Floating Thrombus in the Internal Carotid Artery: Surgical Planning Defined by Vascular Ultrasound

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Abstract

The main objectives for this case report were: To emphasize the importance of ultrasonographic diagnosis of a floating thrombus in the internal carotid artery, responsible for the stroke of a patient seen in the emergency room, and to describe a visionary new imaging technique called Ultrasonographic Tissue Characterization (USTC). The USTC is designed to evaluate and estimate the composition of the thrombus, its adherence to the artery wall, and the risk of embolization potentially linked to the severity of cerebrovascular symptoms. The ultrasonographic demonstration of the floating thrombus was the determining factor for surgical planning and the endarterectomy confirmed the presence of thrombotic material.

Keywords: **Thrombosis; Carotid Arteries; Ultrasonography; Carotid endarterectomy.**

Case Report

This case report includes a summary of the clinical history, summary reports on preoperative diagnostics, information about the surgery performed, and additional diagnostic evaluation in order to determine the origin of a cerebral embolus.

Clinical History

Male, white, 50 years patient was admitted to the emergency room with sudden onset of hemiparesis and loss of strength in left hemibody associated with dyslalia. He reported hypertension controlled with medication and denied comorbidities, such as diabetes or dyslipidemia. He denied being a smoker or user of illegal drugs. He underwent MRI scans in the brain and extracranial carotid vascular ultrasonography.

MRI

The test was performed by using the technique axial T1 spin-echo, T2 turbo spin-echo (TSE), axial FLAIR coronale, axial T2* echo gradient, diffusion/echo planar imaging (EPI), and apparent diffusion coefficient (ADC) in the axial section. After injecting the paramagnetic contrast (gadolinium), we obtained the volumetric, sagittal, and axial T1 sequences. The findings were consistent with an area of ischemic vascular injury in the left insular region, extending the corona radiate, and left semiovale centrum.

Vascular Ultrasonography (VUS)

Examination of extracranial carotid arteries was performed by using the equipment of high resolution Philips Inc (Issaquah, WA, USA), HDI 5000 with linear transducer with a frequency of 4 to 7MHz. The test was performed according to the diagnostic protocol used for carotid ultrasonographic mapping prior to endarterectomy, as previously reported[1]. The images in B mode and flow evaluation by color mapping were performed in the transverse and longitudinal ultrasonographic views, as shown in Figure 1.

We identified during B-mode examination the presence of homogeneous, hypoechoic image, poorly adhered to the arterial wall in the emergence of the left internal carotid artery, compatible with floating thrombus. The color Doppler showed no flow turbulence and velocities analyzed by pulsed Doppler were normal. The intima-media complex was normal and there were no ultrasonographic signs of atherosclerosis in the carotid lesion or carotid arteries. Because of the thrombus mobility, safely diagnosed by VUS, and given the severity of the case, the vascular surgery team was prompted. In this case, measurements of velocities and estimated percentage of stenosis became irrelevant.

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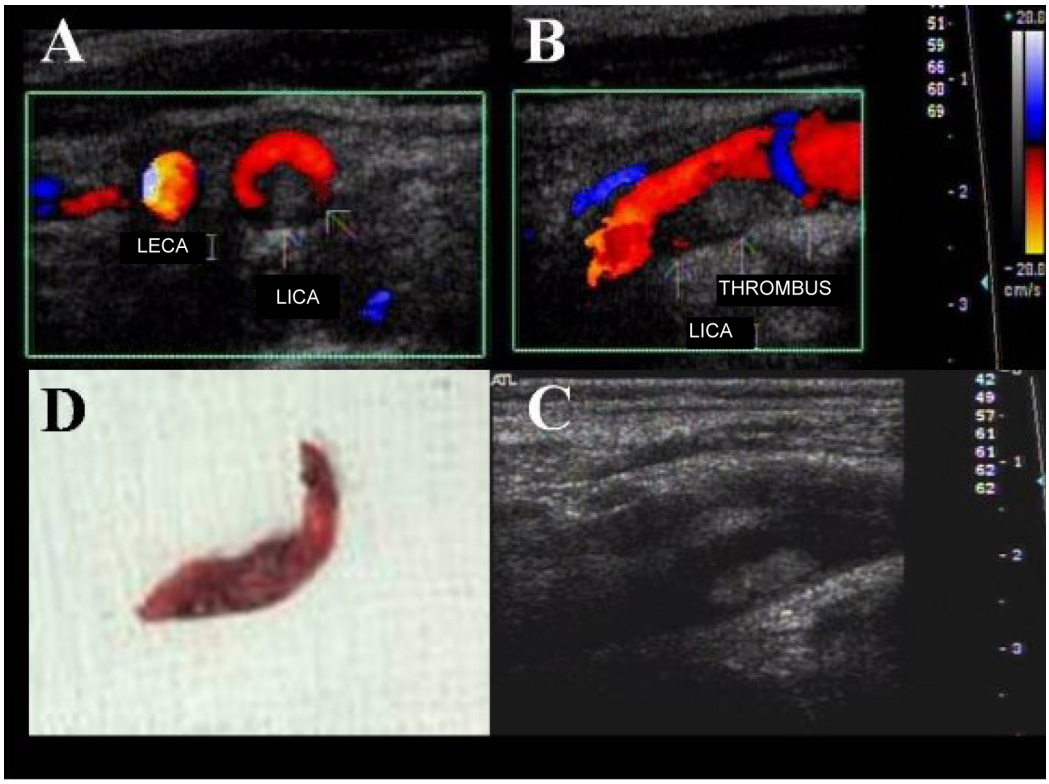

Figure 1 - *Vascular Ultrasonography of the left carotid arteries focusing on the internal carotid artery (LICA). A: Image in transversal ultrosonography section with color Doppler; B: Image in longitudinal ultrasonography section with color Doppler; C: Image (B-Mode) in longitudinal ultrasonography section; D) Thrombus / embolus removed during carotid thromboendarterectomy. LICA / LECA: Left Internal / External Carotid Artery.*

Carotid Surgery

The standard procedure was assumed, considering the risk of re-embolism[2]. The patient underwent endarterectomy. The surgical technique was performed by longitudinal incision on the bulb; common carotid arteries, internal and external, were dissected, isolated, and clamped under general anesthesia. During the surgery, was confirmed the presence of thrombus/embolus in the region of the bulb and internal carotid emergence. The thrombus removal was performed. The arteriotomy closure was performed by poly-propylene 6-0 suture.

Figure 1 D shows the thrombus/embolus removed during surgery.

Complementary Tests

After surgery, the patient was subjected to tests for investigating the origin of the embolus. Transesophageal echocardiography (TEE) showed normal cardiac chamber dimensions, preserved biventricular systolic function, without intracavitary thrombi or in the proximal thoracic aorta. The atrial septum showed minimal shunt evidenced by color Doppler through the patent foramen ovale, which measured about 2 mm in diameter and 23 mm in length (tunnel). We observed spontaneous passage of moderate amount of microbubbles from the right atrium to the left atrium after intravenous injection of stirred saline solution.

Transcranial Doppler was performed 18 days after carotid endarterectomy. Under continuous monitoring of the flow in the middle left cerebral artery we detected ten ultrasonographic signs characteristic of microemboli (MES, micro-embolic signals) after injection of stirred saline solution via peripheral vein of the right arm. These data suggested the presence of a right-left shunt.

Venous, peripheral, and abdominal VUS showed no presence of venous thrombosis. The study included the veins of the upper and lower limbs, the inferior vena cava and major tributaries, and iliac veins.

The patient was referred for hematologic evaluation for investigation of coagulopathy.

Ultrasonographic Tissue Characterization (USTC)

Figure 2 shows the artificial coloring of B-mode ultrasonographic images of the carotid thrombus/embolus. The designation of the colors is performed in accordance with the brightness of each

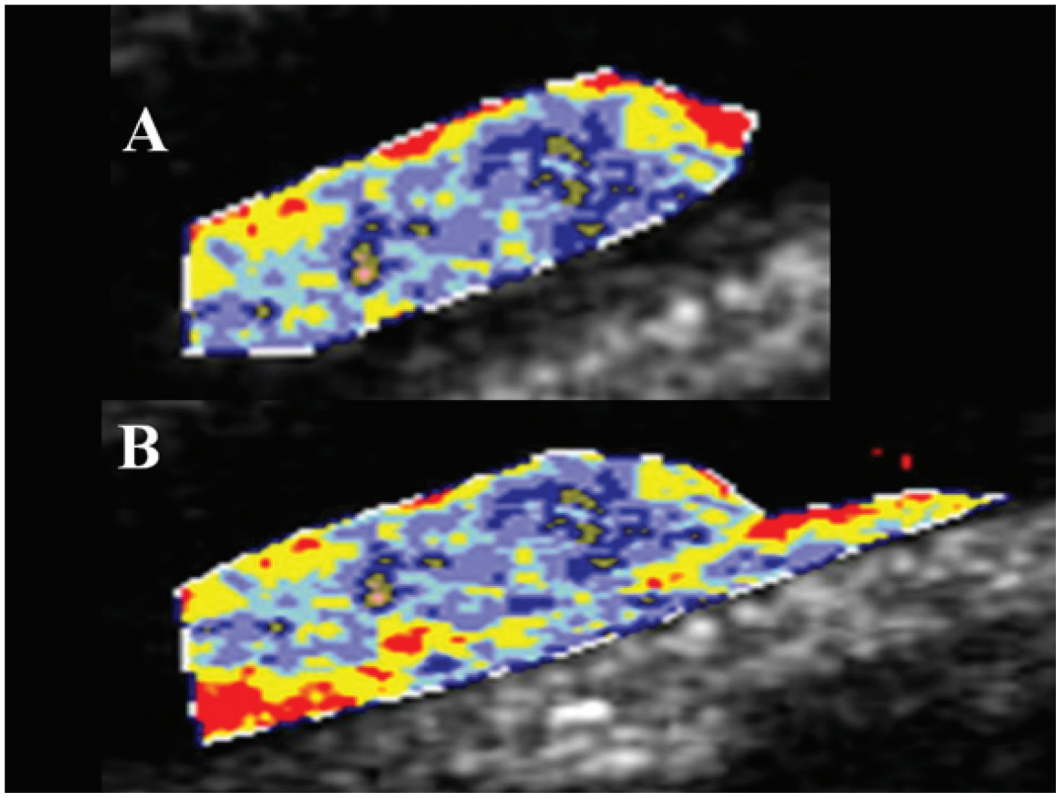

Figure 2 - *Ultrasonographic tissue characterization (USTC) of thrombus / embolus of the internal carotid artery after stroke. A: thrombus / embolus, artificial coloring; B: thrombus / embolus and intima-media complex showing partial adherence; Table 1: Percentages of pixels at brightness intervals corresponding to image 2A.*

pixel in the selected image region. Numerical analysis describes the percentage of pixels at predetermined brightness intervals. The atheromatous plaques were previously evaluated and the echoes are related to the values found for acute, subacute, and chronic venous thrombus[3].

This carotid thrombus / embolus showed some adherence to the artery wall. The grayscale median (GSM) was 41 for Figure 2A and 36 for Figure 2B. This difference can be attributed to the blood found between the floating thrombus / embolus and the image of the intima-media complex. The USTC analysis showed that half image of the thrombus / embolus had features of acute or subacute thrombus. A significant proportion was in the initial process of chronicity (IPC). Small but significant proportion of the thrombus showed advanced process of chronicity (APC) or organization (Table 1).

Discussion

The presence of a floating thrombus/embolus in the internal carotid artery, as documented by the VUS, must be followed by treatment in a short period of time[4,5]. The authors do not recommend performing angiography for diagnostic confirmation, first by understanding that ultrasonography, a noninvasive and risk-free method, is enough to confirm the presence of thrombus, and secondly because of the inherent risk in the angiographic procedure that is invasive and may allow the embolization of thrombus fragments during contrast injection.

It is important to emphasize the importance of the careful positioning of the transducer and the pressure applied from the moment a floating thrombus or embolus was identified. The study protocol can be summarized with an essential documentation for decision and conduct in short time. The patency of the internal distal carotid artery also need to be demonstrated, but the image is more important than speed measurements, and the measurement of the stenosis percentage is irrelevant. Interestingly, in this particular case, the transversal image shows a U-shaped lumen, as shown in Figure 1A.

The axial projection techniques will likely fail in representing such condition. The real-time imaging by means of video recording, showing the movement of the thrombus or embolus, can provide conclusive information, but is not essential. The main message is the possibility of planning a quick treatment, thus avoiding a new picture of cerebral embolization.

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Table 1 - Ultrasonographic Tissue Characterization (USTC) of thrombus / embolus in the internal carotid artery: distribution of pixels in B-mode image

Percentages of pixels at defined intervals between grey from/to

Description		Grey from	Gray to	N Pixel %	Color
Acute thrombus 26.4%	Not echogenic: blood	0	4	4.8	
	Hypoechogenic I: blood-lipid	5	7	1.4	
	Hypoechogenic II: lipid	8	26	20.2	
Acute thrombus	Hypoechogenic III: lipid-muscle	27	40	23.5	
IPC	Hypoechogenic IV: muscle-hypo	41	60	35.1	
APC	Echogenic I: muscle-hyper	61	76	11.0	
Fibrotic process "organization" 4.0%	Echogenic II: muscle-fiber hypo	77	90	2.7	
	Echogenic III: muscle-fiber hyper	91	111	1.0	
	Echogenic IV: fiber 1	112	132	0.3	
Hyperechogenicity	Hyperechogenic I: Fiber 2-calcium	133	255	0.0	

Intervals adapted from Lalet al[1] by Salles-Cunha based on Cassou-Birckholz et al.[2]
IPC: initial process of chronicity; APC: advanced process of chronicity; IPC and APC can be interpreted as thrombus "organization".
Summary of percentages: acute thrombus: 26.4%; subacute thrombus: 23.5%; IPC: 35.1%; APC: 11.0%; Fibrotic process: 4.0%
[1]Lal BK, et al. J VascSurg. 2002;35:1210-7; [2]Cassou-Birkholz, et al. Ultrasound Q. 2011; 27:55-61

Endarterectomy with removal of thrombus is the procedure of choice when a floating thrombus is identified in the extracranial carotid artery[2], however endovascular treatment with reverse flow has been described in the literature with successful outcome[6].

Ultrasonographic Tissue Characterization (USTC) performed later (offline), can bring additional information about the thrombus adherence to the arterial wall. The thrombus in the image shown was partially connected to the intima-media layer. A blood channel, however, was observed between the distal cerebral end of the thrombus and the arterial wall. Other potential information from USTC would be the tissue characterization as acute, subacute thrombus in initial or advanced process of chronicity or organized. It is thought that the resolution of an acute thrombus is easier than a thrombus with older components, especially at the embolic end. Unfortunately, the component of the thrombus responsible for the symptoms cannot be analyzed by post-event ultrasonography. However, the potential risk of a new embolization could be assessed. Conservative measures or immediate procedures can be recommended with the aid of USTC. The images in this case documented a partially floating thrombus, primarily acute and subacute, and with regions in the process of chronicity or organization.

USTC is a generalization of the characterization of pixels described by Lal et al. in atheroma plaques[7,8]. In addition to the carotid atheromatous plaque[9], the USTC has been used in the evaluation of aneurysms treated with stent[10], acute and subacute venous thrombosis of the lower limbs[3,11], basilic vein thrombus as a source of pulmonary embolism[12], normal or transplanted kidneys[13-14], and in characterization of edema, especially lymphoedema[15].

The USTC could be applied to images obtained during echocardiography. Pericardial regions and cardiac muscle could also be evaluated by USTC. Specifically related to this case, cardiac thrombi and potential emboli could be analyzed in their compositions, with probable prognostic value of thrombolysis and determination of clinical risk.

The embolic origin of the cerebral thrombus represents a challenge. It was expected to be found thrombus in the cardiac chambers; however, this was not confirmed by transesophageal echocardiography. The paradoxical embolism favored by the presence of patent foramen ovale was also not confirmed, since the color Doppler ultrasonographic study showed no thrombosis in the veins of the lower limbs, superior limbs, inferior vena cava, and iliac veins. The hypothesis of paradoxical embolism cannot be totally ruled out as we could be facing a subclinical thrombosis or segments not accessible to vascular ultrasonography. Thus, blood investigation was needed.

Conclusion

The authors emphasize the importance of performing vascular ultrasonography in patients with ischemic stroke, and of Ultrasonographic Tissue Characterization (USTC) as an additional tool to evaluate the degree of thrombus aggregation in the arterial wall, thrombolysis potential, and risk of brain embolization. The authors also draw attention to the influence of ultrasonography on planning and quick therapeutic decision in selected cases, such as described herein.

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