

## The role of contrast-enhanced ultrasound in risk assessment of carotid atheroma

Silviu Stanciu<sup>1</sup>, Cristina Enciu<sup>1</sup>, Ioana Răduță<sup>1</sup>, Dan Stoicescu<sup>1</sup>, Adrian Anghel<sup>1</sup>, Daniela Anghel<sup>1</sup>, B. Olan<sup>1</sup>, Lucian Ciobîcă<sup>1</sup>

**Abstract:** *Background and objective: Contrast-enhanced ultrasound, used to assess atherosclerotic carotid plaques, improves visualization of vessel wall irregularities and depicts intraplaque neovascularization. This article illustrates the use of contrast-enhanced ultrasound in the risk assessment of carotid atherosclerotic lesions, especially in challenging plaques evaluation.*

*Materials and methods: For 23 patients with difficult duplex ultrasound examination due to carotid tortuosity or calcifications we assessed plaque morphology (contour, echogenicity and stenosis degree) using contrast substance (Sonovue, Braco) with dedicated vascular low mechanical index CPC software.*

*Conclusion: Contrast-enhanced ultrasound is a new, noninvasive, and safe procedure for imaging carotid atherosclerotic lesions. It is a valuable tool for evaluating the vulnerable plaque at risk for rupture and for the diagnostic of the development and severity of systemic atherosclerotic disease.*

### INTRODUCTION

Carotid atheromatous pathology is responsible for almost 1/3 of strokes through 3 basic mechanisms: atherothrombosis, distal embolism from plaque origin and hemodynamic effect in the case of significant, severe stenosis (1).

Carotid ultrasound technique remains the benchmark for the assessment of carotid-vertebral arterial axis, mainly regarding the presence of obstructive atherosclerotic plaques with a proper evaluation of morphology and stenosis degree, by combining the two methods of examination: Duplex mode-B mode and Doppler mode (Color and Spectral).

Numerous studies have shown the beneficial role of endarterectomy or stenting in stroke rate reduction,

in symptomatic and asymptomatic patients with significant stenosis of over 70%, but there is no clear attitude regarding the therapeutic approach of asymptomatic patients with a lower degree of stenosis. In these patients, in whom stenosis has no cerebral hemodynamic effect, several studies emphasize on plaque morphology, by identifying unstable plaques which would play an important role in the development of symptoms (2).

Often, we encounter in daily clinical practice cases where carotid axe imaging becomes challenging due to intense calcifications in the carotid bulb and origin, due to the presence of carotid tortuosity or because of the impossibility to distinguish between

<sup>1</sup> Carol Davila Central University Emergency Military Hospital, Bucharest

preocclusive (over 90%) stenosis and complete occlusion, which would change the therapeutic approach (3,4).

To overcome these limitations and better characterize unstable plaques, by highlighting the intraplaque neoangiogenesis (5), recently a new imaging technique has been developed using contrast substance, which has the advantage of strictly vascular and plaque and wall vascularization distribution.

## MATERIALS AND METHODS

During the last year, for 23 patients with difficult duplex ultrasound exams due to carotid tortuosity or calcifications we performed a contrast enhanced evaluation in order to assess plaque vascularization and stenosis degree.

In consequence, the protocol for plaque morphology description (contour, echogenicity and stenosis degree) consists in 1 ml bolus of contrast substance (Sonovue, Braco) administered through a catheter in the right arm, followed by 10 ml bolus of saline with the acquisition of 6 seconds clips during 4-5 minutes, maneuver which can be repeated to achieve the objectives of the study.

In our department we currently use dedicated vascular CPC software with low mechanical index, integrated into a SIEMENS Sequoia 512 CV system.

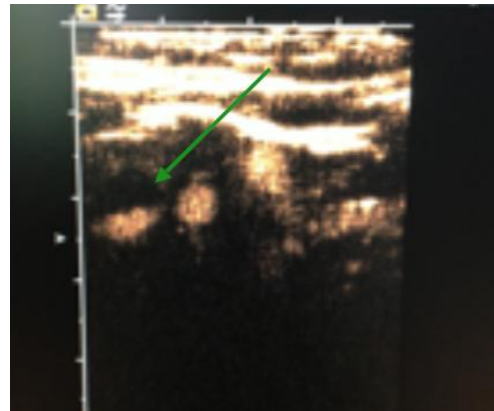
In each case we observed the contrast substance plaque penetration, carefully identifying and assessing intraplaque vascular pattern.

### Detecting intraplaque angiogenesis

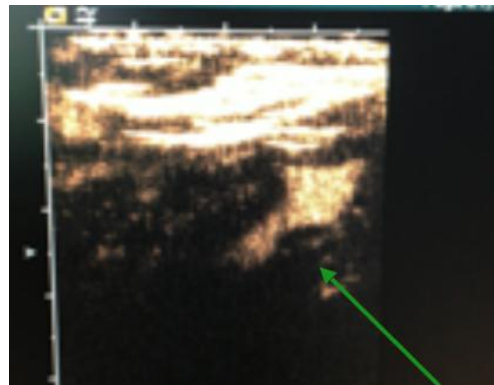
In the majority of patients (68%) with echogenic plaques and no significant stenosis (lower than 70%) intraplaque vascularization has been found, with outside to inside filling pattern, data similar to literature findings (see images).

The existence of this new angiogenesis vessels, mainly situated at the base of atheromatous plaques, can be considered a risk zone for possible plaque rupture, resulting in major stroke.

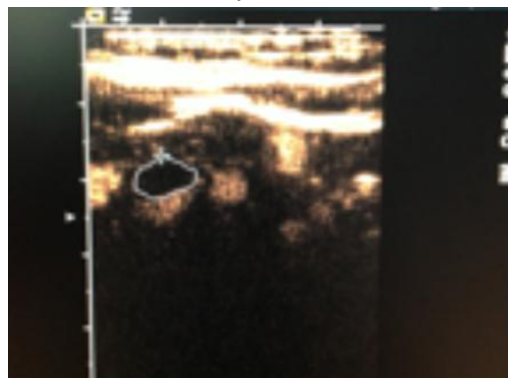
**Figure 1:** Transverse cross section right after left CCA bifurcation, 30 seconds after contrast substance has been administered. Note the lack of opacification of left ICA due to the presence of atheromatous plaque responsible for a 60-70% stenosis.



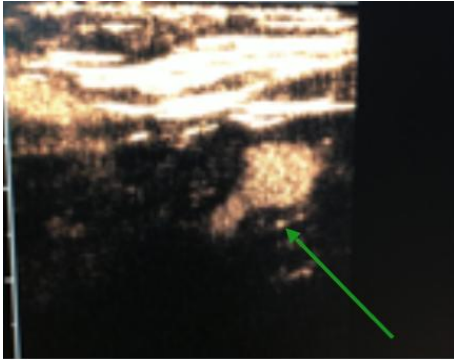
**Figure 2:** Longitudinal section 40 sec after the injection allowing plaque visualization at the origin of the left internal carotid artery with contrast enhancement at the base (arrow)



**Figure 3:** Same plaque from figure 2 at 60 seconds after injection



**Figure 4:** Contrast enhancements at 70 seconds with a filling patten from the outside to inside



In consequence, identifying intraplaque neovascularization in patients with no significant carotid stenosis can be considered a noteworthy additional argument when considering an interventional procedure (stenting or endarterectomy) for stroke prevention.

#### References:

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#### DISCUSSION AND CONCLUSIONS

The concept of unstable or vulnerable plaque, similar to that seen in coronary pathology, is based upon identifying dangerous plaques with immediate stroke like complications, with acute inflammation and angiogenesis (which precede and cause plaque rupture or ulceration), that can't always be detected through conventional duplex ultrasound.

Carotid ultrasound remains the leading non-invasive exploration regarding pre-op/pre-interventional or post-op/post interventional functional and anatomic evaluation. Contrast-enhanced ultrasound studies, bring additional information regarding carotid stenosis quantification in difficult evaluation situations (calcified plaques or difficult to explore vascular tortuosity) but especially brings functional information regarding intraplaque vascularization, thus identifying unstable and high stroke risk plaques allowing an appropriate therapeutic approach.