A user's guide to foot screening. Part 2: Peripheral arterial disease

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ARTICLE POINTS

1 Diagnosis of peripheral arterial disease should not be based upon the findings of one clinical test alone.

2 It is important to check that other risk factors such as hypertension, hyperlipidaemia and smoking are being dealt with.

3 Poor arterial supply reduces healing and increases infection risk.

4 Patient examination should be used as a health education tool.

5 Local vascular surgery referral criteria for interventions should be developed with your local surgeons and physicians.

KEY WORDS
- **Peripheral arterial disease**
- **Vascular assessment**
- **Type 2 diabetes**
- **Ischaemia**
- **Screening**

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Introduction

This article is the second of a series of three that aims to provide a clear, simple and practical approach to diabetic foot assessment. Each of the three articles will focus upon a particular aspect of foot examination and, although they will appear individually, they should be combined to give an overall approach to foot examinations. This article focuses upon identifying the at-risk foot due to peripheral arterial disease. The intention is to provide a simple guide to foot examination for everyday use by clinicians that is derived from evidence-based literature.

Peripheral arterial disease (PAD) can be defined as lower extremity atherosclerosis (see *Appendix 1* for a definition), which is more common in people with type 2 diabetes, as are other cardiovascular disease pathologies (for example ischaemic heart disease, myocardial infarction and cerebrovascular disease), compared with those without diabetes (MacGregor et al, 1999; Murabito et al, 1997). PAD occurs 20 times more often in people with diabetes compared with the general population (Shaw and Boulton, 2001). It has been reported that PAD is the single most likely cause of lower extremity amputations in people with diabetes (Pecoraro et al, 1990; Apelqvist et al, 1992; Bird et al, 1999); and, importantly, it is more rapid in its progression and occurs at a younger age compared with cases of such amputations in people without diabetes (Brand et al, 1989; Strandness et al, 1964).

Pure ischaemia in patients with diabetes is not common; however, the presence of reduced arterial supply in combination with neuropathy (neuro-ischaemia) is common, affecting up to 45% of patients with foot ulceration (Shaw and Boulton, 2001; Thomson et al, 1991). With an ageing population and a rising prevalence of type 2 diabetes, an increase in the incidence of neuro-ischaemic ulcers may be anticipated.

Arterial assessment

Arterial occlusive lesions causing ischaemia vary from aortoiliac disease to multi-segmental diffuse lesions extending to the ankle and foot (Hamy and Allen, 2001). Arterial insufficiency is not always easily recognisable until it is quite advanced.

Arterial assessment should be grounded in a clear knowledge of anatomy and pathophysiology, together with the ability to take a comprehensive patient history. Some basic points to remember when taking a patient history in order to assess the diabetic foot are as follows.

- Always explain what you are going to do to a patient and why. The time spent examining the foot is a golden opportunity to discuss health education and explore a patient's beliefs, understanding and fears relating to diabetes and blood flow.
- Always inform the patient of your findings and what these mean in terms that they can relate to.
- Reduced arterial blood flow results in poor oxygenation, malnutrition and poor healing capacity of the skin.
- Screening for contributing factors, particularly smoking, hyperlipidaemia, hypertension and hyperglycaemia, is essential.
- It is unwise to suggest a diagnosis of PAD based upon one clinical test or observation, such as an absent foot pulse, or cold skin.

In order to undertake a thorough vascular assessment it is essential to have a clear working knowledge and understanding of basic arterial anatomy. *Figure 1* illustrates the major arteries of the lower limb, from the

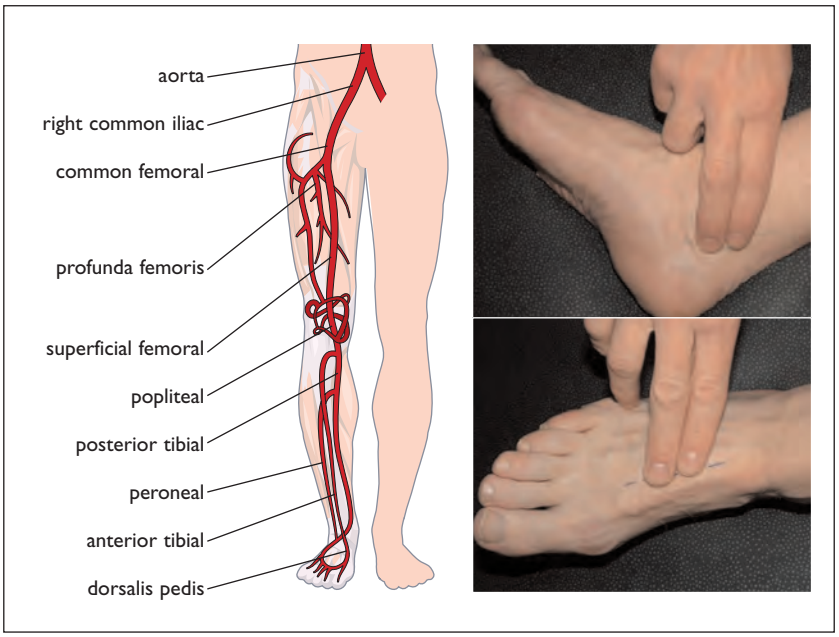

Figure 1. Left: illustration of the major lower limb arteries. Right, top: location of the posterior tibial pulse. Right, bottom: location of the dorsalis pedis pulse.

division of the aorta into the left and right common iliac arteries to the smaller arteries at the lowest extremity of the foot.

Rationale for vascular assessment of the foot

Why should we regularly test for the presence of arterial disease in people with diabetes? Identification of ischaemia allows intervention strategies to be implemented. These should include appropriate podiatry provision, especially good nail and skin care; targeted education; and, more holistically, a full and prompt review of cardiovascular protection measures such as management of hypertension, hyperlipidaemia, glycaemic control and antiplatelet therapy.

Additionally, if vascular assessment is performed annually in a standardised way, any deterioration in the patient's circulation can be promptly identified.

History taking

Comprehensive history taking is vital to assess the vascular status and general fitness of the patient. General vascular history includes asking about previous heart attacks and angina, other diabetes-related complications (for example, eye disease, renal disease and neuropathy), current medication, and general fitness including exercise tolerance. This is important because many older people with arterial disease have serious co-existing conditions which may influence future decisions about treatment.

Presence of other concomitant risk factors for PAD such as the use of tobacco, excessive alcohol consumption and hyperlipidaemia should be elucidated.

More specifically, history to determine intermittent claudication and/or rest pain should be ascertained as it is important to distinguish this from other pain aetiologies like neuropathy, plantar fascitis, meralgia and Morton's metatarsalgia (*Table 1*).

Clinical manifestations of PAD

Remember, if the skin looks healthy, then it probably is! When examining feet it is good practice not to be drawn to the most

Table 1. Features of PAD symptoms and painful neuropathy.

	Intermittent claudication	Ischaemic rest pain	Neuropathic pain
Site	Calf/thigh	Foot/calf	Foot/shin
Onset of pain	On exercise	Upon elevation	Especially night-time but can be constant
Type of pain	Cramp-like	Constant gnawing ache	Tingling, burning, shooting, skin hypersensitivity
Relief of pain	Rest	Lowering foot/leg	Exercise
Clinical features	Weak/absent pulses, ankle brachial pressure index (ABPI) <0.8, reduced tissue vitality	Cold, pulseless, ABPI <0.5, poor tissue viability	Warm foot, palpable pulses, ABPI >0.8, good tissue

PAGE POINTS

1 When examining feet it is good practice not to be drawn to the most obvious clinical feature, taking time to systematically examine the lower leg and the whole foot making note of any features that may be observed.

2 Ulceration due to just ischaemia is nearly always located on the dorsum of the foot and is rare.

obvious clinical feature, taking time to systematically examine the lower leg and the whole foot making note of any features that may be observed. Only when all of the presenting features are put together should an opinion be reached regarding the status of the patient's arterial blood supply. The most commonly occurring clinical features of reduced arterial supply are discussed below (see also *Table 2*).

Nail dystrophies

The toenails are generally of poor quality and are either very thin or yellowed and thick. They may be hard to cut or quite brittle and characteristically they are very slow growing. It is not uncommon for ulcers to occur under the nail plate, especially when the nails are thick.

Skin condition

Characteristically the skin condition is very poor with a general loss of substance. This is clearly demonstrated by gently pressing the skin at the end of a toe; in a healthy state the skin will spring back, but, in patients with ischaemia the skin remains depressed. It can be likened to 'a grape that has been in the fruit bowl too long!' The skin may be very dry with hair loss and, not uncommonly, multiple small skin fissures or increased skin creases are observed, particularly in the arch and around the heels.

Callused/hard skin

If one or more calluses are present, they are often very thin and hard, occurring in small isolated areas unlike the diffuse thick calluses seen in patients with neuropathy. Calluses in patients with ischaemia may be described as appearing like 'onion skins'.

Table 2. Features of the at-risk ischaemic foot.

- Nail dystrophies
- 'Beef chipolata' toes
- Gangrene
- Pain
- Depression
- Soft tissue atrophy
- Thin callus
- Reduced pulses
- Colour
- Temperature
- Ankle brachial pressure index

Skin colour

The colour of the skin is determined by the amount and condition of the blood flowing through it; therefore it may vary in colour significantly. Generally the skin is more pallid than normal but can range from intense deep pink to dusky red to mauve/purple.

Skin temperature

The skin temperature is determined by the amount of blood flowing through it and, therefore, may vary. This is particularly true during cold or wet weather. Localised areas of increased skin temperature should alert the examiner to the possibility of disease processes such as infection or gout.

Toes

The toes of patients with significant arterial disease are often slightly swollen and dark pink in colour, resembling 'beef chipolata sausages'. However, if an individual toe has this appearance and ulceration is present, osteomyelitis should be suspected.

Ulceration and gangrene

Ulceration due to pure ischaemia is nearly always located on the dorsum of the foot and is rare. It is characteristically painful and can deteriorate very rapidly, exposing tendons and bone. The surrounding tissue is very devitalised and the wound base has no substance.

The vast majority of ulcers can be described as 'neuro-ischaemic' and, as their name suggests, have both neurological and arterial components. Characteristically they occur on the margins of the feet, especially around the heels, resulting from skin fissures, or at the sides of the first and fifth metatarsal heads. They can also occur over the dorsal toe joints or tips (*Figure 2*).

The ulcers tend to have a 'punched out' appearance with thin 'glassy' surrounding callus. The ulcer bases are very frequently sloughy with interspersed light granulation tissue. Characteristically these lesions are very slow to heal and are prone to frequent low-grade infections.

Gangrene is the result of either insufficient

Figure 2. Examples of neuro-ischaemic ulcers.

PAGE POINTS

1 Gangrene is the result of either insufficient blood flow to sustain any life (leading to mummification of tissue, most commonly seen in the digits) or infection, or a combination of both.

2 It is recommended that in patients with diabetes, an annual inspection of vascular status should be undertaken.

3 Where possible, one must try to ensure that patients are put at ease, examined in a warm room, and an explanation of what is being done and why given.

4 It is a common misunderstanding that a palpable pulse equates with good perfusion.

blood flow to sustain any life (leading to mummification of tissue, most commonly seen in the digits [*Figure 3*]) or infection, or a combination of both. In the presence of infection, gangrene can spread to neighbouring toes or through larger areas of the foot.

Vascular assessment

It is recommended that in patients with diabetes an annual inspection of vascular status should involve:

- identification of symptoms related to ischaemia
- examining the foot for clinical manifestations of ischaemia
- palpation of foot pulses in both feet.

Additional tests that may be required include:

- palpation of popliteal and femoral pulses if foot pulses are reduced or absent
- using hand-held Doppler to locate non-palpated pulses
- ankle systolic pressures/ankle brachial pressure indices (ABPIs)
- Buerger's test – elevation and dependency
- toe pressures
- transcutaneous oximetry.

Figure 3. Gangrenous foot.

Where possible, one must try to ensure that patients are put at ease, examined in a warm room, and an explanation of what is being done and why given.

It must be remembered that small arteries are very vaso-active and will, therefore, constrict easily and so may affect some assessment tests, especially Doppler signals.

Clinical examination: Pulse

A pulse is a reflection of the pressure wave generated by ventricular contraction and relaxation during the cardiac cycle and is a means of clinically determining arterial inflow to the lower extremity. Heart rhythm and output, ambient temperature and degree of arterial stenosis or occlusion are factors that influence the amplitude of a palpated pulse (Baker and Rayman, 1999).

It is a common misunderstanding that a palpable pulse equates to good perfusion (Andros et al, 1988). Markers such as intermittent claudication and rest pain may be dulled or confused with other causes such as painful neuropathy or spinal stenosis.

Feeling for the pulses

Place your first and second fingers lightly on the patient's skin overlying the pulse site you are examining. You should feel a regular light beating under the pulps of your fingers. If you cannot feel a pulse, move your fingers slightly to the adjacent skin until you can locate one. If you still cannot feel a pulse try the next site and then return to this one afterwards and try again. Reasons for difficulty in obtaining a pulse can include:

- oedema
- poor technique
- abnormal position of arteries
- diseased or absent arteries
- low cardiac output.

In most instances it is sufficient to record pulses as being present or absent, but they can also be further clarified as weak or strong and regular or irregular.

Palpation of dorsalis pedis

The dorsalis pedis pulse is located on the dorsum of the foot running along the lateral side of the first metatarsal shaft at approximately the mid-point (*Figure 1; right bottom*). This artery is congenitally absent in approximately 10% of the population and

PAGE POINTS

1 The use of a hand-held Doppler to examine lower limb pulses and particularly to obtain systolic ankle pressures is becoming more commonplace.

2 Using a hand-held Doppler and a sphygmomanometer an ankle systolic pressure measurement can be obtained.

may also deviate slightly more laterally than stated above.

Palpation of posterior tibial pulses

The posterior tibial pulse is considered to be more anatomically constant and is usually located just behind the medial malleolus at the level of the ankle joint (*Figure 1; right top*).

When the foot pulses cannot be palpated, a hand-held Doppler can be used to detect the arteries. Additionally, it is important that if the pedal pulses cannot be palpated, an examination of the popliteal and the femoral arteries should be performed to delineate the level of stenosing disease.

Popliteal pulse palpation

The popliteal artery is located behind the knee in the popliteal fossa and is located just lateral to the midline of the knee. This pulse is not an easy one to palpate and requires considerable practice. The patient should be either seated with legs extended or lying down, with the knee bent to approximateley 60° and the foot flat on the couch. Hands should be placed either side of the knee so that the fingers meet in the middle at the back of the popliteal fossa with the thumbs gently pressing either side of the kneecap at the front of the knee. In this position the examiner's fingers should be able to feel a pulse, although the fingers may have to be moved slightly sideways. If the popliteal is very easy to palpate and seems wider than a normal pulse it is possible that you are palpating a popliteal aneurysm.

Femoral pulse palpation

As the femoral artery is felt in the groin it is essential that a chaperone is present when palpating it. The artery is located midway along the groin crease and is usually quite easy to feel. The patient should be lying as flat as possible with the legs extended when feeling for this artery. You will also have to press reasonably firmly if the patient is not thin.

Doppler examinations

The use of a hand-held doppler to examine lower limb pulses and particularly to obtain systolic ankle pressures is becoming more commonplace. Doppler signals can be very useful for locating non-palpable arteries, patient education and quantifying disease progression, especially when waveform analysis is performed. Additionally, they can prove a useful surveillance tool following vascular surgery or angioplasty. Many resources have been produced on the use and interpretation of hand-held Dopplers such as 'Dopplers and the diabetic foot' (Vowden et al, 1999) and 'Examination of the diabetic foot' (video; Huntleigh Diagnostics, Cardiff).

However, in brief, a normal Doppler arterial signal should be multi-phasic with three distinct audible components (triphasic signal) relating to forward flow in peak systole followed by reverse flow in diastole and lastly forward diastolic flow. A two-component signal (biphasic), generally loss of reverse flow, is also considered to be a 'normal' arterial signal, but a degree of arterial obstruction may be present. A single component signal (monophasic), forward flow only, signifies a moderate to severe degree of ischaemia. As a general rule if the signal is of low pitch and muffled, significant arterial disease is likely to be present.

Ankle pressures

Using a hand-held Doppler (*Figure 4*) and a sphygmomanometer an ankle systolic pressure measurement can be obtained. This is achieved by placing a standard arm sphygmomanometer cuff around the ankle, which is inflated after a pedal pulse is identified with a Doppler probe. The cuff is inflated to occlude the arterial signal and then slowly deflated. The point at which the arterial signal can be heard again is the systolic pressure. This is then repeated at the other pedal pulse sites. The brachial systolic pressure is then obtained and divided into each of the pedal pulse values. The figure obtained for each site is the ABPI (*Table 3*).

Pressure in the toes can also be measured and is considered to be more reliable as they are less affected by arterial calcification. However, this is not easy to perform in a normal clinical setting.

It is, however, important to stress that, although ankle pressures are very useful, they should be used in conjunction with a good clinical examination, especially for referral criteria and as a means of determining likely outcomes of healing (Apelqvist et al, 1989).

PAGE POINT

1 The principle of Beurger's test is that there should be sufficient pressure within the arterial tree to maintain adequate blood flow through the limb when elevated to an angle of 30° from the horizontal or 30 cm above the level of the heart.

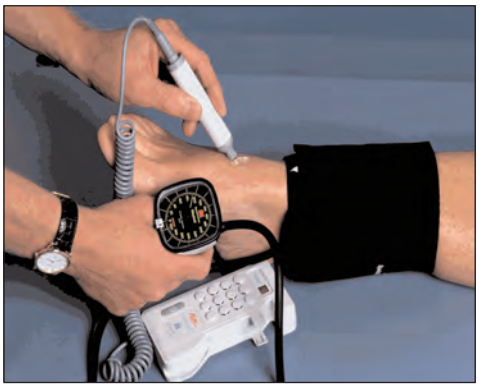

Figure 4. A hand-held Doppler being used to check for a pulse.

Beurger's test: Elevation and dependency

Beurgers test is a very useful clinical method to determine whether there is significant arterial disease, especially if arterial calcification is strongly suspected when calculating an ABPI. The principle of this test is that there should be sufficient pressure within the arterial tree to maintain adequate blood flow through the limb when elevated to an angle of 30° from the horizontal or 30 cm above the level of the heart. A positive result, signifying arterial disease, is observed when the elevated limb becomes pale and a dusky 'sunset' red when placed in a dependent position. The elevation test can be supplemented by listening to the Doppler signal while elevating the limb. If the signal fades or disappears, some arterial obstruction is present and the lower the raised limb is when this occurs the more significant the disease; this is called the 'pole' test (Smith et al, 1994).

Buerger's test method is as follows.

- The patient is laid as flat as possible.
- The leg is supported and lifted by the examiner either to a height of 30 cm above the heart or to an angle of 30° from the horizontal (slightly higher if the patient is not laying flat) and held for 2–3 minutes.
- The colour of the leg is observed. If the limb or foot becomes pale there is a reduced arterial pressure and thus restricted flow.
- The limb is then lowered over the side of the couch into a dependent position and observed for colour changes. If a deep red colour is observed in the toes which then spreads proximally, significant arterial disease is likely to be present.
- The time taken for these changes to occur signifies the severity of the disease.

Pathways of care

For suggested pathways of care following lower limb assessment see *Table 4*.

Once PAD has been diagnosed, patients need to be given clear and relevant advice. Below is some patient's advice that may be useful.

- Never warm feet too quickly.
- Avoid extreme cold; keep legs and ankles warm in the winter by wearing thermal hosiery or long johns.
- Apply emollients at least once daily, massaging well into the skin (not between the toes).
- Avoid slip-on shoes and slippers no matter how soft the uppers may be.
- File any rough edges on toenails and cut them carefully to follow the shape of the end of the toe, if they are not being cut professionally.
- If any cracks to live tissue, oozing around/under nails or between toes are observed seek advice.
- Try to take exercise daily as long as pressure relief is accounted for.

Conclusion

This simple approach to screening for PAD in people with diabetes relies upon good history taking, careful foot observation and

Table 3. ABPI values and their meanings.

Obtained value	Interpretation
>1.3	Suggestive of arterial calcification, so this test is unreliable
0.8–1.3	Suggests 'normal' arterial flow
0.5–0.79	Suggests significant arterial disease
<0.5	Suggests critical limb ischaemia

Table 4. Suggested pathways of care following lower limb assessment.

Observation	Suggested pathway of care
No evidence of vascular impairment	Annual review arterial status
Intermittent claudication (no ulceration or gangrene)	Encourage exercise, monitor coronary heart disease risk factors (for example blood pressure, lipids, diet, exercise, smoking)
Evidence of PAD and ulceration and/or gangrene	Refer to specialist foot clinic or vascular surgery, check pain management, liaise with patient's general practitioner
Non-healing ulceration in a site of neuro-ischaemia	Refer to specialist foot clinic
Rest pain with or without ulceration	Refer for further investigation

clinical examination. It is intended that this article will act as a basis to develop further understanding, skills and expertise to identify PAD as early as possible and help prevent some of its devastating potential consequences in diabetic foot disease. ■

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Appendix 1. Definitions of some common terms.

- Atherosclerosis: A condition in which fatty material is deposited along the walls of arteries. This fatty material thickens, hardens, and may eventually block the arteries. It usually affects large and medium-sized arteries.
- Ischaemia: When the arterial blood flow is so reduced that there is insufficient blood to maintain healthy skin vitality.
- Chronic critical limb ischaemia: Persistently recurring ischaemic rest pain requiring analgesia for more than 2 weeks, with an ankle systolic pressure of ≤50 mmHg and/or a toe pressure of ≤30 mmHg and/or ulceration or gangrene of the foot or toes with an ankle systolic pressure of ≤50 mmHg and/or a toe pressure of ≤30 mmHg (European Working Group on Critical Leg Ischaemia, 1992).

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