Access this article online

Quick Response Code:

Website: http://www.braincirculation.org

DOI: 10.4103/bc.bc_75_22

Importance of multiplanar reformation angiographic images for the detection of carotid web: A case series

Laura Zelada-Ríos[1,2], Danny Barrientos-Imán[1], Lourdes Simbrón-Ribbeck[3], Carlos Abanto Argomedo[1], Jorge Ramírez-Quiñones[1], Pilar Calle La Rosa[1], Ana Valencia Chávez[1], Ricardo Otiniano-Sifuentes[1,4]

Abstract:

Carotid web (CW) is considered a variant of intimal fibromuscular dysplasia. CW represents between 9.4% and 37% of ischemic strokes that were initially misclassified as "cryptogenic." However, in Latin America, there is a lack of detection. We present 5 cases of ischemic stroke due to CW and discuss the usefulness of multiplanar reformatting (MPR) imaging in computed tomography angiography. The identification of CW with the use of tridimensional (3D) reconstructions and maximum intensity projection was 20%, the rest was misdiagnosed as atherosclerotic plaque. With the MPR, the identification of typical CW findings was improved, such as a thin septum, a shelf-like image, and a mountain shadow-like image. However, one must be alert to changes in the 3D disposition of the carotid bifurcation, as they may mask the typical CW findings. A good practice is to align the internal carotid artery exactly posterior to the external carotid artery in the sagittal plane.

Keywords:

Carotid web, cryptogenic stroke, computed tomography angiography, multiplanar reformation

Introduction

Carotid web (CW) is considered a variant of intimal fibromuscular dysplasia,[1] described as a shelf-shaped filling defect arising from the posterolateral wall of the carotid bulb.[2] CW represents between 9.4% and 37% of ischemic strokes that were initially misclassified as "cryptogenic."[3-6] However, in Latin America, there is an underreporting due to many factors, such as the poor recognition of this entity through ultrasonography. Although ultrasonographic studies can detect CW, their detection capacity is operator dependent.[7,8]

Angiographic studies of supra-aortic vessels, such as digital subtraction angiography (DSA) or noninvasive studies, such as computed tomography angiography (CTA) or magnetic resonance angiography (MRA), allow for the diagnosis of CW based on its location and shape.[2] However, viewing only tridimensional (3D) reconstructions or maximum intensity projections (MIP) can mask CW. We present 5 cases of ischemic stroke due to CW and highlight the usefulness of multiplanar reformatting (MPR) imaging in CTA.

Case Report

Between December 2020 and April 2021, there were 84 cases of ischemic stroke, in 5 of these patients (6.0%); the etiology was CW [Table 1]. They were three women and two men aged between 35 and 43 years. A previous stroke (transient ischemic attack) was only reported in case

[1]Department of Neurovascular Diseases, Instituto Nacional de Ciencias Neurológicas, [2]San Fernando School of Medicine - Postgraduate Unit, Universidad Nacional Mayor de San Marcos, [3]Diagnostic Imaging Department, Universidad Peruana Cayetano Heredia, [4]School of Public Health and Administration, Universidad Peruana Cayetano Heredia, Lima, Peru

Address for correspondence:
Dr. Ricardo Otiniano-Sifuentes, Jr. Ancash 1271, Barrios Altos, Lima 15003, Peru.
E-mail: rotinianos@incn.gob.pe

Submission: 08-10-2022
Revised: 22-11-2022
Accepted: 29-11-2022
Published: 24-03-2023

How to cite this article: Zelada-Ríos L, Barrientos-Imán D, Simbrón-Ribbeck L, Argomedo CA, Ramírez-Quiñones J, Rosa PC, *et al*. Importance of multiplanar reformation angiographic images for the detection of carotid web: A case series. Brain Circ 2023;9:44-7.

Table 1: Summary of Carotid web cases associated with ischemic stroke

	Case 1	Case 2	Case 3	Case 4	Case 5
Age (years)	37	43	42	35	41
Sex	Female	Female	Female	Male	Male
Comorbidities	None	None	Chronic headache	None	Migraine
Previous stroke	No	Yes: TIA	No	No	No
NIHSS at admission	8	13	3	17	14
Stroke side	Right	Left	Right	Left	Right
Affected artery	MCA M1	MCA M3	MCA M2	MCA M1	MCA M2
CTA cervical	Yes	Yes	Yes	Yes	Yes
MIP and 3D reconstruction*	Appearance of atherosclerotic plaque	Appearance of atherosclerotic plaque	Appearance of Carotid Web	Appearance of atherosclerotic plaque	Appearance of atherosclerotic plaque
Axial MPR	Posterolateral wall-dependent thin septum	Posterolateral wall-dependent thin septum	Posterolateral wall-dependent thin septum	Appearance of atherosclerotic plaque	Appearance of atherosclerotic plaque
Sagittal MPR	Shelf-like membrane	Shelf-like membrane	Shelf-like membrane	Shelf-like membrane	Shelf-like membrane
Coronal MPR	Mountain shadow-like image	Eccentric plaque appearance	Mountain shadow-like image	Mountain shadow-like image	Eccentric plaque appearance
DSA	No	Yes	Yes	Yes	Yes
CW side	Right	Bilateral	Bilateral	Left	Bilateral
Degree of stenosis (%)	<50	<50	<50	<50	<50
LDL cholesterol (mg/dL)	97	96	122	115	176
NIHSS at discharge	1	NA	0	15	6
Treatment	Aspirin 100 mg/ day, atorvastatin 40 mg/day	Aspirin 100 mg/ day, atorvastatin 40 mg/day	Aspirin 100 mg/ day, atorvastatin 40 mg/day	Aspirin 100 mg/ day, atorvastatin 80 mg/day	Aspirin 100 mg/ day, atorvastatin 40 mg/day
Follow-up time (months)	6	6	6	6	6
Recurrence	No	No	No	No	No

*Neurologist blind to the diagnosis of ischemic stroke. MCA: Middle cerebral artery, MIP: Maximum intensity projection, MPR: Multiplanar reformatting, DSA: Digital subtraction angiography, CW: Carotid web, NA: Not available, LDL: Low-density lipoprotein, TIA: Transient ischemic attack, NIHSS: National institutes of healt stroke scale, 3D: Tridimensional

2, which occurred 2 months earlier. Patients had no cardiovascular risk factors; the only antecedent was headache in cases 3 and 5. In all cases, the cerebral infarction was in the territory of the middle cerebral artery, in the M1 (two cases), the M2 (two cases), and M3 (one case) segments. Echocardiogram and Holter studies were normal. Cervical CTA showed CW ipsilateral to the affected hemisphere. In two cases, there were bilateral CWs and one of them also had a thrombus superimposed on one of its membranes (case 5). Discharge treatment consisted of acetylsalicylic acid 100 mg/day and high-intensity atorvastatin. No recurrences were reported in an average of 6 months of follow-up.

The identification of CW with the use of 3D reconstructions and MIP was 20%; the rest was misdiagnosed as atherosclerotic plaque. With MPR, in the axial planes, a septum was identified at the level of the carotid bulb compatible with CW in 60%. In sagittal planes, in all cases, there was a shelf-like image dependent on the posterolateral wall. In the coronal plane, in 60%, an image was found as a mountain shadow. The presence of at least two of these findings was 80%, and the presence of all three was 40% [Figure 1].

Discussion

We report clinical and imaging characteristics of 5 cases of CW. We found that patient's characteristics that guided the diagnosis were age group and absence of cardiovascular risk factors. The use of MPR by CTA facilitated the identification of CW compared to MIP and 3D reconstructions. MPR findings were the presence of a thin septum in the axial planes, followed by a shelf-like image in the lateral planes and a mountain shadow-like image in the coronal planes.

Currently, CW can be detected with a comprehensive diagnostic workup; therefore, it is not correct to define CW as a cause of cryptogenic stroke. However, in previous studies, ischemic strokes associated with CW represented up to 37% but were misclassified as cryptogenic strokes, probably because their causal role was unknown.[6] In Latin American countries such as Peru, there are few reports of this etiology.[7] Some clinical characteristics, such as those found in our cases, can guide the diagnosis of CW. In these patients, it is important to perform angiographic studies of supra-aortic vessels such as CTA, MRA, or DSA. However, in noninvasive angiographic studies, CW may be missed if only 3D reconstructions or MIPs are viewed.

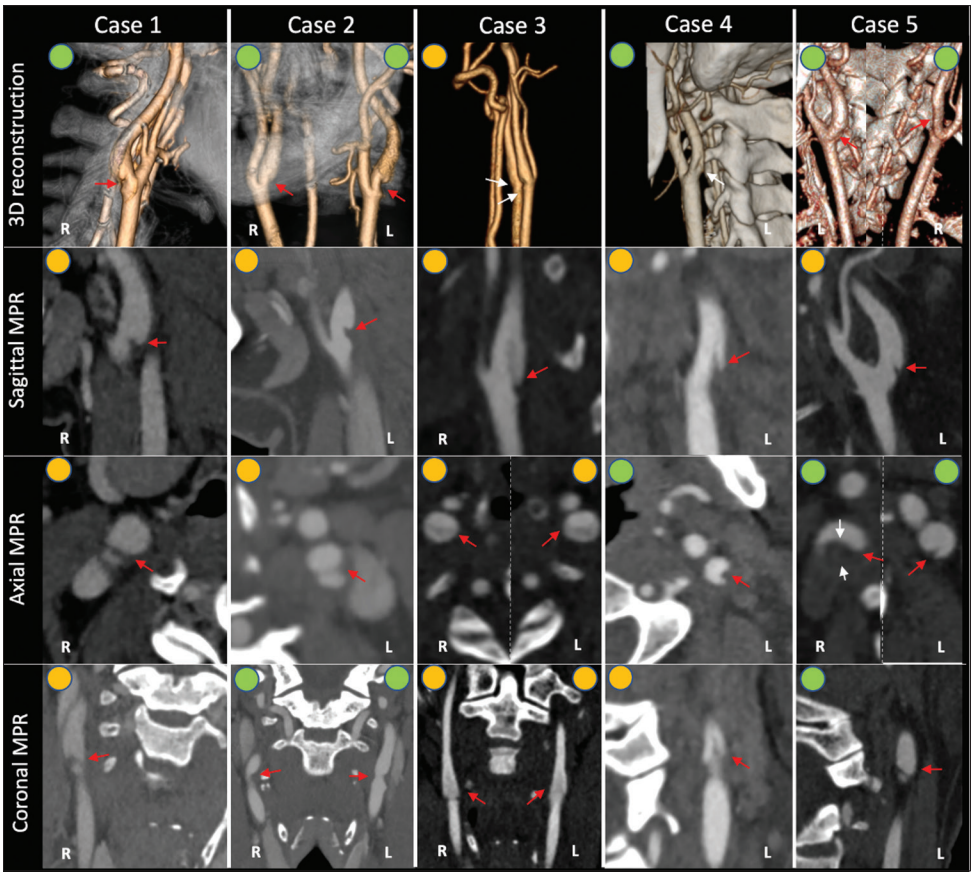

Figure 1: Images of 3D and MPR reconstructions by CTA. Yellow circles indicate imaging modalities that correctly identified a typical CW finding. Green circles indicate imaging modalities that did not identify a typical CW finding. Arrows point to the CW. The typical CW finding in the MPR sagittal plane is a shelf-like image that was identified in all 5 cases; In the axial plane, the typical finding is a thin septum dividing the carotid bulb. This was only found in 3 of our cases. Finally, in the coronal plane, the CW is observed as a mountain shadow image, and it was identified in 3 of our cases. In case 5, a thrombus adhered to the right CW is observed in the axial plane of the MPR (white arrows). R: Right, L: Left, CTA: Computed tomography angiography, CW: Carotid web, MPR: Multiplanar reformatting, 3D: Tridimensional

MIPs display only the voxels that have the highest contrast intensity in a given projection. This generates a sum of images that gives a depth effect that varies according to the determined slice thickness. If the thickness of the MIP slice is wide, it can hide the CW, especially if it is small. The MPR, on the other hand, gives us images in different planes with a minimum thickness. This allows a better appreciation of the typical characteristics of CW and thus distinguishes them from its main differential diagnoses.

Atherosclerotic plaque can mimic CW because they share a location in the carotid bulb. In our cases, MIP misdiagnosed atherosclerotic plaques instead of CW in 80% of cases. However, MPRs achieved better diagnostic accuracy. The sagittal plane was the one that best-detected findings compatible with CW: A membrane with a smooth edge that protrudes into the lumen giving a shelf-like image dependent on the posterior wall of the carotid bulb. In contrast, atherosclerotic plaque is not usually limited to the posterior wall of the bulb, also compromising the distal common carotid artery and above the carotid bulb. In addition, the plaque surface is usually irregular, with ulcerations, intraplaque hemorrhage, or calcifications.[9]

Another differential diagnosis is carotid dissections; because it also occurs in young adult patients without cardiovascular risk factors and has similar imaging findings. In the sagittal plane, an intimal flap from a dissection might resemble a shelf-like image; while in the axial plane, the double-lumen image of a dissection can be confused with the thin septum of a CW. However, dissections usually spare the carotid bulb and start 2 cm above the carotid bifurcation [Table 2].[1]

The visualization of these three findings, in their respective planes, depends on the anatomical distribution. Normally, the internal carotid artery (ICA) has a posterior-lateral origin to the external carotid artery (ECA); however, since the carotid bifurcation is in a soft and adipose environment, its 3D disposition can vary even with movements of the throat (coughing and swallowing) and mask the CW. For this reason, it is recommended to align the ICA exactly posterior to the ECA in the sagittal plane. This will allow to improve the visualization of typical CW finds in their respective planes.

Table 2: Carotid web mimics in computed tomography angiography

	Sagittal plane	Axial plane	Coronal plane
CW	Shelf-like membrane dependent on the posterior wall of the carotid bulb	Thin septum dividing the lumen of the carotid bulb	If the internal carotid artery is posterior to the external carotid, it is seen as a mountain shadow
Mimics	Dissection: Intimal disruption results in a flap that mimics CW. However, its location is generally above the carotid bulb Atherosclerotic plaque: These are frequently located in the carotid bulb. When these are located in the posterolateral wall and are small, these can simulate a CW	Dissection: The intimal flap produces a double lumen image	

CW: Carotid web

In our case series, all patients were treated with aspirin, and there was no recurrence. However, we cannot affirm that aspirin is an effective treatment given that our series is very small and has a short follow-up. In addition, stenting and open surgery are also widely recommended in CW due to the high incidence of recurrent stroke in young patients.[3] It is necessary to design studies that identify the population of CW patients that best benefit from invasive treatment.

In conclusion, CW-compatible findings are a thin septum, a shelf-like image, and a mountain shadow-like image. The proper use of MPRs improves the identification of these findings and can increase the reporting of CW in Latin American countries. However, one must be alert to changes in the 3D disposition of the carotid bifurcation, as they may mask the typical CW findings.

Ethical approval

This study was approved by the Ethics Committee of the Peruvian National Institute of Neurological Sciences (No. 026-2021-CIEI-INCN). This case report was performed in accordance with the ethical standards of the Declaration of Helsinki.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Kim SJ, Nogueira RG, Haussen DC. Current understanding and gaps in research of carotid webs in ischemic strokes: A review. JAMA Neurol 2019;76:355-61.
2. Yu Y, Wang B, Zheng S, Kou J, Gu X, Liu T. Carotid web and ischemic stroke: A CT angiography study. Clin Imaging 2020;67:86-90.
3. 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.
4. Sajedi PI, Gonzalez JN, Cronin CA, Kouo T, Steven A, Zhuo J, *et al*. Carotid bulb webs as a cause of "cryptogenic" ischemic stroke. AJNR Am J Neuroradiol 2017;38:1399-404.
5. Coutinho JM, Derkatch S, Potvin AR, Tomlinson G, Casaubon LK, Silver FL, *et al*. Carotid artery web and ischemic stroke: A case-control study. Neurology 2017;88:65-9.
6. Joux J, Boulanger M, Jeannin S, Chausson N, Hennequin JL, Molinié V, *et al*. Association between carotid bulb diaphragm and ischemic stroke in young afro-Caribbean patients: A population-based case-control study. Stroke 2016;47:2641-4.
7. Calle La Rosa P, Ecos R, Otiniano-Sifuentes RD, Ramírez-Quiñones J, Abanto C, Quispe-Orozco D, *et al*. Carotid web diagnosed by ultrasound carotid duplex in a patient with ischemic stroke. Cureus 2021;13:e16330.
8. Luo X, Li Z. Ultrasonic risk stratification of carotid web. Echocardiography 2019;36:2103-7.
9. Trelles M, Eberhardt KM, Buchholz M, Schindler A, Bayer-Karpinska A, Dichgans M, *et al*. CTA for screening of complicated atherosclerotic carotid plaque – American Heart Association type VI lesions as defined by MRI. AJNR Am J Neuroradiol 2013;34:2331-7.