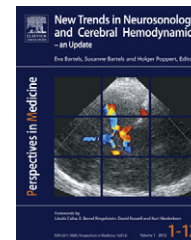




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“A horse, a horse, my kingdom for a horse” – Saddle thrombosis of carotid bifurcation in acute stroke

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KEYWORDS

Saddle thrombosis;
High-resolution
ultrasound;
Acute stroke care;
Endarterectomy

Summary

Background: Saddle thrombosis is less frequently detected in carotid arteries than in peripheral arterial embolism. The clot and the distal vessel patency have to be promptly recognized in these cases, because if the carotid vessel is open distally, chances may arise for successful emergent surgical procedures to remove the thrombus. At conventional static imaging, mobile floating thrombi may be difficult to differentiate from thrombosis on carotid complicated lesions of atherosclerotic origin. High-resolution ultrasound (US), with its unique capability of real-time imaging, adds fundamental data for interpretation of the findings.

Methods: Carotid ultrasound has been performed in acute stroke patients with high-resolution probes. Real-time clips are analyzed and imaging is presented.

Results: Saddle carotid bifurcation thrombosis of cardiac origin has been identified in 2 patients with acute homolateral ischemic stroke, with prompt successful surgical removal in one case. Moreover, an example of a thrombus attached on the ruptured surface of a complicated atherosclerotic plaque in an acute symptomatic stroke patient that was successfully operated in emergency is presented.

Conclusions: Early high-resolution ultrasound with real-time imaging can easily identify peculiar characteristics of carotid vulnerable diseases in acute stroke phase. Different clinical implications result from the early identification of these different conditions, modifying the therapeutical strategies.

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Introduction

“Saddle” arterial thrombi, by definition, are clots located at the sites of vessels bifurcations, “riding” the tips of the flow dividers. The most common sites for the peripheral localization of the saddle emboli are the aortic-femoral artery bifurcation, in cases of distal limbs arterial embolism, the pulmonary artery and across a patent

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interatrial foramen ovale [1–6]. Saddle carotid bifurcation embolism due to cardiac thrombi – paradoxical or not – is uncommon to be displayed with conventional static imaging in clinical practice, but it is not so rare a condition that may be observed, especially with high-resolution, real-time ultrasound (US) imaging [7].

In respect to “static” imaging with the computerized tomography (CTA) and magnetic resonance angiographies (MRAs), high-resolution ultrasound have the unique possibility to study real-time pathophysiology, displaying the emboli floating in the carotid lumen during their way to the intracranial district, when they find adhesion to the carotid arteries wall. These aspects clearly differentiate these clots from those arising on complicated atherosclerotic plaques, with the consequent therapeutical implications [7]. The identification of these highly unstable conditions is indeed particularly important in the acute stroke phases, since emergency surgery procedures – such as thrombus mechanical retrieval or emergent carotid surgery – can be performed, in order to prevent further deterioration of neurological conditions [8–11]. This surgical approach is similar, but more risky, than well-established mechanical thrombus retrieval procedure commonly applied in peripheral arteries embolism [12].

We describe two cases of uncommon carotid bifurcation saddle thrombosis of cardiac origin and a case of local thrombosis on a complicated carotid plaque. All these features could be detected easily with ultrasound, leading to the following implicated therapeutical decisions.

Description of cases

Case 1

DR, male, 84 years old, hypertensive, affected by chronic atrial fibrillation, presented acute left hemiplegia. Cerebral CT scan showed an extensive ischemic damage in the right middle cerebral artery (MCA) territory, with CT hyperdense MCA sign, indicative of intracranial vessel M1 occlusion (Fig. 1A). Carotid duplex (Siemens S2000; 9, 14, 18 MHz linear probes) showed a saddle thrombus at the carotid bifurcation: the head of the clot was floating in the internal carotid artery and only partially reducing the lumen, and the tail was mobile in the external carotid artery (Fig. 1 C and D, Clip 1). Flow in the distal internal carotid artery was preserved, with only slight increased resistive indices (Fig. 1D, Clip 2). Even though the mobile clot seemed to be very harmful for the possibility of further distal embolism, considering the MCA occlusion and the extensive ischemic cerebral damage, surgery was however considered not indicated and the patient underwent only medical treatment.

Case 2

FR, male, 47 years old, asymptomatic for relevant cardiovascular history, presented acute mental confusion and bilateral strength deficit at the lower limbs. Cerebral MRI scan showed an ischemic damage in both the anterior

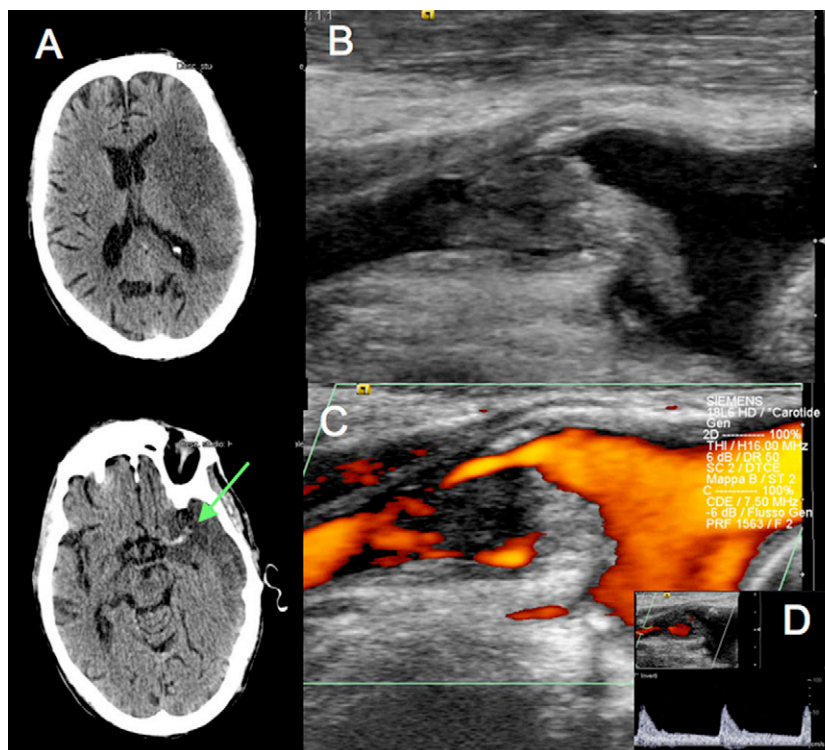


Figure 1 Case 1. Cerebral CT scan (A) with middle cerebral artery hyperdense occlusive sign (green arrow, below). Carotid ultrasonography: B-mode (B), power duplex (C) of a “horse riding” thrombus located at the carotid bifurcation. The distal tract of the internal carotid artery is patent, as revealed by both power Doppler (C) as well as by the pulsed wave Doppler (D).

cerebral arteries (ACA) territory. Both ACA were scarcely visible at magnetic resonance angiography while MCAs were patent and the related brain parenchyma spared from ischemic damage (Fig. 2A). Carotid duplex (Siemens S2000; 9, 14, 18MHz linear probes) showed a clot in the left carotid bulb, adherent to the anterior vessel wall (Fig. 2 B–D, Clip 3). Considering the patency of both the MCAs and that the cerebral tissue was still normal in the left MCA territory, the patient was successfully operated in emergency, to prevent further embolism. A second MRA revealed that both ACAs were originating from the left side, thus explaining why embolism affected the ACA bilaterally from the left bifurcation. Further cardiovascular screening revealed multiple thromboses, at the pulmonary artery and at the saphenofemoral right junction and the patient was also positioned a caval filter. Blood coagulation tests revealed altered AT III, Prot C and Prot S levels. Patient was then treated with anticoagulants.

Case 3

MD, 63 years old, slight hypercholesterolemic, presented acute transient mild left hemiparesis, with rapid spontaneous recovery. Carotid duplex showed moderate, non-hemodynamic, internal carotid artery stenosis by a heterogeneous, partially hypoechoic plaque with a soft component. High-resolution B-mode imaging revealed that the plaque had a ruptured surface and a very soft and compressible area and with the superimposition of a mobile clot, the tail freely floating in the lumen of the internal carotid artery (Fig. 3A–C, Clips 6–7). Cerebral MRI showed a small ischemic lesion in the right deep MCA territory, in the internal capsule (Fig. 3D). Patient underwent successful early urgent endarterectomy and intraoperative findings (Fig. 3E) confirmed the presence of a complicated plaque with a thrombus attached to its surface

Discussion

Therapeutical decisions in acute stroke patients have to be taken in few minutes, due to the narrowness of the therapeutical window. The decisions depend not only from the characteristics of the patient (age, time, co-morbidity, clinical severity, etc.), but also from the results of the first instrumental evaluation performed such as CT, MR with diffusion/perfusion sequences, MRA and sonography. Cases addressed to acute surgery or acute cerebrovascular treatments are though not so frequent (almost 5–10% of all acute presentations), also due to the frequent lack of 24h availability of diagnostic facilities and expert performers.

Characterizations of carotid plaque morphology and of internal carotid artery stenosis hemodynamics have become nowadays a fundamental step for the surgical management. In cases of tight, pre-occlusive proximal internal carotid artery stenosis inducing distal low-flow velocities a vessel ‘‘occlusion’’ may indeed be over diagnosed, if the vessel hemodynamics are not correctly evaluated. While the occlusion excludes further indications for surgical

revascularization, this well-known misleading entity – the so-called ‘‘pseudo-occlusion’’ – may be a very high-risk condition, since further distal embolism may still occur thorough the patent vessel and, thus, the debate on the opportunity of a surgical approach [13,14]. The pseudo-occlusion diagnosis has then to be promptly done, because emergent surgery can still be indeed successful in selected cases [15]. In these regards, several are the factors that may concur for the decision to perform a surgical procedure. First, the lumen of the vessels distal to the stenosis has to be patent and without excessive distal extension of the atherosclerotic process, that could hamper the surgical approach. Second, in cases of stroke, cerebral parenchyma should not be severely compromised, for the negative effects exerted by revascularization when performed in an already cerebral necrotic tissue. Conventional imaging with CT and MR provides the information on the status of cerebral tissue, but, on the other hand, when the distal tract of the carotid artery is patent and with low flow velocities, they may misinterpret the vessel as occluded, because of the low signal relate to the low-flow velocities [7]. High-resolution ultrasound, with real-time imaging of the vessel wall and hemodynamics evaluation with Pulsed-Wave Doppler, can be of valuable help for the identification of distal vessel patency in such cases [7], even with the aid of ultrasound contrast agents [16,17].

Another point to be taken into account for the management of the patient is the comprehension of the local bifurcation disease causing the pseudo-occlusion: atherosclerotic processes usually involve longer tracts of the artery, limiting the possibilities of surgery when the stenosis extends too distally, while a migrating thrombus is usually of smaller size and induces damage of the vessel wall only at the site of adhesion. We have already described the advantages of US in respect to CT and MR to identify carotid occlusions due to cardiac embolism [7] and, in these new cases, US could easily identify uncommon carotid ‘‘saddle’’ thrombi attached to the vessel wall and leaving the distal tract of the vessel open and without wall disease. Even without strictly following stroke guidelines, surgery was performed successfully in one case. The identification with high-resolution US of the embolic source on the plaque surface in case 3 indicated that surgery had to be performed as soon as possible, and not on elective bases.

This small case series underline that high-resolution US, even with contrast agents, is a feasible and reliable technique, nowadays commonly diffused in clinical practice, with more and more detailed imaging quality. These better resolution pictures can be of help in reducing operator’s dependency, usually claimed as a major limit of US investigations. The detection of dynamic, real-time, aspects ‘‘in motion’’ is a strong potentiality of this technique, to better understand vascular pathophysiology. Moreover, ultrasound can easily differentiated cardiac clots from local thrombosis on a complicated atherosclerotic plaque, with the related clinical implications. All these findings underline the role of early ultrasound in the management of acute stroke patients. In conclusion, the achievement of his ‘‘kingdom’’ for the patient is linked to the availability of an expert joker, able to obtain the best results from his horse, besides ... ‘‘saddle problems’’.

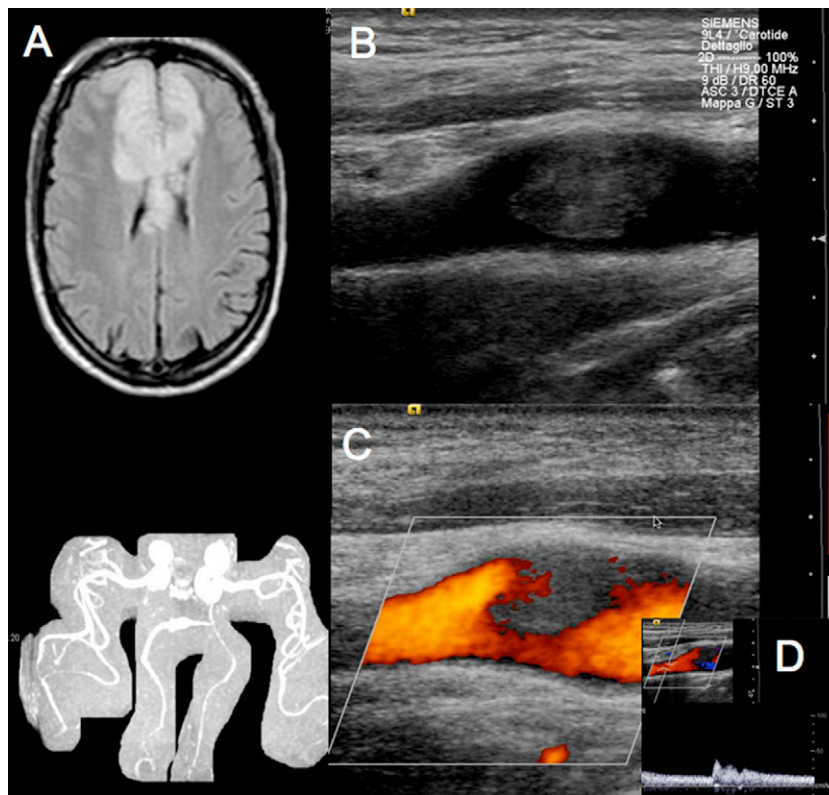


Figure 2 Case 2. Cerebral MR scan (A) with both anterior cerebral arteries ischemic lesions and normal middle cerebral arteries at MRA (below). Carotid ultrasonography: B-mode (B), power mode (C) of a mobile clot adherent to the superior wall of the carotid bulb. Distally, the internal carotid artery is patent, as shown by the power Doppler (B) and pulsed wave Doppler (D).

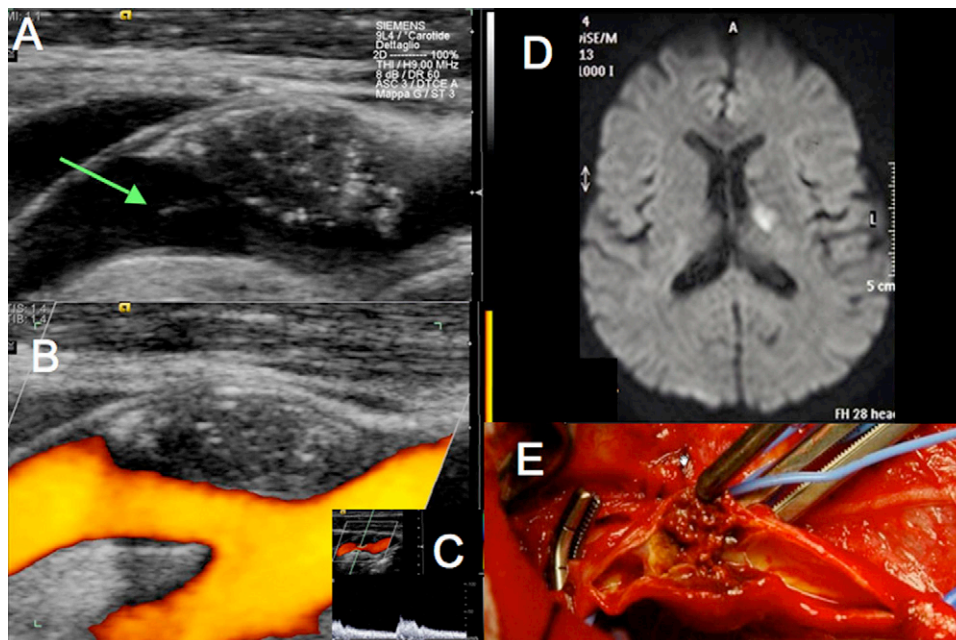


Figure 3 Case 3. Carotid ultrasonography: B-mode imaging (A) of the internal carotid stenosis with heterogeneous structure in a homolateral middle cerebral artery acute ischemic stroke patient. High-resolution images show a small thrombus with the head adhesion at the ruptured surface of the plaque, freely floating in the internal carotid lumen (green arrow). The distal tract of the artery is fully patent at the color Doppler (B), with normal blood flow velocities (C). Cerebral MRI scan shows a small lacuna in the homolateral internal capsule (D) and intraoperative findings (E) confirm the presence of a complicated plaque, with a thrombus attached to the surface of the plaque.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at [doi:10.1016/j.permed.2012.02.001](https://doi.org/10.1016/j.permed.2012.02.001).

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