IMAGES IN CARDIOLOGY

Unexpected vascular Doppler findings in an asymptomatic patient with marked blood pressure difference between arms

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Abstract: In clinical practice, significant lesions of the innominate artery are far less common than subclavian artery stenoses. In these patients both the blood flow to the right arm and the right carotid circulation is impaired, resulting in an increased risk of ischemic cerebrovascular events. Vascular ultrasound is a useful noninvasive tool for occlusive diseases of the subclavian and innominate arteries, but direct visualization of these proximal segments is difficult, and diagnosis is usually based on indirect Doppler signs.
Keywords: innominate artery, vascular ultrasound, subclavian steal phenomena

Rezumat: În practica clinică leziunile semnificative de trunchi brahiocefalic sunt mult mai rare decât stenozele de artere subclavii. La acești pacienți sunt afectate atât fluxul sanguin către brațul drept cât și circulația carotidiană, cu creșterea riscului de evenimente ischemice cerebrovasculare. Ultrasonografia Doppler este o metodă neinvazivă utilă pentru depistarea leziunilor severe ale arterelor subclavii și trunchiului brahiocefalic, dar vizualizarea directă a segmentelor proximale este dificilă și diagnosticul se bazează de cele mai multe ori pe semne Doppler indirecte.
Cuvinte cheie: trunchi brahiocefalic, ecografie Doppler, fenomenul furtului subclavial

We present the case of a 56 years old patient who was admitted for dyspnea at moderate exertion. He was a heavy smoker, with poorly controlled type 2 diabetes mellitus and dyslipidemia. Basic cardiovascular and neurological exam did not reveal any abnormality, except marked bilateral arm blood pressure (BP) difference on repeat measurements - left arm BP was 120/60mmHg, and right arm systolic BP was 70 mmHg. Blood tests revealed hyperglycemia (217 mg/dl) with an elevated HbA1c (7.5%). Doppler ultrasound of the extracranial arteries was performed, and the spectral Doppler tracings from the right and left carotid and vertebral arteries are shown below (Figure 1 and Figure 2).

The indirect Doppler signs revealed by vascular ultrasound: the complete reversal of flow in the right vertebral artery and the systolic reversal of flow in the carotid arteries were suggestive of a significant obstructive lesion of the innominate artery. Of note, in addition to these Doppler findings, the diameter of the right common carotid artery was considerably smaller than at the level of the left common carotid artery (4.2 mm versus 7.6 mm). Computed tomography angiography was performed in order to confirm these results and for an accurate description of the vascular lesion (Figure 3).

DISCUSSION

In patients with severe innominate artery disease blood flow to the right arm is ensured by retrograde flow through the right vertebral artery, similar to the subclavian steal phenomenon in severe lesions of the subclavian artery[1]. Additionally, carotid circulation is affected in various degrees. Doppler vascular ultrasound reveals a distinctive pattern of hemodynamic alterations in the right carotid and vertebral arteries, depending on the multiple ways of compensation of cerebral circulation through the circle of Willis and

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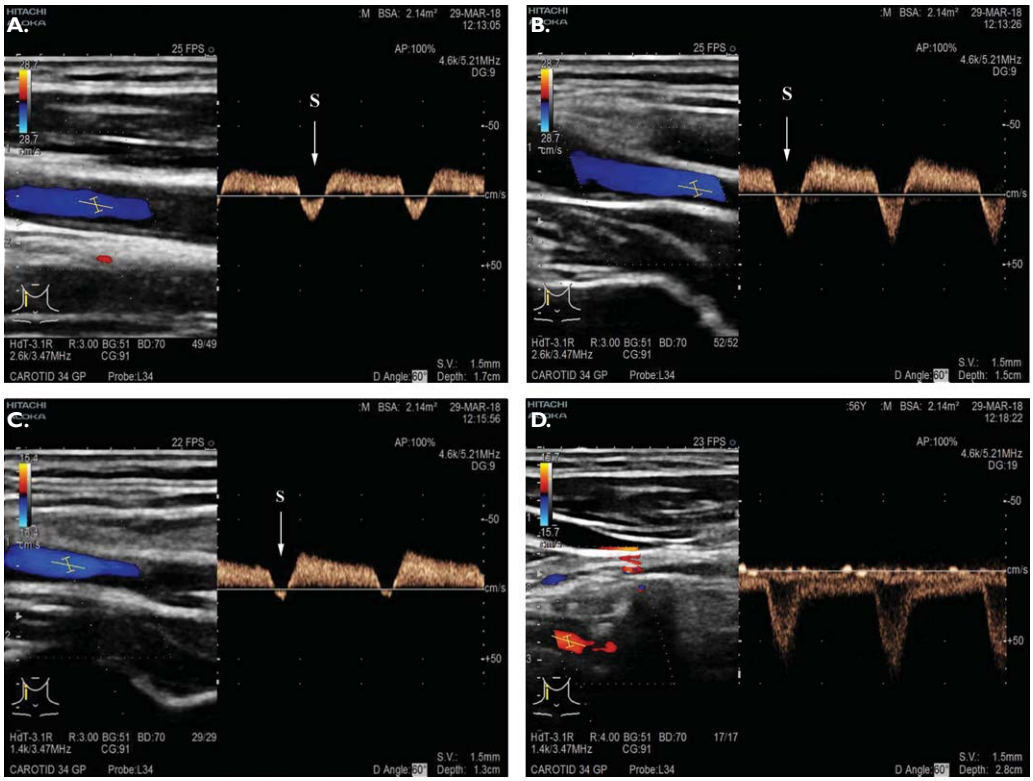

Figure 1. Spectral waveforms from right common **(A),** internal **(B)** and external **(C)** carotid arteries showing the complete reversal of flow in systole (S, arrow) and antegrade flow in diastole. **D.** Spectral Doppler tracing at the level of the right vertebral artery showing a complete flow reversal. These abnormalities are highly suggestive of significant innominate artery stenosis.

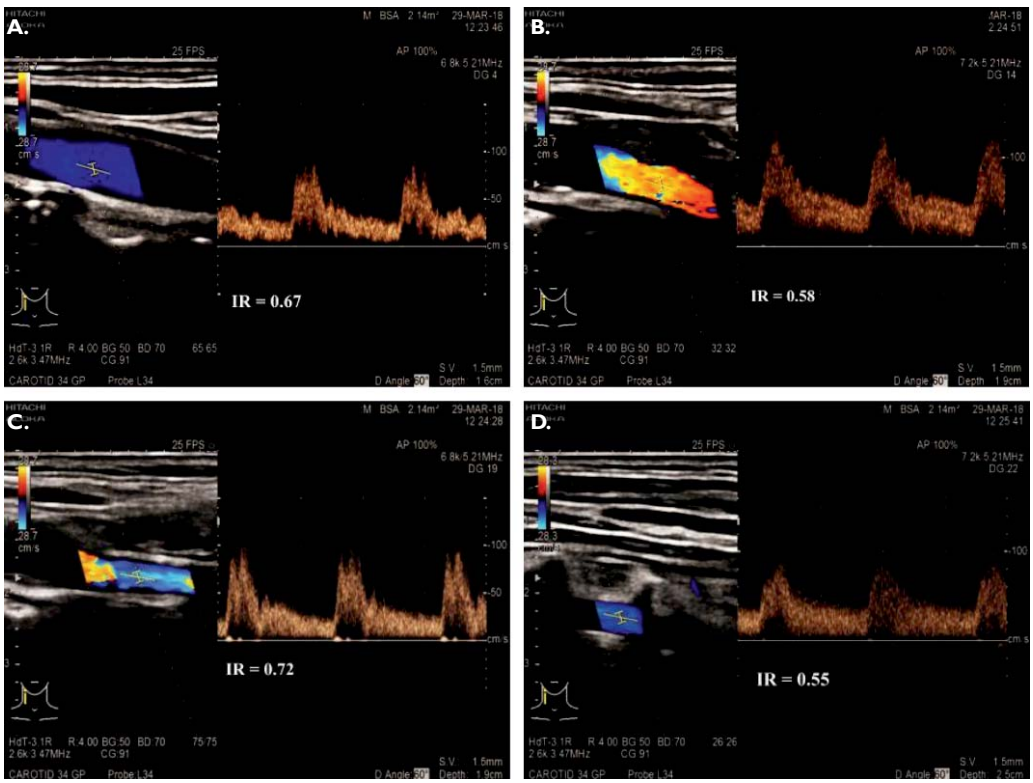

Figure 2. Spectral Doppler tracings at the level of the left common **(A'),** internal **(B')** and external **(C')** carotid arteries and left vertebral artery **(D')**. Note the relatively decreased resistive index of the left external carotid artery (suggesting internalization) and the increase of flow in the left vertebral artery.

Figure 3. Computed tomography angiography, sagital view **(A)** and coronal reconstruction **(B)** showing the circumferential thickening of the innominate artery wall on its entire length, with a patent lumen of minimum 2 mm (red arrows).

the association of contralateral carotid or vertebral stenosis. Findings include reversed or bidirectional flow in the right vertebral artery and the presence of mid-systolic deceleration or the complete reversal of flow in systole in the right carotid artery and its branches[2]. Identifying these particular vascular Doppler signs is essential in clinical practice, since although uncommon, innominate artery lesions are associated with neurologic symptoms in a high percentage of patients.

Several theories have been proposed to explain these findings. The pressure gradient that occurs beyond the subclavian stenosis relative to that of the systemic circulation was proposed as a potential mechanism for the rapid deceleration of flow in the vertebral artery after peak systole[3]. In early systole, the systemic pressure exceeds the pressure in the arm and blood flow slows dramatically or reverses in the vertebral artery. In late systole and diastole the systemic pressure falls, and is exceeded by the pressure in the poststenotic segment and antegrade flow is restored in the vertebral artery. With the increasing grade of proximal stenosis, midsystolic deceleration and ultimately flow reversal occur for a longer period in the cardiac cycle. This explanation is generally accepted for the classic subclavian steal phenomenon while midsystolic deceleration in the carotid arteries is more difficult to explain. It may be the result of a pressure gradient between the left and right carotid arterial systems communicating through the circle of Willis[2]. In view of the central location and large caliber of the innominate artery and the gradual development of stenosis in most patients, the potential for recruiting collateral arterial flow is considerable. The Doppler findings are further complicated by the presence of significant contralateral carotid lesions.

In our patient the left carotid system and the left vertebral artery were patent, without signs of significant stenoses. The patient was asymptomatic and the neurological examination was within normal limits. Nevertheless, additional brain imaging is warranted in order to make a decision regarding the management of this particular case.

Conflict of interest: none declared.

References

1. Grosveld WJHM, Lawson JA, Eikelboom BC, Windt JM, Ackerstaff RGA. Clinical and hemodynamic significance of innominate artery lesions evaluated by ultrasonography and digital angiography. Stroke 1988; 19:958–962.
2. Grant EG, El-Saden SM, Madrazo BL, Baker JD, Kliewer MA. Innominate artery occlusive disease: sonographic findings. AJR Am J Roentgenol. 2006 Feb;186(2):394-400.
3. Kotval PS, Babu SC, Shah PM. Doppler diagnosis of partial vertebral/subclavian steal convertible to full steals with physiological maneuvers. J Ultrasound Med 1990; 9:207–213.