Carotid diaphragm: an unusual and easily missed cause of internal carotid artery stenosis

S Raman, GD Osborn, PY Khan, RK Winter, CS Champ, MH Lewis

INTRODUCTION

Carotid endarterectomy is now well established as the treatment option of choice for symptomatic carotid artery stenosis. Atheromatous carotid artery disease usually manifests in patients as amaurosis fugax, transient ischaemic attack (TIA) or stroke.

Carotid duplex ultrasound is now recognized as the best non-invasive screening test for carotid artery stenosis (Khaw, 1997). Despite being considered the gold standard, carotid angiography, which carries a significant complication rate, is no longer routinely used before surgery but has been replaced by the newer, non-invasive techniques of magnetic resonance angiography (MRA) and computed tomography angiography (CTA). Many centres, including the authors' own, rely solely on duplex ultrasound for preoperative assessment.

This article presents a previously undocumented carotid artery diaphragm overlooked on initial duplex scanning, a potential pitfall in the symptomatic patient.

DISCUSSION

Carotid endarterectomy is a well-established treatment for symptomatic carotid artery stenosis (Favre et al, 1994; Cundy, 2002). The most cost-effective method of evaluating symptomatic patients is duplex ultrasound, which eliminates the risks associated with angiography (Sidhu and Allan, 1997a). Non-contrast-enhanced MRA using a time of flight technique compares favourably with angiography and ultrasound, but has been largely replaced by gadolinium contrast-enhanced MRA because of reduced imaging time and improved signal to noise ratio. However, this can overesti-

CASE REPORT

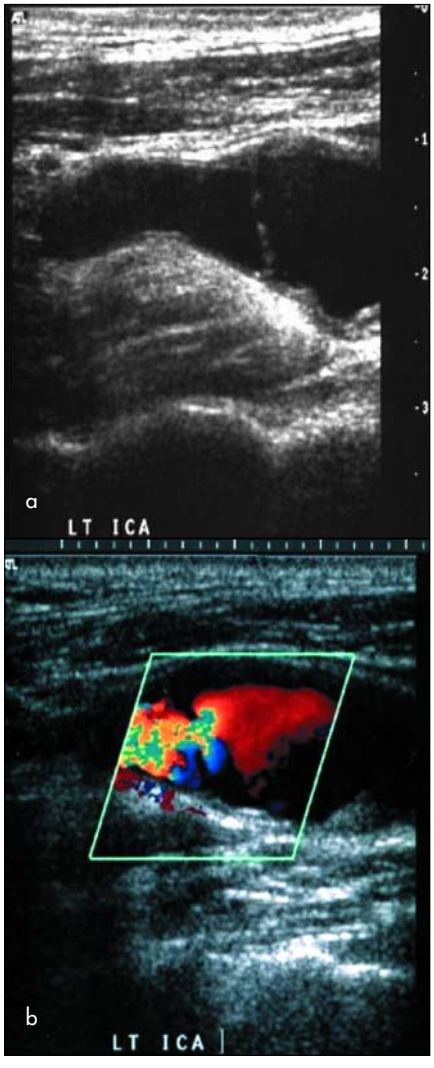
A 79-year-old retired railway worker presented to the ophthalmology department with a history of two episodes of transient loss of vision in the left eye, each lasting approximately 10 minutes, highly suggestive of amaurosis fugax. He had an extensive past medical history including a myocardial infarction, hypertension and peripheral vascular disease. In addition, he was an ex-smoker on lipid-lowering drugs and was taking regular aspirin. On physical examination, he had bilateral carotid bruits but no other cardiovascular or neurological abnormality was demonstrated. He was referred to the department of vascular surgery following duplex scanning of his carotid arteries.

Initial duplex scanning carried out by an experienced sonographer revealed increased peak systolic and end diastolic velocities in the right internal carotid artery, indicating a greater than 70% stenosis. Velocities in the left internal carotid artery were normal, excluding stenosis, although slight turbulence of flow was noted. As these results did not correlate with the clinical scenario, a repeat duplex scan was performed. It was only on the second occasion by careful scanning of the left internal carotid artery that a thin diaphragm across the carotid bulb with a small central lumen was identified (*Figures 1a* and *b*). The high velocity blood flow through this lumen associated with turbulent flow downstream correlated with a greater than 70% stenosis of the left internal carotid artery. An echolucent, eccentric plaque causing a tight stenosis of the left external carotid artery was also noted.

A left carotid endarterectomy was performed and the intraoperative findings correlated with the ultrasound findings. The excised specimen is shown in *Figures 2a* and *b*. The patient made an uneventful postoperative recovery and is now asymptomatic.

Histology confirmed that the 2.2 cm x 1.5 cm tubular, internal carotid artery atheromatous plaque contained a thin diaphragm 6 mm across with a 1 mm central hole. The diaphragm was composed of dense fibrous tissue while the central lumen was lined by endothelium (*Figures 3a* and *b*).

Figures 1. a and b. Duplex scan showing carotid diaphragm withing left internal carotid artery (ICA).



Mr S Raman is Surgical Research Fellow, **Mr GD Osborn** is Senior House Officer, **Dr PY Khan** is House Officer, **Dr RK Winter** is Consultant Radiologist, **Dr CS Champ** is Consultant Histopathologist and **Mr MH Lewis** is Consultant Vascular Surgeon, Royal Glamorgan Hospital, Llantrisant CF72 8XR

Correspondence to: Mr MH Lewis

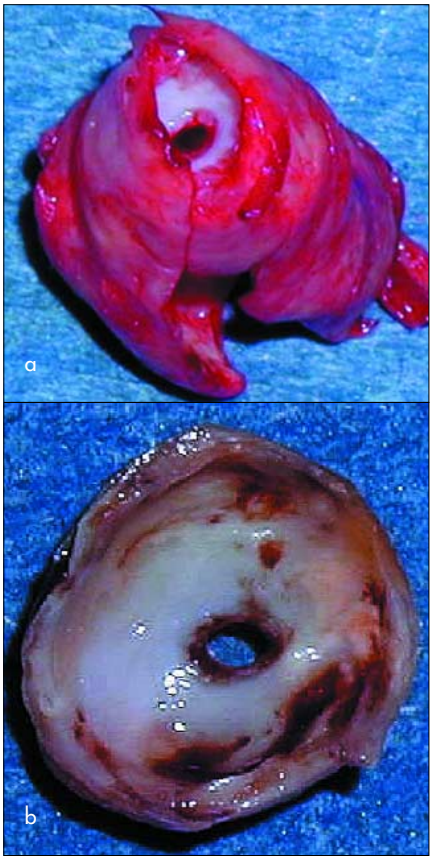


Figure 2. a. Fresh carotid endarterectomy specimen showing the carotid diaphragm. b. Fixed and trimmed specimen.

mate the degree of stenosis (Townsend et al, 2003). Furthermore, MRA is less reliable than ultrasound in identifying pseudo-occlusion (Furst et al, 1999).

Early reported experience with CTA suggests it is highly accurate in detecting and quantifying carotid stenosis (Berg et al, 2002). However, duplex ultrasound remains the imaging modality of choice and, as in the authors' practice, carotid endarterectomy can be done in the majority of cases, based solely on the findings of a duplex scan (Logason et al, 2002).

Studies have shown that factors such as hypertension, echolucent plaques and progressive lesions tend to be associated with an increased risk of neurological events and necessitate their consideration in determining treatment strategies for carotid stenosis (Liapis et al, 2001). In addition to the degree of stenosis, plaque morphology plays an important role in the presentation of carotid artery disease (Ballotta et al, 2000).

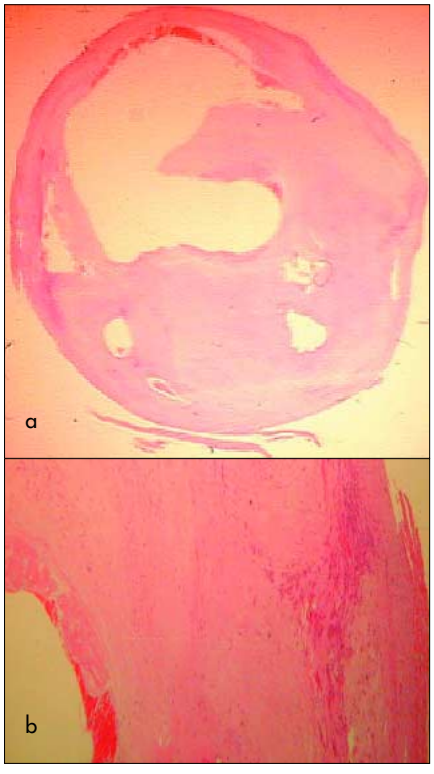


Figure 3. a and b. Histological appearance of the carotid diaphragm.

Ultrasound has the added benefit of being able to characterize atheromatous plaques. Fibrous plaques tend to be echogenic on ultrasound, but as the lipid content increases, the plaque becomes more echolucent. Intraplaque haemorrhage also results in an echolucent area within the plaque. Whatever the precise histological components of the echolucent areas seen on ultrasound of an atherosclerotic plaque, this finding implies a greater risk of symptomatic cerebrovascular disease (Sidhu and Allan, 1997b).

This patient presented with a symptomatic carotid artery stenosis which, given the past medical history, was believed to be of atherosclerotic aetiology. Typically, such patients with a significant stenosis have concentric or eccentric plaque extending over one to a few centimetres of the vessel. However, this patient had a wafer-thin diaphragm causing a high-grade stenosis. This resulted in a very localized increase in peak systolic velocity with distal turbulent flow. Thus careful siting of the Doppler sample gate was vital in order not to overlook the stenosis, as happened on the initial examination.

As to the aetiology of this diaphragm, it would seem unlikely to be an anatomical variant as presumably the patient would have been symptomatic at an earlier stage. It is thought the fibrous diaphragm represents an unusual form of atherosclerosis. Alternatively, recanalization of a previously occluded carotid artery is a possibility.

This unusual and previously unreported pathology is presented to alert surgeons, radiologists and vascular sonographers to its existence. **HM**

Ballota E, Da Giau G, Rennon L (2000) Carotid plaque gross morphology and clinical presentation: a prospective study of 457 carotid artery specimens. *J Surg Res* **89**(1): 78–84

Berg MH, Manninen HI, Rasanen HT, Vanninen RL, Jaakkola PA (2002) CT angiography in the assessment of carotid artery atherosclerosis. *Acta Radiol* **43**(2): 116–24

Cundy JB (2002) Carotid artery stenosis and endarterectomy. *AORN J* **75**(2): 31042

Favre JP, Guy JM, Frering V, Boissier C, Barral X (1994) Carotid surgery in the octogenarian. *Ann Vasc Surg* **8**(5): 421–6

Furst G, Saleh A, Wenserski F et al (1999) Reliability and validity of noninvasive imaging of internal carotid artery pseudo-occlusion. *Stroke* **30**(7): 1444–9

Khaw KT (1997) Does carotid duplex imaging render angiography redundant before carotid endarterectomy? *Br J Radiol* **70:** 235–8

Liapis CD, Kakisis JD, Kostakis AG (2001) Carotid stenosis: factors affecting symptomatology. *Stroke* **32**(12): 2782–6

Logason K, Karacagil S, Hardmark HG, Bostrom A, Hellberg A, Ljungman C (2002) Carotid artery endarterectomy solely based on duplex scan findings. *Vasc Endovascular Surg* **36**(1): 9–15

Sidhu PS, Allan PL (1997a) The extended role of carotid artery ultrasound. *Clin Radiol* **52**(9): 643–53

Sidhu PS, Allan PL (1997b) Ultrasound assessment of internal carotid artery stenosis. *Clin Radiol* **52**(9): 654–8

Townsend TC, Saloner D, Pan XM, Rapp JH (2003) Contrast material-enhanced MRA overestimates severity of carotid stenosis, compared with 3D time-of-flight MRA. *J Vasc Surg* **38**(1): 36–40

Correspondence

If you would like to comment on this or any article published in *Hospital Medicine*, or any issues relevant to our readers, please write in no more than 250 words to:

Dr Jack Tinker
Editor-in-Chief, *Hospital Medicine*
c/o Yvonne Perks
MA Healthcare
Unit A15, Dinton Business Park
Catherine Ford Road
Dinton, Salisbury
Wilts SP3 5HZ