

Contrast-enhanced ultrasound imaging of the vasa vasorum of carotid artery plaque

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Abstract

The vasa vasorum of carotid artery plaque is a novel marker of accurately evaluating the vulnerability of carotid artery plaque, which was associated with symptomatic cerebrovascular and cardiovascular disease. The presence of ultrasound contrast agents in carotid artery plaque represents the presence of the vasa vasorum in carotid artery plaque because the ultrasound

contrast agents are strict intravascular tracers. Therefore, contrast-enhanced ultrasound (CEUS) is a novel and safe imaging modality for evaluating the vasa vasorum in carotid artery plaque. However, there are some issues that needs to be assessed to embody fully the clinical utility of the vasa vasorum in carotid artery plaque with CEUS.

Key words: Vasa vasorum; Carotid artery; Plaque; Vulnerability; Contrast-enhanced ultrasound

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Core tip: Stroke is a major cause of morbidity and mortality all over the world. At-risk patients is so-called vulnerable patients because they possess a higher likelihood of developing symptomatic stroke compared with those low-risk patients. Vulnerable patients usually have carotid artery vulnerable plaques and vulnerable plaques possess a higher likelihood of rupture to lead to acute stroke. The vasa vasorum of carotid artery plaque has been confirmed as same as vulnerable plaques and contrast-enhanced ultrasonography could detect the vasa vasorum of carotid artery plaque.

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INTRODUCTION

The plaques with a thin fibrous cap covering a large lipid necrotic core, and active inflammation is so-called vulnerable atherosclerotic plaque, which that make the plaque at increased risk of rupture^[1]. The vasa

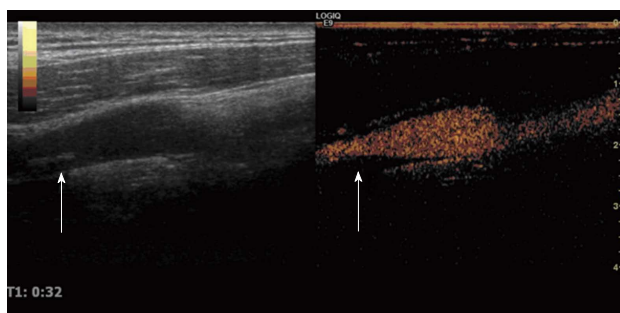


Figure 1 Presence of the vasa vasorum in carotid artery plaque. There are mild ultrasound contrast agents in carotid artery plaque (arrow).

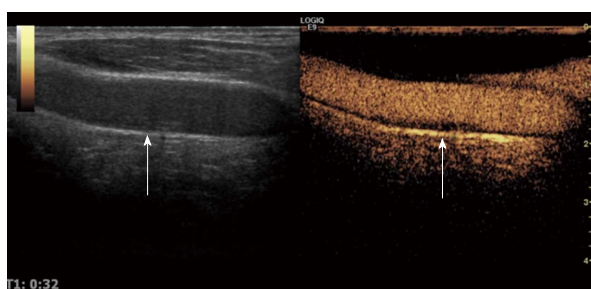


Figure 2 Presence of the vasa vasorum in carotid artery plaque. There are abundant ultrasound contrast agents in carotid artery plaque (arrow).

vasorum of carotid artery plaque is a novel marker of accurately evaluating the vulnerability of carotid artery plaque^[1,2]. The presence of vasa vasorum in carotid artery plaque has been associated with symptomatic cerebrovascular and cardiovascular disease^[3,4] because the vasa vasorum in carotid artery plaque is increased risk for rupture, causing intraplaque hemorrhage and subsequent rapid progression to symptomatic disease.

Recently, contrast-enhanced ultrasound (CEUS) has been introduced for identifying the presence of the vasa vasorum in carotid artery plaque^[5-9], therefore, CEUS is capable of assessing atherosclerotic carotid lesions at risk for rupture^[5,10]. The currently approved and used agents are SonoVue (Bracco SpA, Milan, Italy) in china. Ultrasound contrast agents have been administered in millions of patients and are safe and side effects are extremely rare^[11]. The presence of ultrasound contrast agents in carotid artery plaque represents the presence of the vasa vasorum in carotid artery plaque (Figures 1 and 2) because the ultrasound contrast agents (SonoVue) are strict intravascular tracers, and the appearance of contrast enhancement of CEUS was shown to correlate with the presence and degree of the vasa vasorum in carotid artery plaque which were assessed by histology^[12,13].

PERFORMANCE OF CEUS

After implemented in the routine carotid ultrasound scan acquisition protocol, CEUS of carotid artery plaque can be relatively straightforward^[8,9]. Firstly, a venous access catheter is placed into median vein of

elbow. Secondly, the contrast presets of the ultrasound system are selected, which are available in nearly all currently used vascular ultrasound systems. Carotid CEUS imaging usually uses a linear array transducer that transmits frequencies are between 5 and 10 MHz and a low-level mechanical index condition is used to avoid destruction of the microbubbles^[8,9]. Thirdly, high quality CEUS dynamical images of the continuous appearance of carotid artery plaque can be obtained after ultrasound contrast agent followed by a 5 mL saline flush are injected into median vein of elbow according to venous access catheter^[8,9]. Usually, the optimal time window for the performance of CEUS after administration of the contrast agent is approximately in 2 min^[8,9]. Lastly, the ultrasound contrast signal intensity becomes weaker because the ultrasound contrast agent is eliminated after a few minutes, and administration of the ultrasound contrast agent can be repeated^[8,9].

FUTURE PERSPECTIVES

Criterion of assessment

There are too many criterions about assessment of the vasa vasorum in carotid artery plaque with CEUS at the present^[4-9,12,13], which includes quantitative criterion, semi-quantitative criterion and qualitative criterion^[4-9], therefore, the criterion of assessment of the vasa vasorum in carotid artery plaque with CEUS is inconsistent among all kinds of clinical studies^[4-9,12,13]. Thus, the clinical value of the vasa vasorum in carotid artery plaque with CEUS yet remain sure accurately, therefore, the criterion about assessment of the vasa vasorum in carotid artery plaque with CEUS should be assessed in the future studies.

Dosage of ultrasound contrast agent

The dosage of ultrasound contrast agent was different among some studies^[4-9]. To our experience^[8,9], 1.2 mL ultrasound contrast agent followed by a 5 mL saline flush acquire high quality CEUS dynamical images of the continuous appearance of carotid artery plaque, although some studies and authors propose 2.4 mL or 2.0 mL ultrasound contrast agent followed by a 5 mL saline flush^[4-6,12,13]. However, the different dosage of ultrasound contrast agent could cause the results according to quantitative criterion, semi-quantitative criterion and qualitative criterion significantly discrepancy, therefore, the dosage of ultrasound contrast agent should be unified according to the quality of CEUS dynamical images and cost-effectiveness.

Consistency and repetition

The clinical studies^[4-9,12,13] about the vasa vasorum in carotid artery plaque with CEUS are exciting because the authors think the method could provide early detection and classification of atherosclerotic disease, however, consistency and repetition of the method is poorly established^[4-9,12,13]. The lowness of consistency and repetition could cause the method not extensive

use, therefore, consistency and repetition of the method needs to be assessed in prospective studies.

Accuracy of diagnosis

It is well known that the vasa vasorum in carotid artery plaque with CEUS were well correlated with histologic specimens obtained after endarterectomy^[5-7], however, the diagnosis accuracy of the histologic degree of the vasa vasorum in carotid artery plaque using CEUS remain unclear. Therefore, this issue should be assessed in the future perspective study.

Perspective study

Most of the studies about the vasa vasorum in carotid artery plaque with CEUS are retrospective studies^[7-9], therefore, too many issues about the clinical utility of the vasa vasorum in carotid artery plaque with CEUS remain unclear. In addition, most of studies about the vasa vasorum in carotid artery plaque with CEUS are small-scale, which causes the results of these studies unimpressive. Therefore, the large-scale perspective studies should be performed to assess the clinical utility of the vasa vasorum in carotid artery plaque with CEUS.

CONCLUSION

CEUS is a novel and safe imaging modality for evaluating the vasa vasorum in carotid artery plaque, which could detect the vulnerable plaque at risk for rupture. However, there are some issues that needs to be assessed to embody fully the clinical utility of the vasa vasorum in carotid artery plaque with CEUS and the perspective studies needs to be performed to resolve the above-mentioned issues and assess the clinical utility of the vasa vasorum in carotid artery plaque with CEUS.

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