

WHAT IS AN ANKLE BRACHIAL PRESSURE INDEX?

This short article aims to discuss the Ankle Brachial Pressure Index (ABPI) in clinical practice and attempt to partially delineate some areas of confusion. It will discuss ABPI measurement and interpretation in relation to arterial perfusion, venous insufficiency and subsequent decision making.

“Failure to recognise arterial disease or incorrect interpretation of the ABPI result can result in the unsafe application of high compression therapy and can lead to serious injury.”

The Ankle Brachial Pressure Index (ABPI) was originally described by Nauman in 1930; but it was Winsor who was first to use the test on patients with peripheral arterial disease (PAD), circa 1950. It was another 20 years, however, before Yao noticed that the reduction in ABPI was linked with the severity of peripheral arterial disease (Caruana et al 2005; Khan et al 2008; Aboyans et al 2012).

Under normal conditions, systolic blood pressure in the legs is equal to, or slightly greater than, the systolic pressure in the arms (i.e. = 1). This is logical since the circulatory system is a closed system, so the pressure should be the same throughout. Pressure tends to be higher at the ankle as a result of where the muscular peripheral arteries are located and due to the summation of reflected pressure waves (Caruana et al, 2005). When an arterial stenosis (narrowing of the arterial lumen) is present, a reduction in pressure occurs distally to the lesion, which can then be detected by ABPI (Donnelly et al, 2000). In practice, this means that the ABPI will be below 0.9 and the patient will be said to have a diagnosis of PAD. The values for ABPI results can be seen in *Table 1*.

The ABPI is the ratio of the systolic blood pressure measured at the ankle to that measured at the brachial artery. The index should be calculated in each leg by using the systolic pressures for the anterior tibial and posterior tibial arteries and dividing the highest ankle pressure by the highest brachial pressure as this gives the most accurate result (Scottish Intercollegiate Guidelines, 2006; Armstrong et al, 2010; Aboyans et al, 2012; NICE, 2012).

A result is achieved for each leg using the following equation:

Ankle	The highest systolic reading in the ankle (mmHg)
Brachial	The highest systolic reading in the arm (mmHg)

The right and left side may have a different ratio, which is not unusual.

A handheld Doppler ranging from 5-8 MHz should be used to insonate (make audible) the pressure at which the systolic pulse returns (NICE, 2012). When we use a doppler and listen to a pulse in a healthy person, we would expect to hear a normal ‘triphasic’ signal. The triphasic signal corresponds to the three different phases of arterial flow and reflects three distinct sounds heard during a single cardiac cycle (Donnelly et al, 2000). The typical

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Table 1. Values for ABPI results.

Resting ABPI	Severity of peripheral arterial disease
>1.3	Calcification/Mönckeberg's sclerosis may be present
>0.9	No peripheral arterial disease
0.81-0.9	Mild peripheral arterial disease
0.5-0.80	Moderate peripheral arterial disease
<0.5	Severe peripheral arterial disease
<0.4	Critical limb ischaemia

pattern of arterial flow during a single heart beat is where the blood rushes forward, reverses briefly, then propels forward again (echoing the elastic walls of the main artery leaving the heart (aorta) as it stretches and contracts).

If all three sounds are present it is called a triphasic waveform; if just the first two are present the waveform is referred to as biphasic; if only the first is observed, it is described as monophasic. Being able to understand what these three sounds represent is vital, as it has been shown that an increasing stenosis (narrowing of the artery) results in progressive dampening of the waveform, and development of a monophasic sound (Vowden et al, 2004).

ABPI and venous disease

For many years, compression therapy has been the cornerstone of treatment for venous disease and leg ulceration (Vicaretti, 2010). Indeed, 70% of leg ulceration is known to be caused by venous insufficiency, where sustained hypertension in the superficial or deep veins of the leg occurs due to faulty one-way valves in the veins allowing the blood to abnormally reflux back, subsequently causing oedema and an increase in pressure in the venous system (Agale, 2013). Thus, the application of external

pressure in the form of compression bandaging or compression hosiery to the affected leg can help in part to counteract these changes and aid in venous return, oedema control and reduce venous hypertension (SIGN, 2010).

It is always important to assess the arterial supply of the limb before applying compression on a patient with venous disease. Venous disease is common, and becomes more common with advancing age. It is not surprising therefore that arterial disease can co-exist in approximately 10-20% of patients with leg ulceration (Vowden, 2001). This is why it is recommended to reassess patients receiving any form of compression at regular three monthly intervals (RCN, 2006) and the measurement of the ankle brachial pressure index by a hand held Doppler is the most reliable way to detect if there is any evidence of arterial insufficiency developing. The ABPI result itself however is not a diagnostic indicator of venous disease or ulceration, but rather it is used by the clinician to help guide their decision making and determine a safe level of treatment.

Failure to recognise arterial disease or incorrect interpretation of the ABPI result can result in the unsafe

application of high compression therapy and can lead to serious injury such as pressure damage, exposed tendons and tissue damage/necrosis (Chamanga 2014). The arterial perfusion of the patient with advanced venous disease and/or leg ulceration should therefore always be evaluated using the hand-held Doppler and calculation of the Ankle Brachial Pressure Index prior to considering compression therapy.

Evidence suggests that compression may be safely applied with an ABPI reading of 0.8 or higher (RCN, 2006) However, this should be viewed as an arbitrary cut off point to help guide the clinician. Evidence in practice would suggest that an ABPI of 0.8 does not always indicate that high compression bandaging can be undertaken safely and other factors may need to be considered before applying compression. Indeed, in addition to the ABPI result a comprehensive medical/surgical history and physical assessment should also be taken into account when considering treatment options for the patient with venous disease or leg ulceration.

If the ABPI is less than 0.8, high level compression (i.e. 30-40 mmHg at the ankle) is not recommended and reduced compression levels (i.e. 23-30 mmHg) are advised instead. If the ABPI is less than 0.4 compression should be avoided and the patient referred to a vascular surgeon for surgical evaluation and/or further testing (SIGN, 2010). If an ABPI of ≥ 1.3 is obtained the patient should be referred to a leg ulcer clinical specialist for further review.

Treatment for venous disease needs to be aimed at ameliorating the symptoms, reducing pain and promoting ulcer healing. It is prudent, however, to remember that even though the leg ulcer has healed externally, the underlying abnormality of venous incompetence will still exist and the risk of ulcer recurrence remains high. NICE varicose vein

guidelines (2013) suggest that all patients with active or healed leg ulceration, or signs of skin changes associated with venous insufficiency, should be referred to the vascular surgeon for more in depth vascular investigations and consideration of the patient's suitability for surgical intervention.

Q&A: Common areas of confusion:

What is hardening of the arteries?

In some older patients we find that we are unable to compress the artery and achieve a value for the returning systolic pressure, or the pressure we do obtain is elevated. This happens in patients with diabetes and renal disease more so than the general population (Rocha-Singh et al, 2014) This is often referred to as hardening of the arteries, Mönckeberg's sclerosis or medial artery calcification (MAC). It is important to remember that hardening of the arteries is linked with cardiovascular events and an increase in mortality (Resnick et al, 2004; Joachim et al, 2012). It is essential, therefore, to ensure that the patient's cardiovascular risk factors are controlled.

If the patient's feet/legs are warm, well perfused with biphasic signals and they are asymptomatic, then monitoring may be sufficient. If, however, the patient is symptomatic or has tissue loss, then the patient should be referred onwards for an opinion by a vascular surgeon and further imaging e.g. Duplex or MR Angiography.

What are the extrinsic and intrinsic factors that affect ABPI?

Ambient temperature, age, ethnicity, height, pulse volume, smoking, drugs/medication, and white coat syndrome (an artificial elevation of the blood pressure due to anxiety

of having ones blood pressure taken by a professional). As long as these factors are taken into consideration and reasonable adjustments are made, they have negligible effects on the overall clinical diagnostic ability of the ABPI.

What size cuff do I use?

A cuff appropriate for the limb is recommended. As a rough guide to width it should be at least 40% of the limb circumference (Aboyans, 2012). Having a standard and a large adult limb cuff available is recommended.

Does cuff position matter?

The cuffs should be placed just above the ankles or just above the elbows, making sure the arteries you wish to sound are accessible. A top tip is to turn the cuff upside down so that the tube is away from where you plan to put the Doppler probe, it will not make a difference to the pressure you obtain, but will help you obtain it.

How long do I have to rest the patient for?

Given that a complete history can take between 10-15 minutes to obtain, we think this is a reasonable enough time, for normalisation of the systolic pressure to occur without impacting on clinical efficiency. In some patients, laying them flat is not an option, either due to an underlying medical condition or just due to discomfort. In these patients, having them semi-reclined is acceptable, just be aware the pressure may be slightly higher, though in the author's experience not enough to significantly alter the result.

Can anyone do an ABPI?

The ABPI is a really simple examination, but its apparent simplicity may beguile the unwary (Caruana et al, 2005). ABPI measurements have been found to have good interobserver reliability

between experienced physicians (Al-Qaisi et al, 2009). ABPI Measurement is however a skill and there are statistically significant discrepancies between experienced and in-experienced physicians (Caruana et al, 2005; Kaiser, 1999). You should have your competencies assessed and regularly review the skill using reflective practice and peer reviews.

What are patient's cardiovascular risk factors?

Cardiovascular risk factors (CVs) can be split into modifiable and non-modifiable. We are interested in the modifiable CVs which are:

- ▶▶ Smoking
- ▶▶ Sedentary lifestyle
- ▶▶ Obesity
- ▶▶ Hyperlipidaemia
- ▶▶ Hypertension
- ▶▶ Hyperglycaemia.

Can exercise cure PAD?

Exercise cannot cure PAD, but it can help to alleviate symptoms and reduce mortality rates. Cardiovascular death-free rates with exercise are 79.9% vs 58.4% without, at 10 years (Sakamoto et al, 2009).

Does everyone with PAD need to see a surgeon?

No definitely not. Approximately 25% of people with PAD will require a surgical opinion (Fox et al, 2012). All patients diagnosed with PAD, however, should be offered an antiplatelet (e.g. clopidogrel 75mg once daily) and a statin (e.g. Atorvastatin 80mg once daily) (NICE, 2010). If a patient has symptomatic peripheral arterial disease then cardiovascular risk factor management and a referral to an exercise programme should be the first line treatment. These patients, however, need to be reviewed in a reasonable time frame (6-12 months) and if they are symptomatic and failing to improve, then onward referral may be indicated.

Does a monophasic waveform always mean PAD?

In general, yes (Vowden et al, 2004). That said, there are instances where it may appear that the waveform is monophasic when in fact it is an anomaly. If there is a lot of oedema, the signal may sound monophasic but changing the probe from an 8Mhz to a 5Mhz may help to give a clearer signal. Sometimes applying the probe with too much pressure can occlude the artery and give a weak or monophasic signal. Not directing the Doppler against the flow of blood can cause an obscured signal; aim the Doppler at a 45° to 60° angle.

How do I know if it's critical limb ischaemia (CLI)?

Critical limb ischaemia is the point at which the arterial supply is so poor that tissue loss is occurring or imminent. A clinical diagnosis can be made for critical limb ischaemia if we use the following assessment tool:

- ▶▶ Foot pulses non palpable (or)
 - ▶▶ Handheld Doppler signals monophasic / absent.
- Plus any of the following factors:
- ▶▶ Ischaemic rest pain in toes or foot (use the visual analogue score for pain (0-10))
 - ▶▶ New gangrene or necrosis of foot or leg
 - ▶▶ Ankle systolic pressure < 50mmHg (or <70mmHg with an existing foot or leg ulcer).

What do I do if I think it's CLI?

Get help. Speak with the vascular consultant, registrar, nurse or GP in your area, use the clinical tool explained in the article and ask for their advice. If you cannot get that advice, CLI is a problem requiring urgent medical care and the patient may need to be sent to Accident and Emergency (at a hospital that has a vascular department). Urgent foot referral to specialist care is crucial for patients with

critical limb ischaemia to avoid unnecessary foot amputations (STAMP, 2014). The urgency will depend on the clinical picture. Generally, if infection is present or there is advancing necrosis, this is likely to warrant immediate admission. Another reason might be if the patient is on opioids or unable to take opioids and their ischaemic rest pain is severe and uncontrolled. If the patient's CLI is stable, their pain controlled (this should be done in the community as a priority), there is no advancing necrosis or new tissue loss, then a referral to vascular can be made (within 24 hours), requesting an urgent outpatient appointment.

What are the contraindications of performing an ABPI?

The evidence around contraindications for doing an ABPI is anecdotal. It can be said that, if a patient has had a recent deep vein thrombosis (within the last two weeks) then it is contraindicated. However, if the patient is anticoagulated and it is post two weeks, expert opinion may suggest this is acceptable. Sick cell anaemia may require a cautious approach and specialist advice from the local vascular department could be sought. Infection is the most common contraindication as this should be treated prior to ABPI and application of compression. If CLI is suspected, it may of course be necessary to conduct an ABPI despite infection being present, as this will help to direct clinical decision making.

Summary

Overall, the ABPI is a useful non-invasive tool that can be used at a patient's bedside or in the home setting. It can help to confirm or exclude the presence of arterial disease and indicate the disease severity, which, in turn, can be linked to risk to limb (amputation)

and life (CV events/mortality). Before performing an ABPI, several important questions should be considered, such as what is the reason for performing it? Is the person trained in interpreting the results? Have all contraindications for performing an ABPI been excluded? In the case of a patient with advanced venous disease, the ABPI is an essential procedure as the results of the ankle/brachial systolic measurements will be relied upon to help guide the clinician in deciding the most appropriate type of treatment and what level of compression can be safely used. **WE**

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