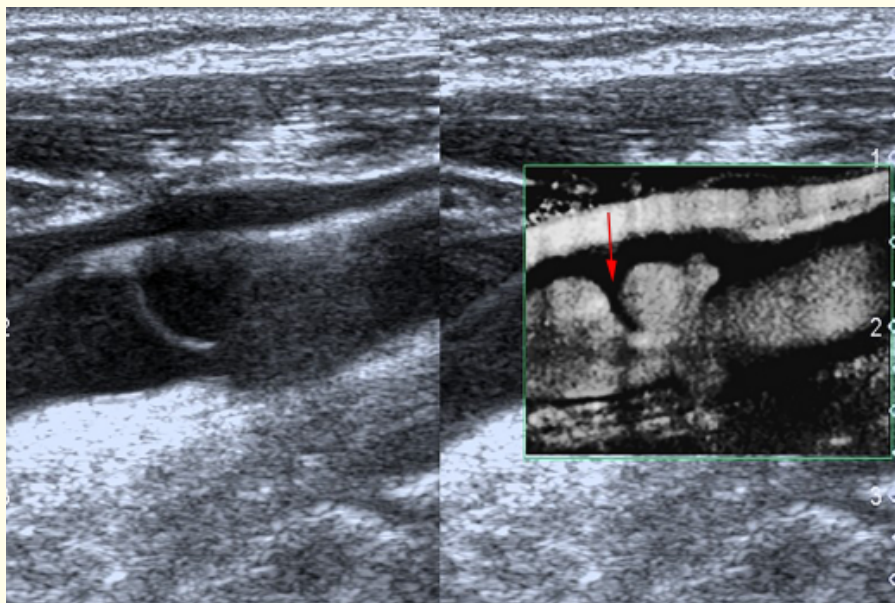


Figure 5: Superb Micro-vascular Imaging, SMI, showing the membrane-like filling defect of the carotid web (arrow) on longitudinal view.

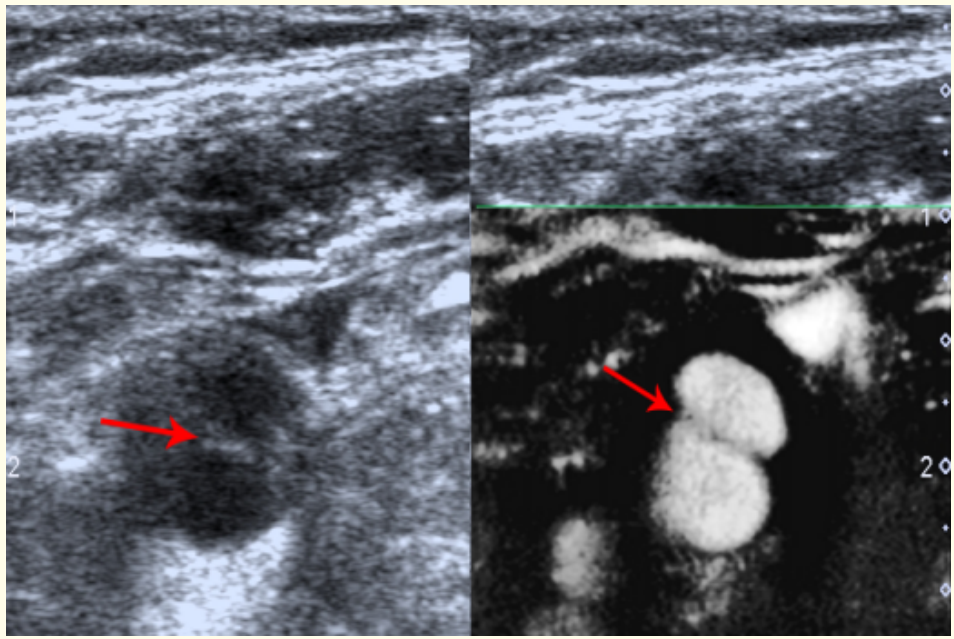


Figure 6: Superb Micro-vascular Imaging, SMI, showing the carotid web on transverse view (arrow).

Furthermore, spectral Doppler imaging was performed on an ultrasonic imaging system (TOSHIBA Aplio 500, Japan) equipped with a linear array transducer (11L-4 probe) at the carotid preset (frequency = 8 MHz, wall filter = 5).

Treatment and histopathology

To relieve the symptoms of the patient, CEA was performed. The diagnosis of a carotid web with an atherosclerotic plaque by DUS was confirmed by the postoperative specimen (Figure 7); both the carotid web and the plaque surface were smooth without evidence of ulceration, which was consistent with the findings of DUS. The lesion tissue after CEA was fixed in formalin, embedded in paraffin, and sectioned in the axial plane. Sections were stained for hematoxylin and eosin, and the postoperative gross specimen and histopathology showed that the basilar part of the carotid web contained an atherosclerosis plaque (Figure 7 and 8). The carotid web consisted of extensive intima fibroid hyperplasia with myxoid degeneration (Figure 9), moreover, no ulceration was found in any of the sections. Subsequently, we performed CTA multiplanar reconstruction, and the membrane-like filling defect was best shown in both the sagittal and axial views (Figure 10 and 11); however, the atherosclerosis plaque attached to the carotid web could not be observed clearly. The patient’s neurologic status continued to improve postoperatively.



Figure 7: Macroscopic views of surgical specimens. The carotid web (red arrow), atherosclerosis plaque (red star), and any part of the tissue were smooth. No ulcer on the surface of plaque or carotid web was noted.

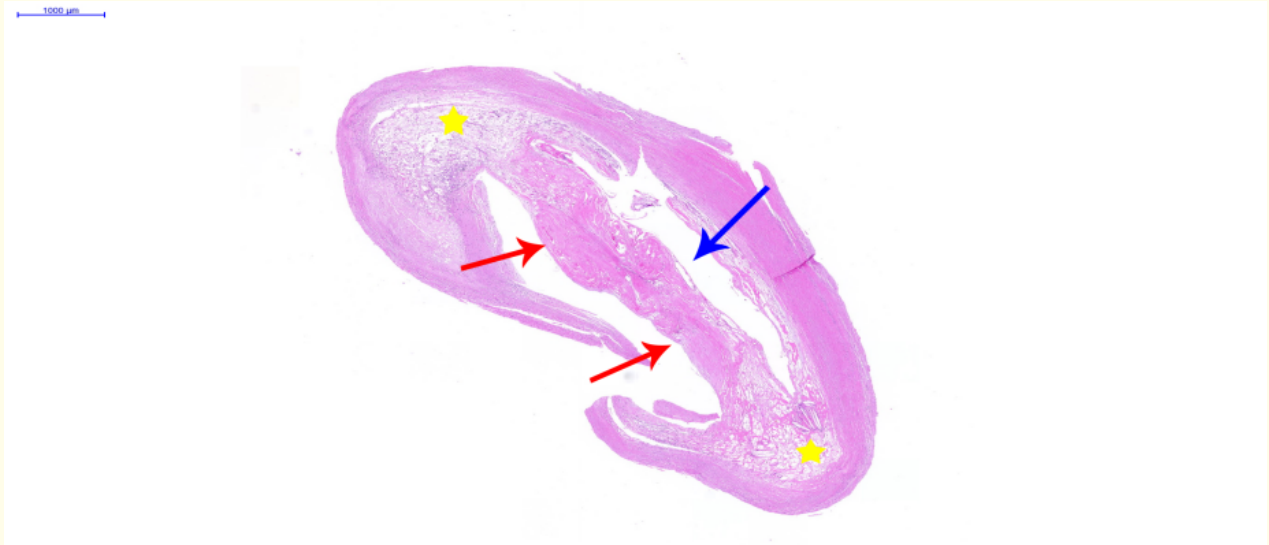


Figure 8: Hematoxylin-eosin staining confirmed that carotid web (red arrow) is extensive intima fibroid hyperplasia with plaque (yellow star) and cavity (blue arrowhead) between the carotid web and plaque.

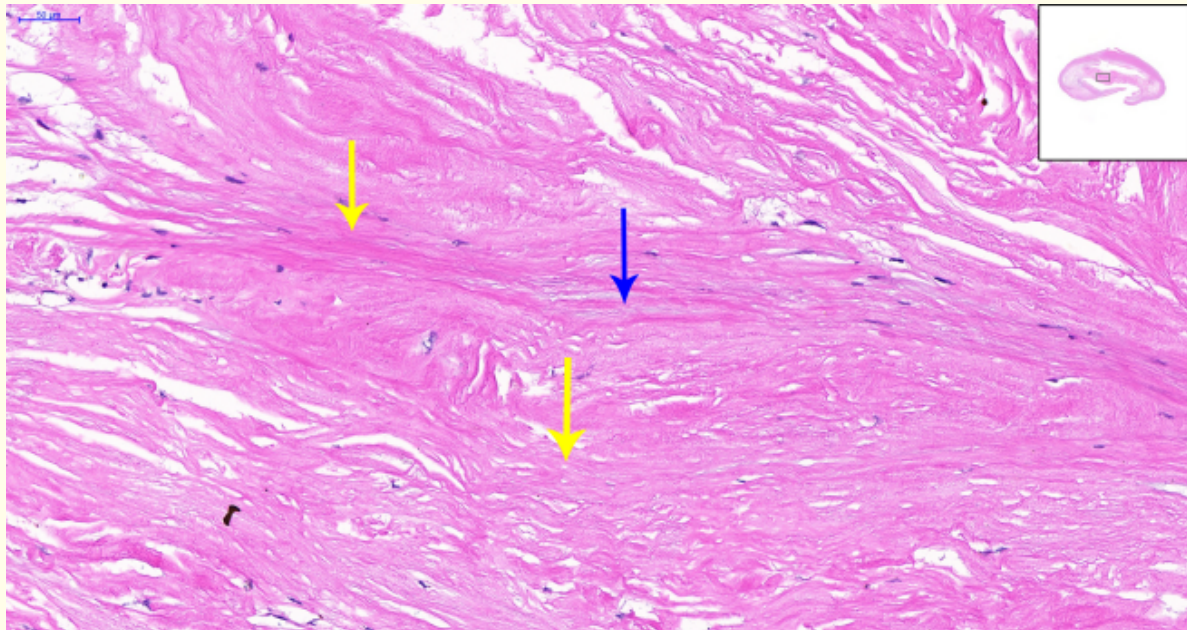


Figure 9: The carotid web was extensive intima fibroid hyperplasia (yellow arrow) with myxoid degeneration (blue arrow) (high magnification).



Figure 10: Multiplanar reconstruction of computed tomography angiography (after carotid endarterectomy) showed membrane-like filling defect (red arrow) on sagittal view.

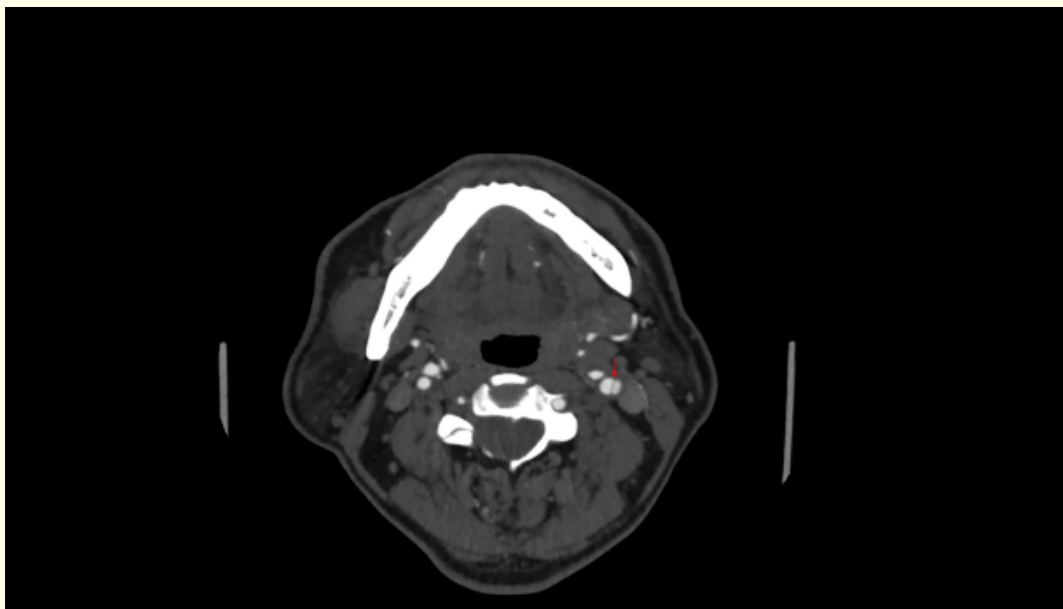


Figure 11: Multiplanar reconstruction of computed tomography angiography (after carotid endarterectomy) showed membrane-like filling defect (red arrow) on axial view, which could be easily confused with artery dissection or ulcer.

Discussion and Conclusion

To understand carotid webs with plaque formation, we should first fully understand a carotid web. The term “web” was first used to describe this disease by Momose and New in 1973 at the Massachusetts General Hospital. They analyzed 7000 carotid angiograms for 8 years and found 4 cases with web-like tissue in the lumen in the cervical portion of the internal carotid artery [1]. Subsequently, relevant studies on carotid webs were reported [2-6], which suggested that carotid webs are thin membrane structures protruding into the lumen, are more common in the posterior or lateral posterior wall of the internal carotid bulb and are approximately eight times more common in patients with stroke than in controls. Moreover, carotid webs are strongly associated with ischemic stroke [3,8] and it is one of the causes of cryptogenic stroke in young patients [1,4,10,15]. However, it is often missed [11] and could be an underappreciated risk factor for stroke [4,9]. In addition, carotid webs may contribute to recurrent ischemic stroke [6,9,10] and despite antithrombotic use and antiplatelet therapy, 30% incidence of recurrence was previously reported [12]; the recurrence could be attributed to carotid webs being a nidus for thrombus formation, which could in turn result in ischemic stroke via arterial embolism [1,6]. Surgical intervention is the preferred method of treatment. Traditional endarterectomy is performed in nearly all carotid web cases identified in the existing literature [6,12,13,16]. Histopathology of the specimens in previous studies showed smooth muscle with extensive myxoid degenerative changes [12,16-18], which is consistent with our results; however, in our case, atherosclerosis plaque is attached to the basilar part of the carotid web (Figure 6-8). Furthermore, based on the literature, the three key points of carotid web are as follows: it is subtle and small, it tends to affect young patients, and it could cause ischemic stroke via arterial embolism by the whirlpool around the carotid web. Thus, because of its subtle morphology and small size and with the lack of familiarity of this disease, radiologists and clinicians tend to ignore the subtle image features, and as the disease is more common in young patients, radiologists and clinicians typically do not consider the disease in elderly patients, thereby resulting in misdiagnosis. Different from previous reports, our report identified a plaque at the basilar part of the carotid web, and a cavity was observed between the carotid web and the atherosclerosis plaque. This could lead to hemodynamic changes, such as whirlpool formation, turbulence, and blood stasis, increased possibility of endothelial cell injury of the surface of the atherosclerosis plaque and /or carotid web, activate coagulation mechanisms, lead to thrombosis, which in turn could trigger a stroke.

It is worth emphasizing that the image characteristics of the carotid web with atherosclerotic plaque formation could be easily confused with plaque surface ulceration, especially in geriatric patients. Both radiologists and sonographers may not consider the possibility of this disease and thus make the wrong diagnosis, i.e. plaque surface ulcer formation. However, the two diseases are treated differently. Carotid webs with or without atherosclerotic plaques should be treated with antiplatelet therapy, and the most effective and radical treatment is surgical intervention, whereas the treatment of atherosclerosis plaque surface ulceration may include plaque stabilization therapy. Thus, accurate diagnosis is key to preventing stroke and treating the disease. We consider that ultrasound has absolute diagnostic advantages, although reports on the disease diagnosed by ultrasound examination are rare. Nonetheless, Kliewer and Perren described carotid webs using DUS in 1991 and 2004, respectively [13,14] and another case of carotid web by DUS was reported in 2015 [11]. While almost all diagnosis and reports on this disease were based on CTA or digital subtraction angiography, a study in 2017 using DUS reported on a carotid web with a short segment filling defect [15]. Thus, DUS could make an accurate diagnosis and may have the ability to diagnose carotid web. Nevertheless, an accurate diagnosis depends on the full understanding and careful observation of the image characteristics. In our case, we found that the carotid web with a plaque had similar image characteristics to plaque surface ulcer formation due to the cavity structure; however, substantial differences between the two diseases were noted. The top of ulcer cavities had no membranous structure, while the plaque attached to the base of the carotid web did have a membranous structure on the cavity surface.

Moreover, DUS could show the carotid web and the plaque clearly, i.e. the structural and positional relationships between the carotid web and plaque could be clearly displayed on ultrasound. Nevertheless, slightly adjusting the probe direction is needed to trace the direction and angle change of the membrane structure, and careful observation on multiple angles is necessary. Moreover, high suspicion of the disease may be helpful for the diagnosis. In our case, a minor niche shadow on the lateral wall at the beginning of the internal carotid

artery was identified with CTA (Figure 1) and the carotid web was not found. Therefore, the absence of any suspicion and insufficient recognition of this disease may be the reasons for the misdiagnosis with CTA. After CEA, we observed the fresh tissue and histopathology features of the disease and summarized the image characteristics based on DUS and made a CTA image reconstruction. Interestingly, the manifestations of the carotid web with plaque based on DUS and CTA image reconstruction were similar (Figure 5, 6, 10 and 11). The filling defect were membrane-like or shelf-like and a cavity was found between the web and the plaque, which could be easily confused with plaque surface ulceration. However, the disease differs from plaque surface ulceration as the surface of the ulcer is eroded and damaged and does not have intact smooth endothelium, whereas the surface of the carotid web with an atherosclerotic plaque is smooth and intact.

Clinicians, including radiologists and sonographers, should be aware that carotid webs with atherosclerotic plaques could occur on not only in young patients with stroke but also in elderly patients with stroke. Because the pathogenesis of carotid webs alone versus carotid webs with atherosclerotic plaques are similar, accurately distinguishing the two diseases presents a diagnostic and therapeutic challenge. Thus, careful examination of the diseases is vital to decrease missed diagnosis and misdiagnosis. A previous study reported that early and correct diagnosis of carotid webs is crucial not only to establish the probable cause of stroke but also to prevent the risk of recurrence [2]; thus, adequate understanding of this disease for early diagnosis is critical for the prevention of stroke and recurrence and for the clinical management of the disease.

However, currently, carotid webs are challenging because of its small and thin characteristics. The low detection rate may be due to a lack of experience, insufficient scanning skills, and limited understanding of the image characteristics. To reduce the rate of missed diagnosis and misdiagnosis, both radiologists and sonographers should increase their familiarization of the image features of the disease. Moreover, acoustic beam direction should be traced along the direction of the carotid web, the whole length evaluated, and the basilar part of the carotid web carefully observed to detect whether the base is attached to the plaque or has thrombus formation. Lastly, high suspicion of the disease could aid in the diagnosis.

In conclusion, DUS could show the morphology of the carotid web with or without plaques, Nevertheless, improvement in scanning skills is vital. CTA was considered the gold standard for the diagnosis of this disease; however, without adequate knowledge, it could lead to misdiagnosis and missed diagnosis. Early diagnosis of the disease could guide the clinical management of the disease, thereby reducing the incidence and recurrence of stroke.

Ethics Approval and Consent to Participate

The research has been approved by the ethics committee and consent to participate, the registration number: ChiCTR 1900027295.

The scientific title: Mild carotid stenosis and stroke recurrence: a national multicenter cohort study based on multimodal ultrasound imaging evaluation.

Consent for Publication

Written informed consent was obtained from the patient for the publication of this case report and any accompanying images.

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing Interests

The authors declare that they have no competing interests.

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Authors' contributions

DZ performed the surgery in this case. BN, DZ, BS, and WH contributed to the treatment of the patient and the writing of this manuscript. All authors have read and approved the final version of the manuscript.

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