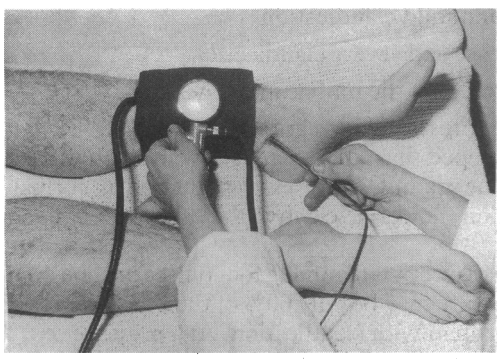
ASSESSMENT OF LEG ISCHAEMIA

Andrew N Nicolaides



Measurement of systolic ankle pressure with simple inexpensive equipment: pneumatic cuff and pressure gauge (left), and Doppler ultrasound velocimeter (right) to detect dorsalis pedis and posterior tibial signals.

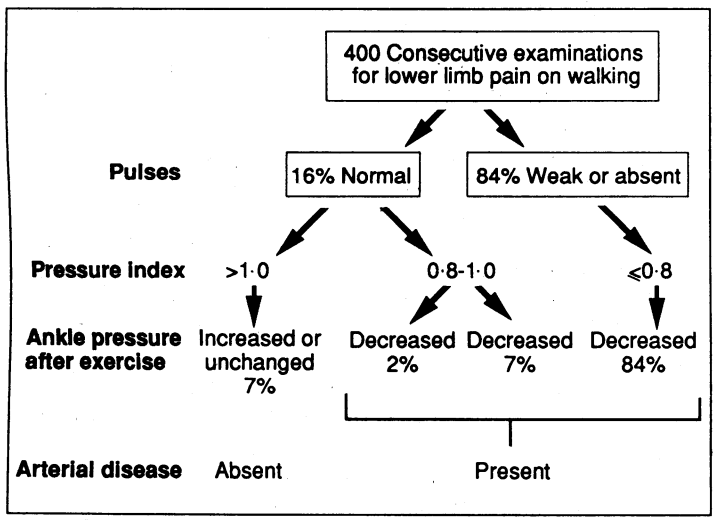
Pain on walking is a common complaint usually caused by arthritis or sciatica, but stenosis of the spinal canal and venous insufficiency must also be considered before ischaemia is confirmed. This is easy in most patients, but may be difficult if the ischaemia is mild, or there is coexistent arthritis. Evidence of peripheral ischaemia such as skin changes, cold feet, and absent pulses will confirm any suspicion of arterial disease that has been raised by the history. Rest pain, especially at night, is diagnostic, and urgent admission to hospital for arteriography should be arranged with the expectation of early operation for revascularisation. In some claudicant patients, however, there may not be such clear cut evidence of ischaemia because there are no skin changes and all the peripheral pulses are present when the patient is examined at rest.

Patients can be divided into four main groups:

- Those in whom femoral pulses are absent or weak, suggesting the presence of aortoiliac disease
- Those with absent foot pulses but normal femoral pulses, suggesting femorodistal disease
- Those whose foot and femoral pulses are normal at rest but become weak or disappear on exercise
- Those with normal foot and femoral pulses at rest that are not altered by exercise.

Most patients can be diagnosed by simple and careful history taking and examination. Decisions about treatment, while based on the clinical features above, may be clarified by non-invasive investigations. In most patients arteriography can be avoided.

Is there arterial disease?



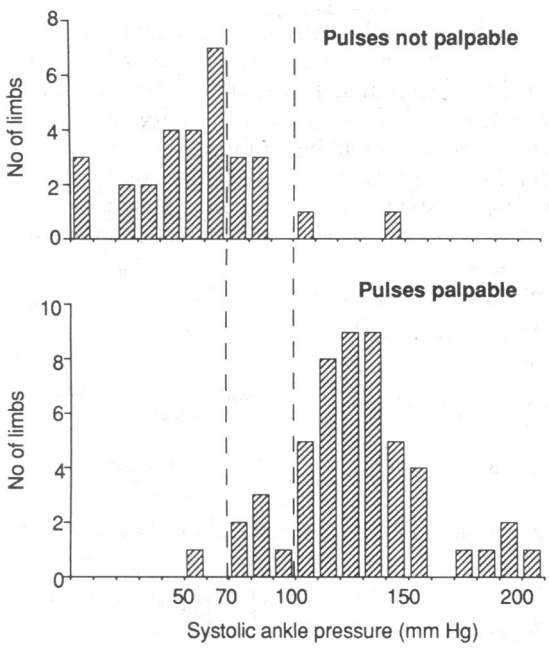
Value of pulses, pressure index, and ankle pressure after exercise in determining the presence or absence of arterial disease.

If the pulses are absent the clinical examination alone is enough to determine the presence of arterial disease; non-invasive tests are not necessary to make the diagnosis and they are used mainly to document the presence and extent of disease. If the pulses are weak the non-invasive tests are also unnecessary but they can provide objective quantitative confirmation. The ankle pressure at rest is simple to measure, confirms the clinical impression, and is particularly useful in obese patients or if there is ankle oedema that makes the pulses difficult to feel. If the pulses are normal, however, and the patient has pain on walking, further tests are necessary. In such patients the ankle pressure should be measured both at rest and after exercise because it is possible to have normal ankle pressures at rest, and a fall in ankle pressure after exercise may be the sole indicator of disease.

The ankle pressure after exercise is the most sensitive sign of the presence of arterial disease

A fall in ankle pressure after a standardised exercise test on a treadmill is the most sensitive measure of the presence of occlusive arterial disease. A study of 400 patients with pain on walking showed the comparative accuracy of assessment of the pulses and measurement of the pressure indexes at rest and the ankle pressures after exercise. The ankle pressure after exercise was the most sensitive index of the presence of severe disease, and relying on the pulses alone would have resulted in the wrong diagnosis in 9% of patients. Whenever the ankle pressure after exercise was increased or unchanged the aortogram was normal and the symptoms were the result of other conditions such as osteoarthritis, sciatica, or venous insufficiency. Thus if there was an increase in ankle pressure after exercise severe arterial disease could be excluded and patients spared unnecessary investigations.

How severe is the disease?



Relation of ankle pressure to presence or absence of foot pulses in a study of 82 limbs.

From the history and clinical examination patients may be divided into three groups:

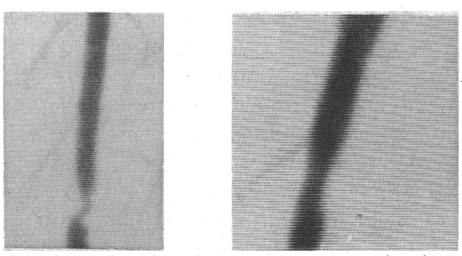
- Those with mild disease and mild claudication
- Those with moderate disease and severe claudication
- Those with disease so severe that the limb is in danger.

The measurement of ankle pressures was simplified in the late 1960s when instruments were developed that could detect flow in small vessels distal to a pneumatic cuff. The grading of pulses by palpation as normal, weak, or absent lacks precision, however sensitive the examiner's fingers may be.

When the ankle systolic pressure is 110 mm Hg foot pulses may be graded as normal, although this pressure may be only 60% of the brachial systolic pressure (180 mm Hg) in a patient with claudication. At a pressure of 70 mm Hg the foot is not in immediate danger, but at a pressure of 30 mm Hg it is, yet palpation may indicate absent pulses in both cases.

The decrease in ankle pressure after a standard exercise test and the time taken for it to return to the value before exercise (the recovery time) are good indicators of the severity of the disease, whereas the time of onset of claudication is an accurate measure of the patient's incapacity; this bears little relation to the patient's own assessment of his or her claudication distance. If the patient is tested after walking on the treadmill for one minute the test is simple, not unduly gruelling, and can be used to monitor the progression of the disease.

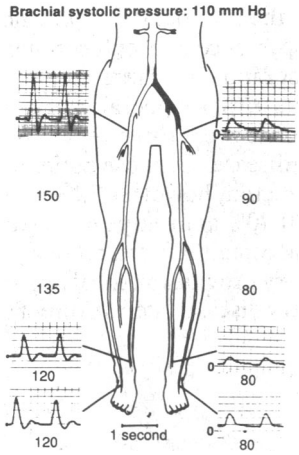
Where is the disease?



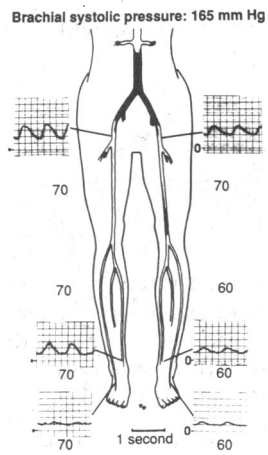
Arteriograms showing a severe stenosis of superficial femoral artery (left), and, immediately after balloon angioplasty, some residual stenosis (right).

There are good reasons for wanting to know whether the disease is in the aortoiliac segment, in the femoropopliteal segment, distal to the popliteal artery, or in more than one segment. In the case of aortoiliac reconstruction or percutaneous balloon angioplasty the results are good and the vessel may remain patent for many years, so that the patient remains free of symptoms. The results of femoropopliteal reconstruction, however, are not good; the primary failure rate is roughly 5-10% and between a third and a half of the grafts occlude within five years. Finally, attempts to reconstruct lesions distal to the popliteal artery are made only if the leg is critically ischaemic. Often the surgeon cannot decide by clinical observation alone whether there is also aortoiliac disease in a patient who has an obvious superficial femoral occlusion and palpable femoral pulses. Simple auscultation may show a bruit at the common femoral artery, but its importance may be difficult to assess.

A clue to the extent of disease can be obtained from the recovery time (the time taken for the decreased ankle pressure after exercise to return to the value before exercise). A recovery time of less than five minutes means that there is only a single lesion, and that it is most probably in the



Blood velocity waveforms and systolic pressure in the lower limb in a patient with occlusion of the left iliac artery. Waveforms recorded from the common femoral, posterior tibial, and dorsalis pedis arteries are monophasic with identical acceleration and deceleration in all arteries.



Waveforms recorded from the common femoral and posterior tibial arteries are different because of two segment disease.

femoropopliteal segment. A recovery time between 5 and 15 minutes also suggests a single lesion, but this is usually in the aortoiliac region. A recovery time of longer than 15 minutes suggests multiple lesions.

The recordings of Doppler velocity tracings from the common femoral artery together with velocity tracings from the ankle and the measurements made from them will supplement the pressure measurements and recovery time, and help to localise the disease because the velocity tracings distal to the stenosis or occlusion are dampened.

Is the aortoiliac segment normal?

The condition of the aortoiliac segment is fundamental in the management of claudication. After identifying the presence of occlusive arterial disease the surgeon should determine whether the aortoiliac segment is normal—that is, whether the disease is confined to the superficial femoral artery—because disease confined to the superficial femoral artery is a benign condition. I have found that about 92% of patients with superficial femoral artery occlusions whose aortoiliac segments are either normal or have less than 30% stenoses show clinical improvement with spontaneous improvement in ankle pressure readings.

How important is an aortoiliac lesion in patients with combined aortoiliac and femoropopliteal disease?

The femoral pulse and presence of a bruit may suggest aortoiliac disease. If the Doppler velocity tracings from the common femoral artery are triphasic, however, it means that the aortoiliac segment is normal.

The importance of disease in the aortoiliac segment in patients who require a femorodistal reconstruction is difficult to assess. Wave form analysis is useful and duplex assessment (Doppler and ultrasonographic imaging) of the aortoiliac segment may show localised stenoses. Many surgeons rely on the response of the femoral arterial pressure to dilatation of the distal arterial bed with 30 mg of papaverine. Providing that aortoiliac flow is adequate there is enough compensation for the increased requirement, but if there is proximal stenosis the injection of papaverine results in a decrease in pressure of 20 mm Hg or more in the femoral artery as the distal vascular bed expands.

The advent of duplex ultrasonic scanning with colour flow imaging has provided us with the ability to localise and grade the severity and extent of superficial femoral artery stenosis or occlusion. It is now possible to decide on the basis of this non-invasive scanning whether the lesion is suitable for balloon angioplasty without angiography.

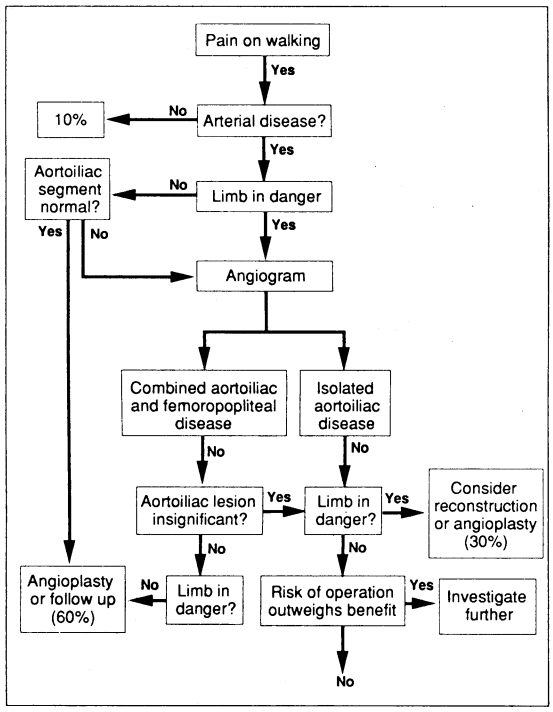
Is there other important vascular disease?

Patient exercising on a bicycle ergometer.

Whether the surgeon recommends an operation depends on the severity of symptoms, the patient's incapacity, and the danger to the limb if the operation is not done, balanced against the risk of reconstruction and both the long term and the short term results. Surgeons must be able to estimate how long the reconstruction will last, and, finally, be able to say what the short term results will be. A patient will not be grateful for a successful arterial reconstruction if he or she is still incapacitated by angina or pain from an osteoarthritic hip. The surgeon must assess the severity of these conditions and decide whether their symptoms can be relieved too, as they commonly coexist with peripheral arterial disease. He or she may decide—for example—that a patient should have a coronary artery reconstruction and then peripheral arterial reconstruction.

Many patients with lower limb ischaemia have occult myocardial ischaemia. They give histories of one or more myocardial infarctions, or of angina that disappeared when their claudication distances decreased. In my experience over half the patients with claudication have electrocardiographic evidence of myocardial ischaemia on exercise, although only 3% develop angina. I have found that although their walking ability may be limited, they can exercise on a bicycle ergometer and raise their heart rates enough to give meaningful electrocardiographic results. In addition, the ability to diagnose the presence of one, two, or three vessel coronary disease by electrocardiographic chest wall mapping during bicycle ergometry offers the chance to select the high risk group that is responsible for the operative mortality (3-5%) and late mortality, which can be as high as 30% at two years.

At least three quarters of patients presenting with peripheral arterial disease are likely to have serious vascular lesions elsewhere as well



Initial management of patients with suspected arterial disease with decisions based on history, clinical examination, and information from non-invasive tests.

Further support for this comes from the Cleveland Clinic, where in a series of 1000 consecutive patients the presence of occult coronary disease was detected by routine coronary angiography in a large proportion of patients. The five year survival of patients with peripheral arterial disease and cardiac disease was 43% in the presence of severe three vessel coronary disease and 85% in the absence of such disease. Of those patients who had their severe coronary vessel disease corrected, however, 72% survived. Because of these figures a mortality of 20-40% at three years in patients with peripheral arterial disease is no longer acceptable. Referral of a patient for peripheral vascular reconstructive surgery provides an ideal opportunity for the diagnosis of associated coronary artery disease; such an opportunity may never occur again in his or her lifetime."

The questions posed by the physician and the clinical decisions that are based on the answers can be summarised by an algorithm. In my experience 10% of patients who attend because of pain on walking do not have arterial disease. I also find that 60% of the patients have mild claudication with superficial femoral occlusion and a normal iliac segment. These are treated conservatively. Thus 70% of patients are spared any further investigation and only 30% require an arteriogram.

Conclusion

Non-invasive tests permit:

- Confident exclusion of arterial disease
- Assessment of the affected segment
- Objective evidence of severity of disease

In summary, non-invasive tests are valuable adjuncts to the history and clinical examination. They permit confident exclusion of arterial disease, assessment of the affected segment, and objective evidence of the severity of disease. Finally, objective measurements of the progression of the disease and the follow up of reconstructions can be monitored.

The diagrams of blood velocity wave forms and systolic pressures are reproduced by kind permission of Churchill Livingstone. We acknowledge with thanks the assistance of the audiovisual department, St Mary's Hospital, London, in the preparation of the illustrations.

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The ABC of Vascular Diseases has been edited by Mr John H N Wolfe, FRCS.

Health and the Environment

Dangers of ozone depletion

Fiona Godlee

Atmospheric ozone absorbs ultraviolet light from the sun, especially in the ultraviolet range (290-320 nm), and protects plants and animals from its damaging effects. Loss of ozone from the earth's outer atmosphere could have dire consequences for human health.

Ozone is present in greatest abundance in the stratosphere (15-50 km above ground level.) In 1985 Joe Farman of the British Antarctic Survey reported considerable losses of ozone over the Antarctic during springtime. This confirmed fears first aired in the early 1970s that chlorofluorocarbons (CFCs), released into the atmosphere from aerosol sprays, light industry, and refrigeration, were destroying stratospheric ozone. Although less severe, depletion of ozone was also reported over the North Pole during the spring of 1989, and there is now evidence of generalised thinning of the ozone layer across the northern hemisphere. In 1988 the Ozone Trends Review Panel estimated a loss of 2-3% since the early 1970s at latitudes 53-64° north.[1]

Steady state concentrations of ozone in the stratosphere depend on the balance of the processes that form it and destroy it. Ozone is formed by the photochemical breakdown of molecules of oxygen. This occurs slowly and with a regeneration half time of three to four years. Chlorofluorocarbons are almost inactive at ground level, which allows them to rise unchanged into the stratosphere. There they generate free radicals which catalyse the photochemical breakdown of ozone. Chlorofluorocarbons have a long half life, persisting in the atmosphere for up to 100 years. Large amounts have been produced only since the second world war, and during the 1980s atmospheric concentrations increased at a rate of about 5% a year.

British Medical Journal, London WC1H 9JR
Fiona Godlee, MRCP, *assistant editor*

BMJ 1991;**303**:1326-8