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INVITED REVIEW

Temporal Artery Ultrasonography in Giant Cell Arteritis

Mehmet Ruhi Onur[1]
ORCID: 0000-0003-1732-7862

Necmeddin Abdurrahimli[1]

[1]Hacettepe University Faculty of Medicine, Department of Radiology, Ankara, Turkey.

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ABSTRACT

Temporal arteries may be involved in giant cell arteritis. Ultrasonography (US) with linear transducers enabling high-resolution image acquisition has a vital role in diagnosing and following giant cell arteritis. Sonographic evaluation needs to be performed with the appropriate technique. US findings of giant cell arteritis include halo sign, compression sign, and luminal stenosis in the temporal artery. Color flow Doppler US may be used in follow-up for patients undergoing treatment of giant cell arteritis of temporal arteries.

Keywords: temporal artery (D013699), Doppler US (D018608), giant cell arteritis (D013700)

INTRODUCTION

Giant cell arteritis (GCA) is a primary systemic vasculitis characterized by the involvement of large and medium-sized arteries [1]. Although the diagnosis of GCA is usually based on clinical criteria, color flow Doppler ultrasonography (CDUS) can be used as a noninvasive, easy-to-use, and cost-effective imaging modality for diagnosis and follow-up. CDUS reveals sonographic features of the arterial wall and lumen and blood flow characteristics of the temporal artery along with its frontal and parietal branches [2].

The ability of high-resolution imaging makes the US the first-choice imaging tool in temporal artery vasculitis. Indications of US in temporal artery vasculitis include signs or symptoms of temporal arteritis (headaches, vision loss, jaw pain, fever, fatigue, and weakness), abnormal laboratory values suggesting vasculitis (e.g., increased erythrocyte sedimentation rate, liver function tests, Immunoglobulin G, complement levels), prior history of vasculitis, polymyalgia rheumatica or other rheumatologic conditions, and abnormal findings on previous imaging studies [3].

US Technique

A linear array US transducer with at least 15 MHz frequency should be used to obtain high-resolution images [4]. Scanning should be started with the gray-scale US and followed by color Doppler mode. Temporal artery Doppler US can be performed as patients lying on their lateral side or back in a recumbent or semirecumbent position [3]. CDUS examination of the temporal artery and its branches is usually started in the transverse plane. After scanning the temporal artery in the transverse plane, the probe can be rotated by 90º to obtain US images of the temporal artery in the longitudinal plane. The operators may find the first part of the temporal artery at the level of the tragus. The temporal artery and its frontal and parietal branches should be examined bilaterally as much as possible as in their entirety in transverse and longitudinal planes [5]. Proximal, mid-and distal parts of the temporal artery and its branches should be scanned in the transverse and longitudinal plane, and the findings related to each segment should be documented. The bifurcation level between frontal and parietal branches of the temporal artery is the marker point to define the proximal part of these branches [3].

The color signal representing blood flow in the vessel lumen should be obtained from the vessel lumen. Appropriate CDUS settings such as color gain and pulse repetition frequency (PRF) adjustments can avoid scattering artifacts outside the vessel wall. The PRF of color Doppler US should range between 2-3.5 kHz depending on the vessel caliber to

overcome the artifacts causing false-positive halo sign [4]. Power Doppler may be preferred in deep or tortuous vessels or cases with very low blood flow or occlusion [3]. In CDUS, at least one duplex spectral Doppler waveform should be obtained in the temporal artery along with its frontal and parietal branches.

CDUS of the temporal artery and its branches should include transducer compression to evaluate the compressibility of the vessels. To assess the compression sign, the operator should hold the transducer perpendicular to the vessel in the transverse plane and compress the temporal artery and its branches.

US operators should perform 30-50 temporal artery CDUS examinations in 30–50 people without GCA to be familiar with the normal appearance of the temporal artery [2].

US Findings

a. Halo sign

A halo sign is characterized by a rim of uniform hypoechogenicity surrounding a segment of the temporal artery and/or its branches. It represents concentric wall thickening towards the luminal side. The hypoechoic or anechoic appearance of the halo sign results from cell infiltration and edema occurring in the media layer of the vessel [5]. If a halo sign is detected in the transverse plane, the presence of a halo should also be confirmed on a longitudinal plane to determine the maximum thickness of the halo. Positivity for the halo sign is assumed to be consistent with active inflammation maximum thickness of the hypoechoic halo is defined as the measurement of intima-media layer thickness (IMT). The cut-off values of IMT to decide GCA involvement of the temporal artery and its frontal and parietal branches were reported as 0.42 mm, 0.34 mm, and 0.29 mm, respectively [5]. However, recent reports suggest that an IMT between 0.2 and 0.6 mm can be detected in normal temporal arteries. They also indicate that vascular wall swelling greater than 0.5-0.8 mm is usually associated with a positive temporal artery biopsy result [5]. The sensitivity and specificity of unilateral halo signs were reported as 68% and 91%, respectively. The specificity of the bilateral halo sign reaches 100% [6].

The operators should be aware that atherosclerotic changes and tortuosity of the vessels may cause interpretation errors in CDUS. Concentric wall thickening in GCA differs from the focal hyperechoic wall thickening in atherosclerosis. Vessel curves in temporal arteries with tortuose appearance may be wrongly interpreted as halo signs due to overlapping vessel walls in transverse and longitudinal planes [3].

b. Compression sign

Compression sign refers to the compression of the temporal artery and its branches by inserting pressure with the transducer. The tiny wall of the normal temporal artery should not be visualized as a separate anatomic structure with compression. The superficial vessels can not be compressed, and luminal narrowing does not occur in the setting of inflammatory cell infiltration. The operators should compress the temporal artery and its branches when detecting the halo sign. Halo sign does not disappear upon compression in patients with GCA [3]. The compression of the temporal artery and its branches may be recorded as cine-loop images to review after the scanning.

c. Luminal stenosis

GCA may appear as luminal narrowing of the temporal artery on transverse and longitudinal planes. Areas of stenosis in GCA may be detected with CDUS as an aliasing artifact secondary to the turbulent flow of the narrowed lumen. Chronic inflammatory changes and segmental stenosis may be manifested with a tortuous appearance. Once luminal narrowing/irregularity is identified, spectral Doppler waveform should be obtained to measure peak velocity before, at, and beyond the area of maximum stenosis [7]. Hemodynamically significant stenosis in the temporal artery presents on spectral Doppler US as two or more times higher flow velocity in the stenotic segment compared with the proximal or distal sides of the stenosis and persistent diastolic flow in the distal segments of the stenosis [8].

Acute temporal artery occlusion is demonstrated on the gray-scale US as an anechoic or hypoechoic appearance of the lumen without flow findings. Chronic occlusion appears as severe luminal narrowing and hyperechoic luminal appearance. Differentiating occlusion and pre-occlusive stenosis

may be accomplished using low PRF values and high color gain settings. The absence of blood flow in the temporal artery in these CDUS settings indicates an occlusion [9].

Utility of US Findings

The sensitivity and specificity of CDUS differ in various studies. However, recent studies report higher sensitivity and specificity values as a possible indication of improvement in the acquisition of high-resolution images and increased experience of operators. A recent report comparing US findings with the final clinical diagnosis noted that the US could diagnose with 91.6% sensitivity and 95.8% specificity [10]. Most studies revealed that the US is more sensitive than temporal artery biopsy since biopsy evaluates only a small anatomical region in a systemic disease while the US enables to visualize whole temporal artery and its branches [5].

US Assessment in Follow-up

Assessment with the US at the early phase may be necessary to evaluate GCA before treatment. CDUS should also be performed immediately in patients with suspected GCA and ophthalmic artery involvement to reduce the visual loss [9]. The sensitivity of US may be decreased in patients under steroid treatment due to the disappearance of findings as halo sign [11]. A recent report found that the halo sign may disappear after only two days of treatment [11]. US findings of GCA in temporal artery following the beginning of medical treatment may resolve after 16-22 days of the treatment [12]. The sensitivity of CDUS was reported as 88% within the first day of treatment, reduced to 50 % after more than four days of treatment [13]. Resolution of halo finding was found to occur in a long period, such as 11 weeks which was attributed to intimal proliferation with fibrosis that is often histologically reported as healed arteritis [14].

CONCLUSION

CDUS should be used as first-line diagnostic imaging for patients with suspected GCA. Characteristic findings of GCA are helpful in the diagnosis and follow-up of the disease after treatment. A fast-track US evaluation provides timely diagnosis and treatment initiation in suspected cases and prevents permanent vision loss.

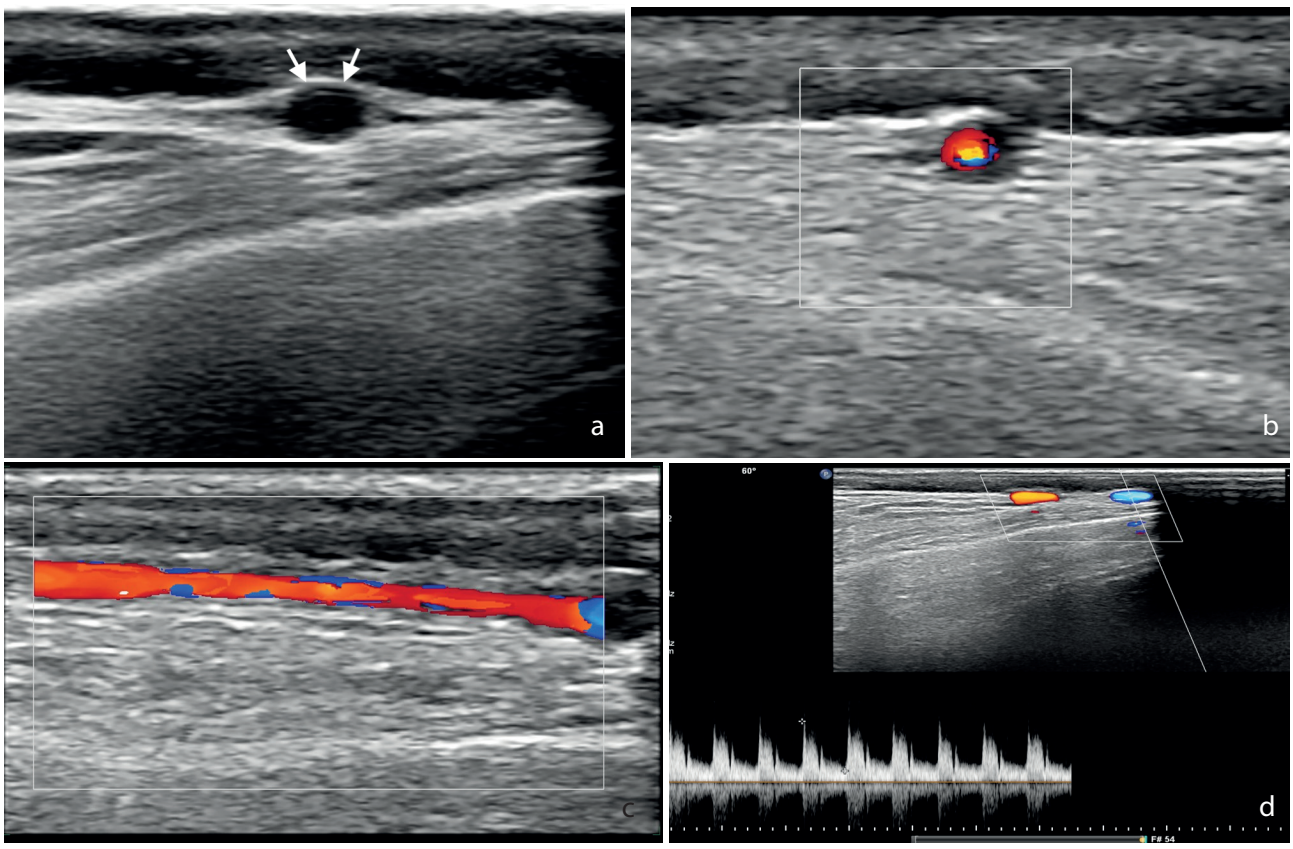

Figure 1. Gray-scale US image at the transverse view **(a)** demonstrates STA with a normal vessel wall appearance. CDUS images at transverse **(b)** and longitudinal **(c)** views reveal color filling in the STA lumen.

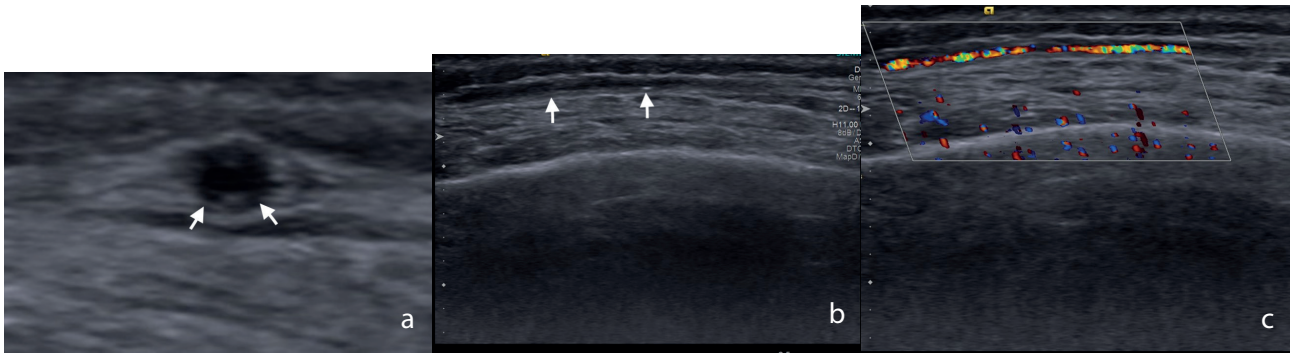

Figure 2. (a) Transverse view of gray-scale US image demonstrates halo sign which is concentric wall thickening of the temporal artery with hypoechoic appearance (arrows). **(b)** A longitudinal view of the gray-scale US image reveals wall thickening and luminal narrowing (arrows) in the temporal artery. **(c)** Color flow Doppler US shows an aliasing artifact representing the temporal artery's turbulent flow.

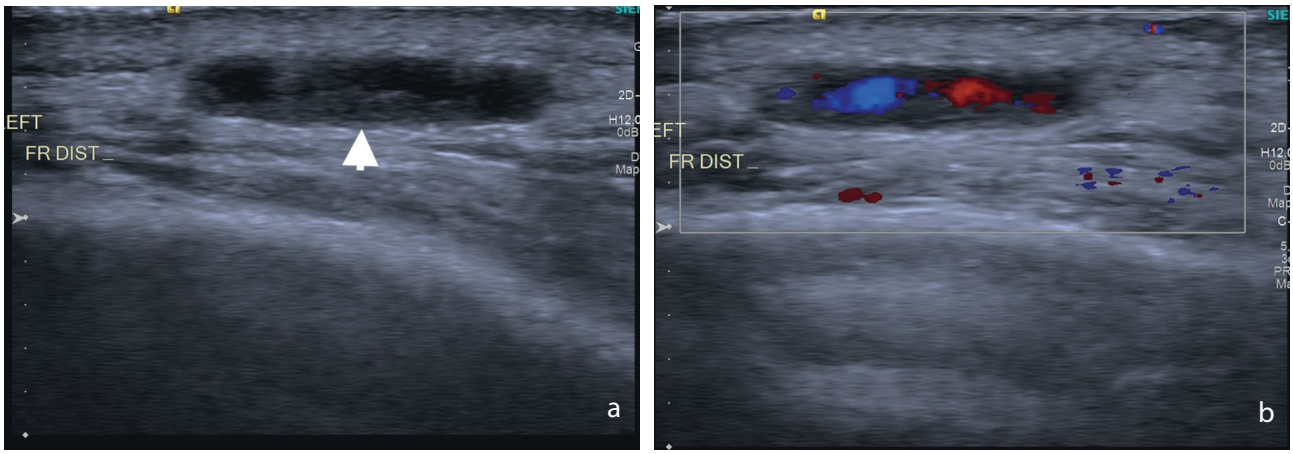

Figure 3. (a) Gray-scale US demonstrates a hypoechoic atheroma plaque (arrow) with an eccentric luminal narrowing in the temporal artery. **(b)** Color flow Doppler US reveals a filling defect in the temporal artery due to atheroma plaque.

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