Ankle–brachial pressure index: A mixed blessing

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Article points

1. The ankle–brachial pressure index (ABPI) is traditionally used to express lower-limb arterial insufficiency.
2. In people with diabetes the ABPI can underestimate the true burden of peripheral arterial disease.
3. The authors discuss their own recent research on the ABPI in people with diabetes and report their findings.

Keywords

- Ankle–brachial pressure index
- Diagnostic test
- Peripheral arterial disease
- Screening

The burden of peripheral arterial disease (PAD) among people with diabetes is high, and its detection during screening is an important indicator for intervention. Yet the traditional measure of arterial insufficiency – the ankle–brachial pressure index (ABPI) – is not a straightforward diagnostic test in people with diabetes. Here, the authors discuss the challenges in the palpation of pedal pulses, the calculation of the ABPI, and how the ABPI still has a place in the screening for PAD in people with diabetes.

Unless pulsatile arterial flow towards a diabetic foot ulcer is available, it will not heal, regardless of proper debridement, local wound treatment, offloading and antibiotic therapy. Therefore, it is essential to determine whether peripheral arterial disease (PAD) is present in the person with diabetic foot ulceration, especially given that atherosclerotic disease is so prevalent among people with diabetes (Faglia et al, 2005).

The ankle–brachial pressure index

One way to refute the presence of PAD is to detect forceful foot pulses. However, the absence of these pulses is more difficult to interpret – the examiner may have been unable to detect the pulses because of low blood pressure, obesity or oedema. Furthermore, a physical examination alone does not provide a full assessment of the severity of PAD.

Traditionally, clinicians have used the ankle–brachial pressure index (ABPI) when appraising atherosclerotic disease in the lower extremity (*Figure 1*). This is a simple, non-invasive test that compares the systolic blood pressure at the level of the ankle against the brachial pressure. If arterial blood flows unobstructed from the iliac arteries towards the foot, the pressure measured over the ankle will be comparable to the brachial pressure, and yield an ABPI of 1. Contrary, if the arterial tree is affected by atherosclerotic disease, the pressure will drop progressively for each flow-limiting lesion that is crossed. The beauty of the ABPI lies in its ability to quantify the aggregate effect of haemodynamically significant lesions in the lower extremity from the aorta to the foot: occlusions cause a larger pressure drop than stenoses, and multiple sequentially located lesions each contribute individually to the decrease in pressure (Caruana et al, 2005).

Limitations of the ABPI

Unfortunately, ABPI is a notoriously unreliable measure of PAD in people with diabetes (Smith et al, 2008). This is usually

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1. Both extremes of the ankle–brachial pressure index (ABPI) should be seen as a sign of advanced atherosclerotic disease and are associated with increased cardiovascular risk.
2. ABPI significantly underestimated the level of atherosclerotic disease seen on angiography.
3. The validity of the ABPI is based on the premise that the pressure measured distally is representative for atherosclerotic disease more proximally; however, when atherosclerotic disease is predominantly or exclusively located in below-the-knee arteries – as is the case in people with diabetes – this assumption falls apart.

attributed to media calcinosis of the arterial wall frequently present in this population. Calcifications increase the rigidity of arteries and make them resist external compression when the sphygmomanometer is insufflated for systolic pressure measurement. This means that a Doppler signal will remain detectable at the level of the ankle, not because systolic pressure is adequate, but because arteries are unable to compress. Arteries may be barely compressible and yield an extremely high ABPI, or become incompressible and prevent proper pressure measurement.

While a low ABPI (<0.7) is representative of PAD, a very high ABPI (>1.3) may indicate that arteries are heavily calcified. In practice, both extremes of ABPI should be seen as a sign of advanced atherosclerotic disease and are associated with increased cardiovascular risk (Mostaza et al, 2008).

New evidence on ABPI in people with diabetes

Aside from media calcinosis, arterial disease in people with diabetes differs in another important way: atherosclerotic lesions predominantly reside in below-the-knee arteries, while above-the-knee arteries are relatively free of disease (Graziani et al, 2007). The effect of this specific distribution of atherosclerotic disease on the reliability of the ABPI in people with diabetes had not been investigated until the authors' recently published study (Aerden et al, 2011).

In this study, we found that: (i) the ABPI could not be obtained in a large number of participants; (ii) the ABPI was falsely elevated and did not correlate well with angiographic atherosclerotic disease, and; (iii) both media calcinosis and the distal distribution of atherosclerotic lesions are the causes of these distortions of the ABPI.

ABPI was found to be undeterminable in one-third of participants, due to the lack of at least one reliable distal pressure measurement. When the ABPI could be calculated, it significantly underestimated the level of atherosclerotic disease seen on angiography: a mean ABPI of 0.92 was found in a population that had already suffered tissue loss due to PAD.

In those participants with arterial calcifications that were clearly visible on plain X-ray, a weaker correlation between the ABPI and angiographic atherosclerotic disease was found than in those without calcification. In addition, participants with calcified arteries also had significantly more advanced atherosclerotic disease and showed larger distal pressure differences than those without calcification.

Importantly, the ABPI has severe conceptual limitations in people with diabetes. The validity of the ABPI is based on the premise that the pressure measured distally is representative for atherosclerotic disease more proximally. This premise is reasonable when atherosclerotic disease is dispersed over the iliac, femoral and popliteal arteries, which are arranged in a series. However, when atherosclerotic disease is predominantly or exclusively located in below-the-knee arteries (which lie parallel to each other) – as is the case in people with diabetes – this assumption falls apart.

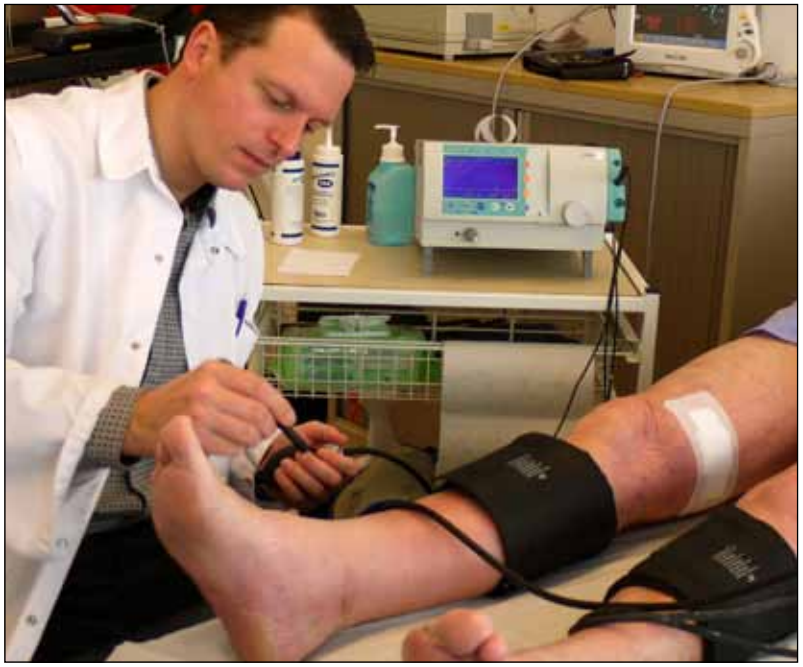

Figure 1. Mr Dimitri Aerden, the first author, conducting a vascular assessment to determine an ankle–brachial pressure index.

In such cases, large pressure differences between the dorsal pedal and posterior tibial artery are to be expected, which means that the ABPI will depend on which distal arterial pressure it is derived from.

This flaw in the ABPI is illustrated by the common use of the highest available distal pressure in its numerator and, as such, is derived from the most patent below-the-knee artery. When the lowest available distal pressure was used to calculate the ABPI, the correlation with angiographic atherosclerotic disease was greatly improved. But even then problems remain: no pressure measurements can be obtained for the peroneal artery, or for occluded or incompressible arteries, meaning that the patency of these arteries is underrepresented by the ABPI.

Experimentation with differently calculated ABPIs was undertaken to prove that the traditional ABPI is ill-designed to assess PAD in people with diabetes. We found that using the average of both distal pressures (adopting a pressure of 0 mmHg when no Doppler signal could be found) as the numerator correlated best with angiographic atherosclerotic disease. Although alternatively calculated ABPIs showed a higher correlation with angiographic atherosclerotic disease – and hence were more reliable – this differing calculation method did not improved the ABPI to a point that it could be considered a trustworthy test in this population.

The ABPI in practice

Despite its shortcomings, the ABPI is a valuable tool in assessing PAD, albeit one which demands cautious interpretation. Low (<0.7) and abnormally high (>1.3) results confidently suggest that advanced atherosclerosis is present. Uncompressible

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Page points

1. The inadequacies of the ankle–brachial pressure index (ABPI) pale in comparison to the disadvantages of other tests of peripheral vascular insufficiency, for example transcutaneous oxygen pressure measurement, or the toe–brachial pressure index.
2. The limitations of the ABPI can be greatly mitigated by assessment for clinical signs of ischemia, and the taking of a thorough medical history.
3. From a practical point of view, the ABPI still has a place in the screening for peripheral arterial disease in people with diabetes.

arteries or occluded arteries that do not propagate a Doppler signal may prohibit proper pressure measurement but, nevertheless, imply significant arterial disease. Finally, a Doppler signal readout is frequently obtained during distal pressure measurement and analysis of these signals can provide additional valuable information: only tri- or biphasic signals infer the presence of good, antegrade pulsatile flow, while monophasic signals represent attenuated pressure curves that are caused by proximal, haemodynamically significant lesions.

The inadequacies of the ABPI in determining PAD in people with diabetes pale in comparison to the disadvantages of other tests. Transcutaneous oxygen pressure measurement, or the toe–brachial pressure index, for example, produce unpredictable results in the presence of inflammation, oedema, prior amputation, scar tissue or large wounds (Williams et al, 2005). These limitations render these tests impractical – especially in the course of normal clinical practice – and are the likely reasons why these techniques are limited to difficult diagnostic problems, and academic and research setting.

Conclusion

From a practical point of view, the ABPI still has a place in the screening for PAD in people with diabetes. The limitations of the ABPI can be greatly mitigated by assessment for clinical signs of ischaemia (e.g. Buerger test, capillary refill or wound-specific factors like dry necrosis), and the taking of a thorough medical history (e.g. existing coronary risk factors, prior carotid- or coronary disease). Taken together, positive results for these investigations can provide sufficient reason to justify an arteriography or an antiplatelet prescription. ■

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