

Diagnostic Role of Doppler Ultrasound in Innominate Steal Syndrome: A Case Presentation

 Gunel Mammadova,  Aysel Azimova,  Seymur Abbasov

Bonum Medical Centre, Department of Radiology, Shaki, Azerbaijan

ABSTRACT

Innominate steal syndrome is a rare clinical finding, caused by steno-occlusive damage of innominate artery leading to cerebrovascular symptoms. Doppler ultrasound is a valuable noninvasive method for examination of innominate artery. We report a case of a 68-year-old man who presented with recurrent blurred vision, dizziness, headache, syncopal episodes, and pain in right arm during physical activity. Arterial blood pressure was not measured and diminished radial pulse was detected in the right arm of the patient. We used a duplex ultrasound Doppler for examination of extracranial arterial vessels. Our findings were reversed flow in the right vertebral artery and systolic deceleration and tardus-parvus waveform in the right carotid artery. The feature angiographic evaluation revealed 90% stenosis of the innominate artery. Endovascular stenting was applied to the patient and enabled normal antegrade flow in the right common carotid and vertebral artery. Duplex Doppler ultrasound is a non-invasive and fairly effective method for detection steno-occlusive atherosclerotic diseases of extracranial arterial system. Here, critical stenosis in the innominate artery was successfully detected by Doppler ultrasonography and confirmed by angiographic examination.

Keywords: Innominate steal syndrome, innominate artery, cranial vessels Doppler, subclavian steal syndrome

INTRODUCTION

Innominate steal syndrome is a rare clinical finding, caused by steno-occlusive damage of innominate artery leading to cerebrovascular symptoms. Symptomatic atherosclerotic steno-occlusive disease of the innominate artery represents 2.5-4% of all extracranial causes of cerebrovascular insufficiency [1]. Doppler ultrasound is a valuable non-invasive method for examination of the innominate artery. The duplex Doppler ultrasonography method allows to determine vessel geometry and narrowing, as well as changes in the spectral characteristics of the flows [2-4]. Subsequent angiographic visualization of the atherosclerotic narrowed vessel segment allows to treat vessels with endovascular invasive methods and surgery [3,5].

CASE PRESENTATION

A 68-year-old man with hypertension and hypercholesterolemia, presented for evaluation of dizziness, headache, recurrent blurred vision, and episodes of syncope and pain in the right arm during physical activity. Arterial blood pressure was not measured in the right arm of the patient as well as barely discernable radial, ulnar, and brachial arterial

pulses were observed on the right upper limb. Written informed consent was obtained.

We did color duplex ultrasound examination, which revealed retrograde flow in his right vertebral artery (Figure 1) and antegrade flow with systolic deceleration and tardus-parvus waveform in his right common carotid artery (Figure 2). This finding is characteristic for subclavian-vertebral steal [2]. On the other side, increased antegrade low-resistance flow in the left vertebral artery (Figure 3) and increased antegrade flow in the left common carotid artery (Figure 4) are observed. This condition is due to the acceleration of flow in the left-sided vessels to meet the increased demand on the right side [1,3].

During the examination of the innominate artery, accelerated flow with aliasing effect in the color Doppler mode and a significant increase in the flow speed of the critical narrowing zone were observed in the spectral Doppler mode (Figures 5, 6). The feature angiographic evaluation demonstrated 90% stenosis of the innominate artery. Endovascular stenting was applied to the patient and enabled normal antegrade flow in the right common carotid and vertebral artery.



Address for Correspondence: Gunel Mammadova PhD, Bonum Medical Centre, Department of Radiology, Shaki, Azerbaijan

Phone: +994 50 663 00 88 E-mail: fortis.sheki@gmail.com ORCID ID: 0000-0002-4693-0321

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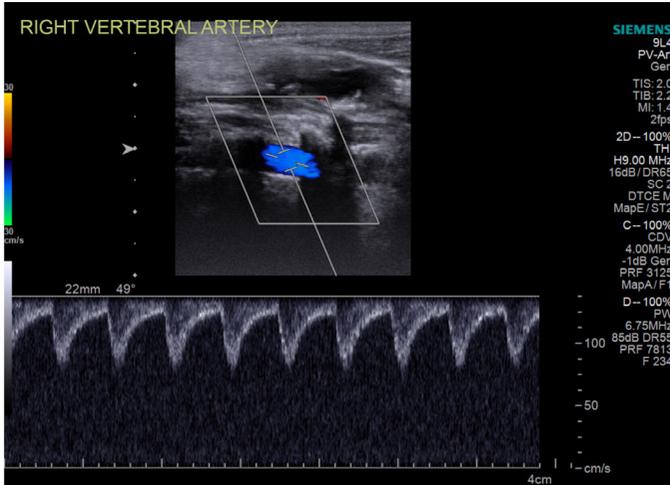


Figure 1. Retrograde flow in the right vertebral artery

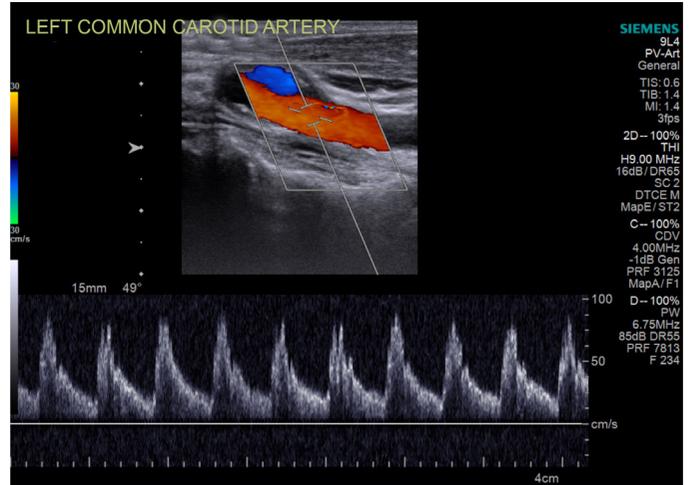


Figure 4. Increased antegrade flow in the left common carotid artery

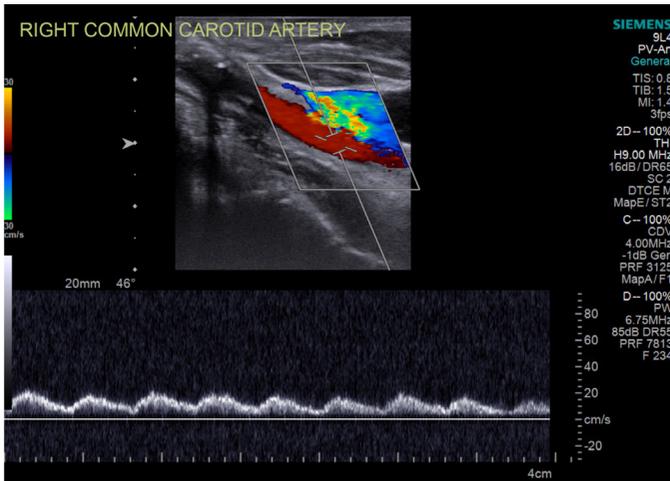


Figure 2. Antegrade flow with systolic deceleration, tardus-parvus waveform in the right carotid artery

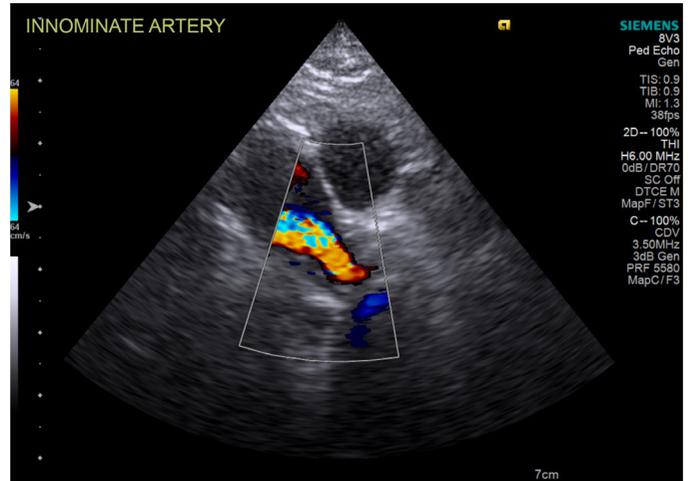


Figure 5. Accelerated flow with aliasing effect in color Doppler mode in the innominate artery

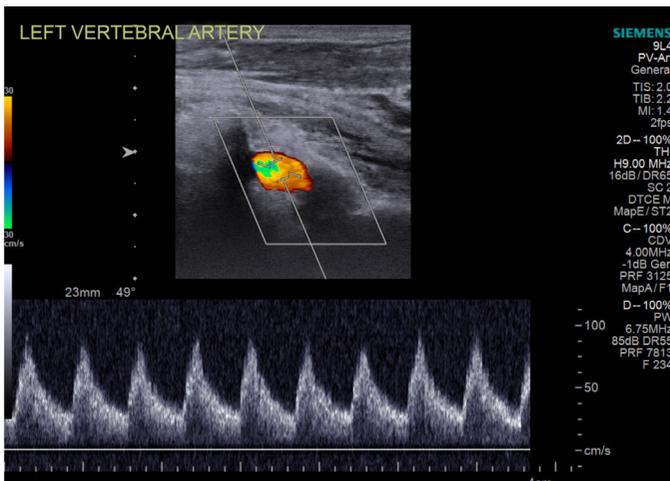


Figure 3. Antegrade low resistance flow in the left vertebral artery

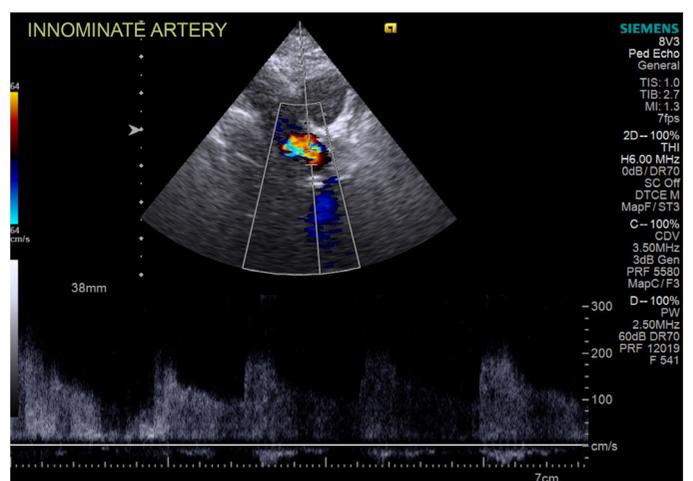


Figure 6. Significant increase in flow speed of the critical narrowing zone in spectral Doppler mode of the innominate artery

DISCUSSION

The main cause of innominate artery steno-occlusive disease is most frequently atherosclerosis. Other vascular diseases such as Takayasu arteritis, giant cell arteritis, radiation, and fibromuscular dysplasia are also potential etiologies for innominate artery steno-occlusive damage [6]. Symptomatic atherosclerotic steno-occlusive disease of the innominate artery represents 2.5-4% of all extracranial causes of cerebrovascular insufficiency [1]. Clinical manifestations of innominate steal can include symptoms referable to the posterior circulation (dizziness, vertigo, ataxia, diplopia, limb weakness), symptoms referable to internal carotid artery territory ischemia (global cerebral hypoperfusion, amaurosis, aphasia, left hemiparesis), or exertional right upper extremity discomfort [6].

In our case, we observed clinical symptoms referable to the posterior circulation (recurrent blurred vision, dizziness, headache, syncopal episodes), pain in the right arm during physical activity, diminished radial pulse, and arterial pressure in the right upper extremity.

Here, we demonstrated how characteristic features of the flow patterns in the vertebral and carotid arteries and in the narrowing zone of the innominate artery can be detected using duplex ultrasonography. Partial or complete reversal of flow in the ipsilateral vertebral artery is a hallmark feature of innominate artery stenosis and subclavian steal phenomenon [1,6]. Spectral Doppler flow patterns in the carotid arteries distal to severe innominate stenosis are more variable due to multiple potential collateral pathways for reconstituting the carotid circulation. In our case, collateral pathways were reconstituted via the basilar artery, and the Circle of Willis did not participate in this reconstruction [1,4]. Thus, the spectral Doppler waveforms in the right vertebral artery are retrograde flow and in the common carotid artery is antegrade but blunted, and we observed tardus-parvus waveform flow pattern in the common carotid artery.

Doppler ultrasound is a valuable noninvasive method for the examination of the innominate artery and extracranial arteries. The duplex Doppler ultrasonography method allows to determine the vessel geometry and narrowing, and changes in the spectral characteristics of the flows. There are very few examples in the literature of direct visualization of the narrowing zone by the use of Duplex Doppler ultrasound in the innominate artery. This is mainly due to the limited visualization area by the clavicle. We used a sectorial probe for a deeper penetration to determine the narrowing zone in the innominate artery and obtained color Doppler imaging of the flow in the narrowing zone. Then, we determined high flow

velocities in the constriction zone by using spectral Doppler. Endovascular stenting was applied to the patient and enabled normal antegrade flow in the right common carotid and vertebral artery.

Detection of narrowing zones in the extracranial vessels by duplex Doppler subsequently leads to angiographic visualization of the atherosclerotic narrowed vessel segment and enables treatment of vessel with endovascular invasive methods and surgery [3,5].

In conclusion, duplex Doppler ultrasound is a noninvasive and effective method for detection of steno-occlusive atherosclerotic diseases of the cranial arterial system. Here, we demonstrated a critical stenosis of the innominate artery determined by duplex Doppler which was confirmed by following angiography. Duplex Doppler ultrasound is therefore could be a cheaper and easily accessible diagnostic alternative in resource-limited conditions.

Ethics

Informed Consent: Written informed consent was obtained.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: G.M., A.A., S.A., Concept: G.M., A.A., S.A., Design: G.M., A.A., S.A., Data Collection or Processing: G.M., A.A., S.A., Analysis or Interpretation: G.M., A.A., S.A., Literature Search: G.M., A.A., S.A., Writing: G.M., A.A., S.A.

Conflict of Interest: No conflict of interest was declared by the authors.

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REFERENCES

1. Grant EG, El-Saden SM, Madrazo BL, Baker JD, Kliewer MA. Innominate artery occlusive disease: sonographic findings. *AJR Am J Roentgenol.* 2006;186:394-400.
2. Rohren EM, Kliewer MA, Carroll BA, Hertzberg BS. A spectrum of Doppler waveforms in the carotid and vertebral arteries. *AJR Am J Roentgenol.* 2003;181:1695-704.
3. Azzarone M, Cento M, Mazzei M, Tecchio T, Ugolotti U. Symptomatic subtotal occlusion of the innominate artery treated with balloon angioplasty and stenting. *J Endovasc Ther.* 2000;7:161-4.
4. Cheng P, Liu B, Yu D, Xu J. The value of color Doppler sonography in diagnosis and hemodynamic analysis of innominate artery occlusion. *J Clin Ultrasound.* 2022;50:351-3.
5. Grosveld WJ, Lawson JA, Eikelboom BC, vd Windt JM, Ackerstaff RG. Clinical and hemodynamic significance of innominate artery lesions evaluated by ultrasonography and digital angiography. *Stroke.* 1988;19:958-62.
6. Borne RT, Aghel A, Patel AC, Rogers RK. Innominate steal syndrome: a two patient case report and review. *AIMS Medical Science.* 2015;2:360-70.