Case Report

The Use of Shear Wave Elastography in the Diagnosis of Prestenotic Phase of Takayasu's Aortoarteritis

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Abstract

We report the use of shear wave elastography with dispersion imaging in diagnosing a case of prestenotic Takayasu's arteritis which presented with symptoms of fever of unknown origin with persistently raised C-reactive protein levels. Vessel wall inflammation was detected in the carotid arteries on dispersion and shear wave imaging along with increased wall stiffness which was characteristic of vasculitis seen in a prestenotic phase of Takayasu's disease. These findings preceded the sonographic finding of vessel wall thickening described as the earliest sign of the disease on routine ultrasonography and not only helped to make an early diagnosis in a patient with a fever of unknown origin but also in the posttreatment follow-up.

Keywords: Dispersion imaging, shear wave elastography, Takayasu arteritis

Introduction

Takayasu's arteritis is the most common form of large vessel arteritis seen more commonly in young women.[1] The disease is characterized by two stages (a) the early or prestenotic stage and (b) the stenotic or pulseless stage. Most of the patients present in the stenotic stage where the diagnosis is easily established using the American College of Rheumatology criteria.[2] However, the diagnosis in the early stages is most challenging when the patients present with a low-grade fever of long duration with raised erythrocyte sedimentation rate (ESR) and constitutional symptoms without any clinical signs. There have been few case reports describing the use of sonography, contrast-enhanced magnetic resonance imaging (MRI), and positron emission tomography (PET) scans for establishing the diagnosis in the early stages of disease.[3-6] The macaroni sign, i.e., characteristic circumferential wall thickening with narrowing of vessel lumen has also been described by the use of sonography to show the characteristic vessel wall appearance of Takayasu's disease.[7] Shear wave elastography (SWE) is a novel technique to measure the stiffness of various organs, and there have been studies on its use in the assessment of vessel wall stiffness in patients with atherosclerotic plaques in carotid arteries.[8,9] A study by Alis *et al*.[10] also described the use of SWE in the evaluation of vasculitis in patients with Behcet's disease. There has, however, been no report so far on its use in the early detection of Takayasu's arteritis in the prestenotic stage. We would like to report the findings of the first case of prestenotic Takayasu's arteritis with normal sonography and contrast-enhanced tomography of the neck detected by SWE.

Case Report

A 25-year-old female presented with a case of 6 months fever of unknown origin. The fever was low grade, and there were flu-like symptoms with generalized body aches and fatigue. There was no evening rise in temperature. Her prior blood investigations done 6 months ago revealed a high ESR of 85 mm and an increased C-reactive protein (CRP) of 65. Her hemoglobin was 11 g/ml. A blood culture has done twice also showed no bacterial growth. ANA/ANF, ENA, C-ANCA, and p-ANCA tests are also negative for autoimmunity antibodies. The patient had undergone routine ultrasound of the abdomen,

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contrast-enhanced computed tomography (CT) of the neck, and plain high-resolution CT of the chest, which were also normal. On follow-up at 6 months, the patient had persistent low-grade fever and a persistently high ESR of 80 mm with high CRP levels of 48 mg/dl. A color Doppler of the neck was done to look at any vessel wall thickening. It revealed an intima–media thickness of 0.25 mm (normal) with a normal flow waveform and peak systolic velocity. SWE was done on the Canon Aplio i 800 (Tokyo, Japan) for both wall stiffness and dispersion and showed increased wall stiffness of both the walls of common carotid arteries on both sides with a mean stiffness 53 Kpa and 80 Kpa of the near walls with increased mean dispersion of 30 m/s/KHz (normal mean stiffness of 18.7 Kpa and dispersion of <14 m/s/Khz (Li *et al*.[11]). These findings were diagnostic of active inflammatory changes in the vessel walls of bilateral common carotid arteries, thus confirming the diagnosis of vasculitis [Figure 1a-d]. A contrast-enhanced CT scan of the chest was done, which revealed a thickening of the walls of the aortic arch [Figure 2a-c]. No narrowing was observed. The origin of the arch vessels was normal. ANCA being negative in this patient, ANCA-associated vasculitis was ruled out as the cause. Overall imaging findings when correlated with a history and age in a young female patient were consistent with the early acute phase of Takayasu's disease. The patient was put on a daily dose of 30 mg of oral prednisolone. On a follow-up after 6 weeks, the patient was afebrile with no constitutional symptoms. The SWE of the common carotid vessels [Figure 3] showed normal wall stiffness of 14.3 Kpa with normal dispersion of 12.3 m/s/Khz.

Discussion

Takayasu's arteritis is a chronic vasculitis of unknown cause with a predilection for the aorta, its main branches, and the pulmonary arteries getting involved by the disease. It has two phases (a) acute or the prestenotic phase and (b) chronic or the pulseless phase. The diagnosis in the prepulseless or the prestenotic phase of Takayasu's disease remains elusive as clinical signs remain absent and patients present with low-grade fever and constitutional symptoms as in this case. Most of the investigations are also unable to detect the disease in this phase, and hence a high level of clinical suspicion is required to reach a diagnosis in this phase of the disease. Unfortunately, the current diagnostic guidelines also apply to the pulseless stage of the disease only. A fluorodeoxyglucose (FDG) PET scan or a contrast MRI has been shown to detect early inflammatory changes in the vessel walls with only occasional case reports describing the use of FDG PET-CT scans where the authors showed increased uptake of the tracer in the walls of the thoracic aorta and its major branches while investigating these patients with fevers of unknown origin.[4-6,12] The use of sonography has been shown to detect vessel wall thickening which is seen in the late phase and may be normal as was seen in this case. In a study by Maeda *et al*.,[7] sonography was shown to be superior to angiography in the detection of wall thickening. In another study by Taniguchi *et al*.,[13] sonography detected wall lesions in 60% of patients and angiography in only 40%. There can thus be discordance in the results of vessel wall thickening and vessel stiffness and inflammation in the early stages of the disease which is pathologically dominated by granulomatous infiltration and inflammatory changes. Measurable vessel wall thickening follows later when fibrosis sets in. Although FDG-PET scans are very sensitive in the detection of inflammation in such patients, it would not be prudent to use them as a tool of diagnosis in the prestenotic stage in any patient with a fever

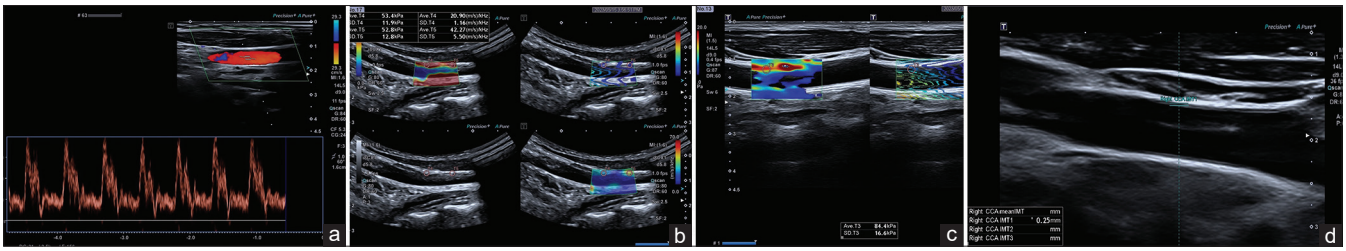

Figure 1: (a) Color Doppler image of the common carotid artery showing normal waveform and peak systolic velocity, (b) shear wave elastography (SWE) of the left common carotid artery showing increased wall stiffness (53 Kpa) with increased dispersion of 30 m/s/Khz (arrow). (c) SWE of the right common carotid artery with increased wall stiffening of the anterior wall – 80 Kpa (arrow). (d) Gray-scale image of common carotid with normal intima–media thickness of 0.25 mm

Figure 2: (a and b) Contrast-enhanced images of the chest showing the thickening of the walls of the aortic arch in coronal and axial sections (arrows). (c) Contrast-enhanced axial image of the neck showing normal lumen and wall thickness of the bilateral common carotid arteries

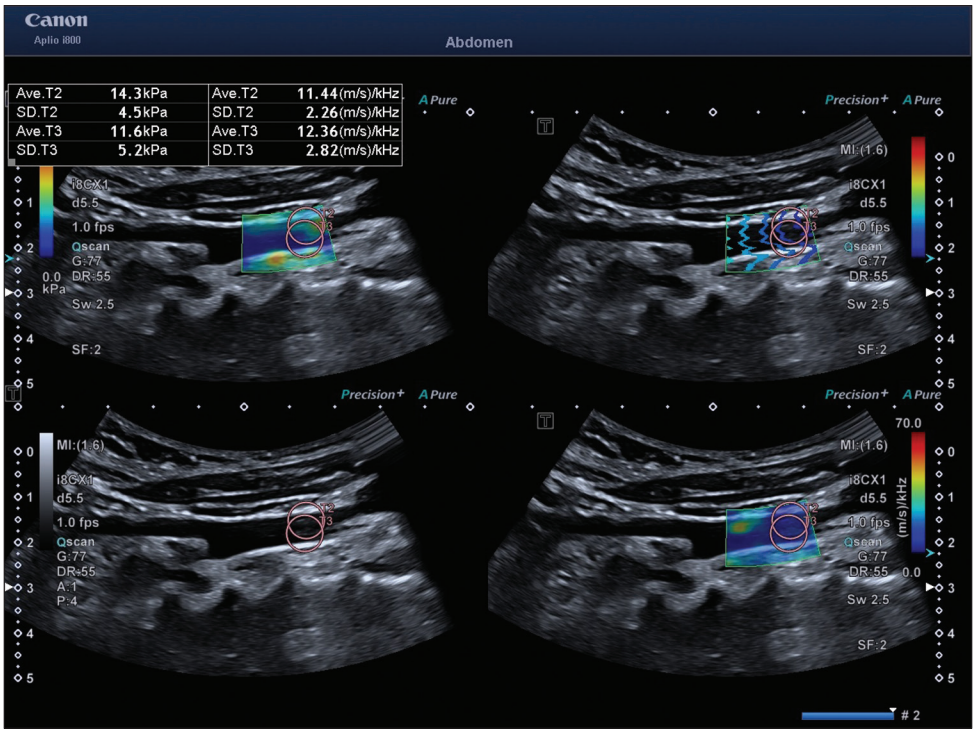

Figure 3: Shear wave elastography on follow-up showing resolution of inflammation and stiffening of the left common carotid artery with stiffness of 14.3 Kpa and 12.3 m/s/Khz, respectively

of unknown origin. SWE is a newer imaging tool integrated with ultrasonography to detect changes in tissue stiffness or elasticity based on the determination of Young's modulus of the tissues which is measured in kilopascals.[14] Recently, there has been the addition of viscosity or dispersion imaging to SWE. The velocities of shear waves generated by acoustic radiation pulse depend on shear wave frequency which is influenced by the viscosity of the tissues, in which these travel. Therefore, a viscous tissue will increase both the shear wave frequency and its speed. The extent of change in frequency, i.e., dispersion is measured on a dispersion slope plot and is a surrogate marker for tissue inflammation.[15] Very few studies have been done to demonstrate the use of SWE in studying the viscoelastic changes in arterial walls. Couade *et al*.[8] demonstrated its use both *ex vivo* and in normal carotid arteries, whereas Li *et al*.[9] demonstrated its use in patients with atherosclerosis and Alis *et al*.[10] estimated vessel stiffness and inflammation in patients with Behcet's disease. The technique has the inherent advantage of being noninvasive, less costly, fast to perform, and ready for availability. Recently, Ucar *et al*.[16] evaluated vessel wall thickness and SWE in patients with Takayasu's disease, SLE, and compared it with controls and showed that maximum wall stiffening and thickening were seen in patients with Takayasu's disease and concluded that elastography could be used as a useful diagnostic tool. Our case highlights the potential of elastography with dispersion to detect and quantify both vessel wall stiffness and inflammation; the presence of which may be seen in all types of vasculitis and even in atherosclerosis but as shown by Ucar *et al*.,[16] highest values were seen in Takayasu's disease. Therefore, there is a need to define cutoff values to clinch the diagnosis. Till, such time findings of vessel wall changes of elastography need to be combined with the patient's history, age, sex, and laboratory parameters such as negative ANCA to reach a final diagnosis of Takayasu's disease as was possible in this case. Vessel wall thickening and Macaroni sign may be absent in acute phases; however, we did see early wall thickening of the aortic arch in contrast CT in this patient which further confirmed the evolution of the disease process in this patient who had ongoing symptoms for the past 6 months. The current case highlights that it is possible to quantify the degree of vasculitis SWE as both inflammation and fibrosis in the vessel wall appear as areas of increased stiffness measured in kilopascals, while inflammation alone is depicted on dispersion imaging as units in m/s/Kpa. Both these changes precede vessel wall thickening in any type of vasculitis as was seen in our patient in the bilateral neck vessels. The addition of dispersion also has the potential to be a useful parameter for posttreatment follow-up of these patients as was seen in the current patient. We propose that SWE can be a simple add-on test to the carotid duplex scan as it is noninvasive and less costly compared to a PET scan. It would not only result in the early detection of the disease but also the early commencement of treatment, but whether it can prevent the progression of the disease is not clear so far.

Conclusion

The case highlights the use of the SWE along with dispersion imaging to detect inflammatory changes in vessel walls in the prestenotic phase of Takayasu's arteritis in patients with

fever of unknown origin. These changes precede the changes in wall thickening seen in sonography. The use of dispersion is also able to quantify the inflammation along with the extent of vessel wall stiffness which is helpful in the follow-up these patients.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent form. In the form the patient has given her consent for her images and other clinical information to be reported in the journal. The patient understands that her name and initials will not be published and due efforts will be made to conceal identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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