Duplex Scan Findings in Patients with Spontaneous Cervical Artery Dissections


Departments of 1Surgery, 2Neurology and 3Radiology, University Hospital. Uppsala, Sweden

Aim: to report duplex scan findings in patients with spontaneous internal carotid artery (ICA) or vertebral artery (VA) dissection.

Material and methods: the records of 24 patients (13 males and 11 females, median age 48 years [range 25–68 years]) with spontaneous extracranial ICA dissection (n = 20) or VA dissection (n = 4), identified between January 1995 and December 1999, were retrospectively analysed.

Results: four different abnormal flow patterns were observed in patients with ICA dissection: (a) absence of flow (15%), (b) staccato flow (50%), (c) reduced flow velocity (25%) and, (d) stenotic flow (10%). B-mode ultrasound showed a homogenous echolucent lesion in eight patients and a double lumen in two. Staccato flow along the entire ICA was observed in only four patients without verified dissection during the study period. In the four patients with VA dissection, duplex scanning demonstrated staccato flow in three and reversed low-amplitude pulsatile flow in one.

Conclusion: duplex scanning is an important noninvasive diagnostic modality in patients with cervical artery dissection. Staccato flow along the extracranial ICA strongly indicates the presence of spontaneous ICA dissection.

Key Words: Duplex; Dissection; Cervical artery.

Table 1. Dominating symptom at presentation and subsequent symptoms in patients with spontaneous cervical artery dissection.

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Initial</th>
<th>Subsequent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head/neck pain</td>
<td>10 (42%)</td>
<td></td>
</tr>
<tr>
<td>Horner’s syndrome</td>
<td>2 (8%)</td>
<td></td>
</tr>
<tr>
<td>TIA/amaurosis fugax</td>
<td>4 (17%)</td>
<td></td>
</tr>
<tr>
<td>Minor stroke</td>
<td>3 (13%)</td>
<td>4 (17%)</td>
</tr>
<tr>
<td>Major stroke</td>
<td>5 (21%)</td>
<td>4 (17%)</td>
</tr>
</tbody>
</table>

Introduction

Spontaneous cervical artery dissection is an increasingly diagnosed cause of cerebral ischaemia, especially in young patients. Intramural haematoma due to the dissection induces luminal narrowing which may lead to occlusion. Early diagnosis is of importance as anticoagulation is recommended by many authors in order to prevent embolisation from, or thrombosis of, the internal carotid artery (ICA). Conventional angiography, MR imaging (MRI) or MR angiography (MRA) are commonly used for diagnosis. In recent years, duplex scanning has emerged as an alternative. The aim of the present study was to report our experience with duplex in patients with spontaneous ICA or vertebral artery (VA) dissections.

Patients and Methods

From January 1995 to December 1999, of around 4700 cervical artery duplex scans performed 37 patients were identified with possible cervical artery dissection. For various reasons 13 did not have a verifying investigation performed and were excluded from further analyses. Seven of these had tapering occlusion of the ICA, three had reduced flow velocity and a homogenous echolucent lesion in the ICA and three had staccato flow along the ICA. In the last three the flow normalised during follow-up. The remaining 24 patients with 20 ICA and four VA dissections had the diagnosis verified by angiography in five and MRA/MRI in 19 cases. There were 13 males and 11 females with a median age of 48 years (range 25–68). Five patients had hypertension, three had preceding trivial trauma and three had diabetes mellitus. The dominating symptom at presentation and subsequent symptoms are shown in Table 1.

* Please address all correspondence to: K. Logason, Department of Surgery, University of Uppsala, 751 85, Sweden.
Duplex scanning was performed using an Acuson model 128 XP with 5 or 7.5 MHz linear array probes or Sequoia (Acuson, Mountainview, CA, U.S.A.) fitted with 4–6 MHz linear probes, or an ATL HDI 5000 SonoCT fitted with 4–7, 5–12 MHz linear probes (ATL Ultrasound, Bothell, WA, U.S.A.). B-mode images and spectral Doppler registrations were obtained from common carotid (CCA), ICA, external carotid (ECA) and VAs on both sides.

Conventional selective digital subtraction angiography was performed by the femoral route. All patients who underwent MRI were investigated with conventional images (axial T1- and T2 weighted images). Seven cases were further investigated with phase contrast MRA, 11 with inflow MRA and one with gadolinium enhanced MRA. The presence of one of the following findings was used for diagnosis of cervical artery dissection: (a) demonstration of a long segment, gradual lumen narrowing (“string sign”) or tapering occlusion without atherosclerotic changes on conventional or MR angiograms, (b) intramural haematoma visualised by MRI.

There were no strict guidelines for duplex surveillance, but those without ICA occlusion were usually followed at 3-month intervals while patients with ICA occlusion or those with complete resolution were not followed.

**Results**

Four different flow patterns were observed in the patients with verified ICA dissection: (a) absence of flow, (b) high resistance obstructive flow with severely diminished systolic and absent or low diastolic flow (staccato flow), (c) diminished peak systolic velocity (PSV) with at least 50% reduction compared to the contralateral side, (d) increased ICA PSV above 140 cm/s.

In three patients, no flow signals were obtained from the ICA and angiography or MRA verified a tapering occlusion. In all three the B-mode image was inconclusive. Staccato flow along the entire course of the extracranial ICA was found in ten patients (Fig. 1). B-mode images were inconclusive in four, two had a double lumen in the ICA visualised while in four a homogenous echolucent lesion was found (Fig. 2). During the study period a staccato flow pattern along the entire course of the extracranial ICA was observed in only four patients without verified dissection. Three of these normalised during follow up while one had Moya-moya disease.

In five patients diminished flow velocity was detected in the ICA. Three of these had a homogenous echolucent lesion in the ICA while in two B-mode was inconclusive. In all five angiography (1 conventional, 4 MRA) demonstrated smooth moderate narrowing of the distal extracranial ICA.

High grade localised ICA stenosis was detected only in two patients with PSV >300 cm/s. PSV was normalized in one patient after 3 months and B-mode images demonstrated resolution of a homogenous echolucent lesion. In the other patient, high PSV, detected at the proximal part of a tapered stenosis, did not normalize during 5-year follow-up.

None of the patients in this study had signs of extracranial ICA redundancy (loop, kinks or coils) or aneurysm formation. During the study period, three patients with clinical suspicion of ICA dissection and normal duplex scan findings underwent conventional or MRA which demonstrated normal findings in two and ICA dissection with string sign in one patient.

Duplex scanning was performed at 3 months intervals during follow-up in 16 patients with ICA dissection. Spontaneous complete resolution was observed in 11 patients during a median interval of 6 months (five out of 10 with staccato flow, all five with diminished flow and one out of two with stenosis). In four patients partial recanalisation was shown prior to complete recanalisation.

In four patients with VA dissection, duplex scanning demonstrated staccato flow in three and reversed low-amplitude pulsatile flow in one. There were no other signs of pathological changes in the carotid or subclavian arteries. Follow-up with duplex scanning was available only in one patient in whom recanalisation was demonstrated after 6 months.
Spontaneous Dissection findings of tapered narrowing of the ICA (string sign), flamed shape occlusion or aneurysmal dilatation are indicative of dissection but are nonspecific. Pathognomonic findings such as the visualisation of a double lumen or an intimal flap are rarely noticed during angiography. Conventional angiography is invasive with rare but potentially serious complications. As spontaneous ICA dissection is not a stable condition, serial evaluations of the temporal profile can be needed and angiography can not be recommended for follow-up due to its invasive nature. During recent years, alternative noninvasive diagnostic modalities such as duplex scanning, MRI or MR angiography have been suggested for initial diagnosis and follow-up of ICA dissections.4,10,11

Duplex scanning has been increasingly used in the assessment of patients with suspected ICA dissection. It has the ability to provide not only direct visualisation of the pathological findings related to ICA dissection but also to give haemodynamic information. The accuracy of duplex scanning in the diagnosis of ICA dissections has been evaluated only in few reports. Steinkne et al.12 evaluated the duplex findings in 48 patients with angiographically confirmed spontaneous ICA dissections. Initial duplex scan findings were abnormal in all patients. High resistance flow pattern was observed in 68% of the patients. Sturzenegger et al.13 analysed the value of ultrasound in the diagnosis of 43 consecutive patients with spontaneous ICA dissection and showed a high accuracy in detecting dissections causing ICA occlusion or high grade stenosis. However, the diagnostic sensitivity of duplex scanning was only 20% in those with low grade stenosis. Treiman et al.14 demonstrated a duplex scan sensitivity of 95% in diagnosis of 19 ICA dissections in 17 patients. Nine arteries showed a tapering of ICA lumen distal to the bulb. Nine arteries had a membrane crossing the vessel lumen, double lumen or an intimal flap overlying intramural thrombus. Spectral Doppler analysis showed a reduction in ICA PSV compared with the contralateral side.

We observed four different abnormal flow patterns; (a) absence of flow, (b) staccato flow, (c) diminished flow and, (d) stenotic flow. Absence of flow in the ICA was observed in 15% of patients with ICA dissection. This probably is an underestimation of the frequency as most did not have confirmatory angiography or MR. Staccato flow pattern along the ICA was observed in 50% of patients with ICA dissection. This flow pattern was also found in three patients with probable dissection but only in one patient who definitely did not have a dissection. The detection of staccato flow along the entire course of extracranial ICA strongly

Fig. 2. Spontaneous ICA dissection in a 27-year-old male presenting with a major stroke. Intramural haematoma ((a) arrows) caused an increased PSV of 280 cm/sc (b). There was a staccato flow in the distal part of the ICA with very low but maintained diastolic flow (c). The intramural haematoma had resolved (d) and the flow in the ICA normalised after 3 months (e).
indicates the presence of dissection. However, the documentation of a patent ICA with staccato flow may also be encountered in patients with intracranial ICA occlusion for other reasons such as moyamoya disease. High resistance flow (pulsatile flow with low diastolic amplitude), which might be seen in patients with increased intra-cranial pressure or embolic disease, can easily be differentiated from staccato flow (obstructive high resistance flow) seen in patients with ICA dissections. Diminished ICA flow was detected in 25% of patients and all these showed recanalisation. It is likely that the degree of luminal narrowing and the status of ICA distal to the intramural hematoma affects the rate of resolution. Resolution was observed in 11 out of 16 patients with available duplex scan surveillance. The number of patients with various duplex scan findings are too small however to draw any firm conclusions with regard to the factors affecting recanalisation. It is likely that in patients with localised distal ICA dissection with moderately narrowed lumen, duplex scan findings may be normal. Dissection causing high grade localised ICA stenosis was observed only in two patients. Sturzenegger et al. found a stenotic signal in high cervical segment in 7 out of 43 patients with spontaneous ICA dissection. In five of these patients this was the only abnormal finding. However, the criteria used for grading stenosis were not clear.

Isolated spontaneous vertebral artery dissection was diagnosed in four patients, with spectral Doppler analysis showing non-specific but abnormal finding. Abnormal vertebral artery spectral Doppler registrations in patients without associated carotid or subclavian artery lesions should lead to conventional or MR angiography in patients with vertebro-basilar symptoms.

It is difficult to evaluate the real diagnostic power of duplex scanning in the diagnosis of ICA dissection due to the fact that there are only small series in the literature. It is also difficult to extrapolate data on possible false negative duplex scans as the majority of patients with non-specific cerebral symptoms and normal duplex scan findings do not undergo angiography. However visualisation of intramural haematoma combined with staccato flow strongly indicate the presence of spontaneous ICA dissection. Such duplex findings in patients with clinical suspicion of spontaneous ICA dissection (such as Horner’s syndrome in younger patients) is sufficient to establish definite diagnosis without need for other imaging modalities. Patients with clinical suspicion of cervical artery dissection, having inconclusive or normal duplex scan findings should be further investigated by conventional angiography or MRA/MRI.

Acknowledgement

Funding for this study was received from the Swedish Medical Research Council, grant no. 00759, Swedish Heart and Lung Foundation.

References