

Investigation of arterial occlusive disease

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Most patients with symptomatic lower limb ischaemia present with mild symptomatology and do not require invasive treatment, such as angioplasty or surgical reconstruction, and the decision of whether or not to intervene can often be made without recourse to special investigations. When further investigation is indicated the purpose is to confirm the presence and severity of peripheral arterial disease (PAD), identify the anatomical location of disease and assess the suitability of the patient for intervention. General investigation Patients with arterial disease tend to be elderly and atherosclerosis is often a multisystem disease process; the presence of arterial disease in the leg is suggestive of disease in other arterial Christian Johann Doppler, 1803–1856, Professor of Experimental Physics, Vienna, Austria, enunciated the 'Doppler principle' in 1842. - trees, including the coronary (50%) and cerebral (25–50%) trees. Many patients have other age-related diseases, such as chronic obstructive pulmonary disease and malignancy, that may impact on both their symptoms and suitability for intervention. Blood tests to exclude anaemia, diabetes, renal disease and lipid abnormalities should include a full blood count, blood glucose, lipid profile and serum urea and electrolytes. High blood viscosity (polycythaemia and thrombocythaemia) may be caused by smoking, but may also be associated with cancer; renal impairment (raised serum creatinine and low estimated glomerular filtration rate) may be caused by drugs and may be exacerbated by intravenous contrast agents used during angiography. An electrocardiogram (ECG) may show coronary ischaemia, left ventricular hypertrophy or a cardiac dysrhythmia, although a normal ECG does not exclude these conditions. More information may be gained by an echocardiogram or exercise testing. Arterial blood gases and a pulmonary function test may be appropriate in patients with severe lung disease. Doppler ultrasound blood flow detection - A hand-held Doppler ultrasound probe is very useful in the assessment of steno-occlusive arterial disease (Figures 61.6 and 61.7). A continuous-wave ultrasound signal is transmitted from the probe at an artery and a receiver within the probe itself picks up the reflected beam. The change in frequency in the reflected beam compared with that of the transmitted beam is due to the Doppler shift, which results from the reflection of the beam by moving blood cells. The frequency change may be converted into an audio signal that is typically pulsatile. Doppler ultrasound equipment can be used in conjunction with a sphygmomanometer to assess systolic pressure in small vessels. This is possible even when the arterial pulse cannot be palpated. Both the pressure and signal quality are important;

disease. Aortoiliac obstruction Claudication in the buttocks, thighs and calves Femoral and distal pulses absent in both limbs Bruit over the aortoiliac region Impotence (Leriche) Iliac obstruction Unilateral claudication in the thigh and calf and sometimes the buttock Bruit over the iliac region Unilateral absence of femoral and distal pulses Femoropopliteal Unilateral claudication in the calf

obstruction Femoral pulse palpable with absent unilateral distal pulses Distal obstruction Femoral and popliteal pulses palpable Ankle pulses absent Claudication in the calf and foot

a normal artery has a triphasic signal whereas a diseased artery may have a biphasic or monophasic signal depending on the extent of disease. However, although the presence of a Doppler signal indicates moving blood, it does not necessarily indicate that the blood flow is sufficient to maintain limb viability and prevent limb loss. Quantitative assessment can be carried out at the bedside by performing an ankle-brachial pressure index (ABI), which is the ratio of the systolic pressure at the ankle to that in the ipsilateral arm. The highest pressure in the dorsalis pedis, posterior tibial or peroneal artery serves as the numerator, with the highest brachial systolic pressure being the denominator. The normal resting ABI is 0.9-1.4; values below 0.9 indicate a haemodynamically significant arterial lesion; a value less than 0.4 suggests CLTI. Values are merely a guide and normal values may be present with intermittent claudication. Retesting after exercise to the onset of pain can be useful; a drop in the resting ABI of >20% after exercise is indicative of flow-limiting arterial disease. Artificially high ABI readings (>1.4) can be caused by media sclerosis and calcification of the arterial wall, causing vessel incompressibility and a falsely elevated ABI; this pattern of disease typically occurs in patients with diabetes mellitus (DM). Toe (digital) arteries are rarely affected by sclerosis and a toe-brachial pressure index (TBI) in combination with ABI is advocated as a more reliable diagnostic tool for the detection of significant large-vessel steno-occlusive disease in patients with DM. A TBI less than 0.6 suggests a significant arterial lesion that may have been overlooked if ABI was used in isolation (Figure 61.8). However, there are limitations to the usage of TBI in the DM population: one in six patients with DM presenting with CLTI will have gangrene or will have undergone an amputation of the hallux.

Duplex Doppler ultrasound This major non-invasive technique uses B-mode ultrasound to provide an image of vessels (Figures 61.9 and 61.10). The image is created because of the varying ability of different tissues to reflect the ultrasound beam. A second ultrasound beam is then used to insonate the imaged vessel and the Doppler shift obtained is analysed by a computer. Most scanners now have colour coding, which allows detailed visualisation of blood flow , turbulence, etc. Different colours indicate changes in direction and velocity of flow with areas of high flow usually indicating a stenosis. In experienced hands, duplex Doppler ultrasound (DUS) is as accurate as angiography and has the advantages of cost-effectiveness and safety . However, there are limitations: the aortoiliac segment can be difficult to visualise because of

Figure 61.6 A simple hand-held Doppler ultrasound probe. Figure 61.7 A hand-held Doppler probe and sphygmomanometer used to

determine systolic pressure in the dorsalis pedis artery, as part of assessing the ankle-brachial pressure index. Figure 61.8 Toe pressures being performed from the hallux. An abso

lute pressure from the hallux of <50 mmHg indicates severe ischaemia that is likely to prevent healing of ulceration.

bowel gas or obesity; vessels that are heavily calcified may limit the ability of DUS to accurately assess the severity of steno-occlusive disease; the overall accuracy of DUS is determined by operator experience. When DUS inadequately visualises or quantifies the level of disease within an arterial segment an alternative imaging modality, e.g. digital subtraction percutaneous angiography (DSA) or computed tomography angiography (CTA), may be undertaken to delineate the anatomy and extent of disease. Digital subtraction percutaneous angiography DSA involves injection of a radio-opaque dye into the arterial tree. Access to the vessel, typically the common femoral artery (CFA), is achieved using the Seldinger technique and is usually done percutaneously (Figures 61.11 and 61.12). The images obtained are digitalised by computer and the extraneous back ground (bone, soft tissues, etc.) is removed to provide clearer images. The benefits of DSA are that it provides dynamic Sven Ivar Seldinger, 1921–1998, radiologist, Karolinska Institutet, Stockholm, Sweden, introduced percutaneous arterial catheterisation in 1956. tive endovascular intervention when indicated. However, it is associated with potential complications, including bleeding, haematoma, false aneurysm formation, thrombosis, arterial dissection, distal embolisation, renal dysfunction and allergic reaction, which may occur in up to 5% of procedures. Furthermore, it is relatively expensive compared with other investigation modalities and its usage should be limited to patients in whom a concomitant intervention is predicted. Computed tomography angiography and magnetic resonance angiography The use of CTA as a minimally invasive alternative to DSA has increased as availability has improved. When used as an adjunct to DSA, CTA is beneficial where DUS is not possible (intrathoracic arteries) or produces poor images (aortoiliac segment). With increased ease of access, better image quality and modern three-dimensional image reconstruction software, CTA has become an invaluable tool when planning revascularisation procedures, enabling the surgeon to visualise and measure diseased arterial segments prior to intervention. The major concern with CTA, in addition to the exposure to ionising radiation, is the use of iodinated contrast. A substantial proportion of patients presenting with PAD

have concomitant renal dysfunction, which may be acutely exacerbated by iodinated contrast, causing contrast-induced nephropathy . -

Figure 61.9 Duplex Doppler ultrasound scan being performed of the right carotid bifurcation. Figure 61.10 Normal duplex Doppler ultrasound of the carotid vessels in the neck. CCA, common carotid artery; ECA, external carotid artery; ICA, internal carotid artery; STA, superior thyroid artery. Figure 61.11 A Seldinger needle and guidewire for introducing an arterial catheter.

This is particularly pertinent to the patient with diabetes, in whom one also needs to be mindful of the interactions between contrast and certain pharmacotherapies, e.g. metformin, as their periprocedural usage may cause dangerous metabolic injury . Magnetic resonance angiography (MRA) is a non-invasive test that avoids the need for ionising radiation and iodinated contrast, thereby having advantages over DSA and CTA. It is becoming more widely utilised, particularly as the proportion of patients with diabetes increases; this patient population typically has calcified crural vessel disease, which is difficult to assess using DUS or CTA. MRA has the ability to separate out contrast from vessel wall calcification and has become the preferred imaging modality in many institutions. MRA has a number of limitations and may be contraindicated in patients with claustrophobia or certain metallic implants, e.g. pacemakers. The majority of peripheral arterial stents are now compatible with MRA, although the image quality will often be downgraded, making interpretation of flow difficult. MRA uses gadolinium as a contrast agent and patients with renal dysfunction are at risk of gadolinium-induced nephrogenic systemic fibrosis (Figure 61.13).

Figure 61.12 Digital subtraction angiogram of the femoral artery complex performed through a sheath (arrow) positioned percutaneously in the common femoral artery (CFA) using the Seldinger technique. PFA, profunda femoris artery; SFA, superficial femoral artery.

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