CSVS

THE COLLEGE AND SOCIETY
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Protocol Guidelines

Ankle Brachial Pressure Index Assessment (ABPI): Resting and Post Exercise

Version 2.0

July 2025

Doc Ref PS-PG001

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Introduction

This document was prepared by the Professional Standards Committee (PSC) of the College and Society for Clinical Vascular Science (CSVS) to support the practise and delivery of high quality standardised Clinical Vascular Science. This document may be used in its entirety (or referenced in part with suitable additions made by local policy implementers) by all parties involved with clinical vascular science. Suggestions for improving this document are welcome and should be sent to the Chair of the PSC (see csvs.org.uk for current PSC Chair details).

This document may be used in conjunction with Vascular Ultrasound Service Specifications [1].

Purpose

Ankle Brachial Pressure Index (ABPI) is a reproducible and quantitative assessment of arterial disease above the ankle. The systolic blood pressure is measured in the arm and at the ankle, this enables a comparison of these pressures to be used to rapidly assess the blood pressure reaching the lower limb and thereby indicate severity of disease.

ABPI measurements pre and post controlled exercise may be used to exclude or quantify the effects of disease in relation to claudication symptoms.

ABPI may also be used to determine if compression bandaging is suitable for patients with leg swelling or ulceration. NICE (March 2024) recommends that if the ABPI range is 0.5 to <0.8 compression generally should be avoided but reduced compression can be used under specialist advice and with strict supervision, If the ABPI is <0.5 compression is contraindicated[2]. The Royal Society of Medicine, in conjunction with the Vascular Society and the College and Society for Clinical Vascular Science has recommended that a figure of 0.9 may be more appropriate [3].

Current NICE Guidelines do not recommend the routine use of automated ABPI machines 22

Common indications

Common indications for performing this examination include:

- Intermittent claudication
- Ischemic rest pain
- Gangrene
- Ulceration
- Non-palpable pulses
- Pre-surgical baseline assessment and post-surgical intervention follow up

Contraindications and Limitations of ABPI:

- Recent surgery, ulcers, casts or bandages that cannot or should not be compressed by pressure cuffs
- Patients who have had a therapeutic intervention (stent or graft) which extends into the lower calf
- Patients with suspected or known acute deep vein thrombosis (DVT) or superficial thrombophlebitis, protocols should reflect local thrombosis management guidance, although a suggested period is within 2 weeks [4]

- ABPIs may be inaccurate or less reliable in patients with diabetes or patients with known calcification of their arteries
- Severe oedema/swelling of the lower limb
- Limited mobility e.g. unable to transfer to a bed, unable to lie flat
- Patients unable to cooperate due to impaired cognition (e.g. dementia) or from involuntary movements

Pre and Post Exercise ABPI:

The following should be considered and may be a contraindication – the list is not exhaustive and should only be used a starting point [19-20].

- Chest pain of recent onset
- Evidence of shortness of breath
- Unsteadiness when walking
- Uncontrolled angina
- Hypertension
- Acute myocardial infarction
- Uncontrolled cardiac arrhythmias causing symptoms or haemodynamic compromise
- Symptomatic severe aortic stenosis
- Uncontrolled symptomatic heart failure
- Acute pulmonary embolus or pulmonary infarction
- Acute myocarditis or pericarditis
- Acute aortic dissection

Patient pathway

ABPI and Exercise Test are important tests in the pathway of patients with suspected lower limb arterial disease and for monitoring disease progression. They can be used as part of surveillance programs to follow up patients who have had intervention such as a lower limb arterial bypass graft, angioplasty or stent.

The measurement of ABPIs is an important test in the pathway of patients with legs ulcers. ABPIs are routinely measured before compression bandaging is prescribed. Compression applied to legs with arterial insufficiency could result in pressure damage, limb ischaemia and even amputation.

Guidance is given to the diagnostic role of ABPI in the patient pathway, in the National Institute for Clinical Excellence (NICE) publication 'Peripheral arterial disease: diagnosis and management [6].

Patient referral

Referrals for ABPI allow investigation or follow-up of patients with the above clinical indications and can be used to check technical adequacy following intervention. The referral should include details of the presenting symptoms.

Patient preparation

No specific preparation is required for measuring ABPI and Exercise Testing although access will be required to the patient's ankle, feet and arms. The patient should be supine and ideally rested for 10 minutes5 before taking any measurements to optimise the stabilisation of the systemic blood pressure. It is acknowledged that time constraints may not always allow for a 10 minute rest time in a busy clinical setting, and a minimum of 5 minutes is acceptable noting that increasing the resting time from 5 to 10 minutes can demonstrate a reduction in absolute pressure at the ankle by up to 5mmHg [5].

This test may be difficult in patients with leg ulcers or open wounds. Sterile dressings or cling film will allow blood pressure cuffs to be placed over these sites and for measurements to be made.

Explanation of Examination & Patient History

The examination should be fully explained to the patient and consent obtained. A full understanding of what is required will aid patient cooperation particularly as the results of the exercise tests are dependent on the patient exercising sufficiently to elicit symptoms. A relevant medical history of ABPIs and/or exercise tests includes:

- Presence of risk factors e.g. diabetes, hypertensions, hypercholesterolemia etc
- Claudication/rest pain symptoms
- Previous arterial angioplasty, stent and/or surgery
- Presence of a fistula
- Suitability for an exercise test if this has been requested (history of angina, heart attack or breathing difficulties), although the referring clinician should have assessed the patient's suitability for this investigation
- Previous DVT
- Results of other relevant diagnostics
- Visual identification of any areas of ulceration, will aid decisions regarding cuff location and whether a thin protective layer (e.g. cling film) may be needed between the blood pressure cuff and areas of ulceration.

Examination – Resting ABPI [7, 8]

The examination room should be quiet and at a comfortable temperature.

The equipment and limbs should be at heart level to reduce hydrostatic pressure inaccuracies.

The use of headphones will aid the assessment and increase accuracy, particularly for patients with significant disease and low ankle pressures.

The cuff size should be appropriate for the limb with a width at least 40% of the limb circumference 9 and at least 20% wider than the diameter of the part of the limb being used. Cuffs that are too small will lead to overestimation of systolic pressure [10].

Obtaining brachial systolic blood pressure:

Perform test bilaterally; if the patient has a haemodialysis fistula, only use the contralateral arm (NB: there may be other reasons that brachial pressure may not be measured). Place the cuff around the upper arm ensuring that the bladder of the cuff is over the brachial artery. Place the Doppler probe over the brachial artery distal to the cuff at an angle (ideally between 45º and 60º) to detect the signal. Inflate the cuff until the audible signal disappears and the artery is occluded. Deflate the cuff slowly (recommended rate of 2-3mmHg per second or per pulse if the heart rate is very slow)23 and record the systolic pressure as the audible Doppler signal returns. Slow deflation is required as fast cuff deflation can lead to a significant underestimation of systolic blood pressure and overestimation of diastolic blood pressure[23]. If there is a significant difference between the arm pressures, a combination of repetition and assessment of the upper limb Doppler waveforms is advised to determine whether there is significant arterial disease in the arm with the lower pressure. In this case it is advisable to alert the patient and medical team that blood pressure measurements from this limb may not be representative of systemic blood pressure.

Obtaining ankle pressures:

This may be assessed bilaterally or unilaterally dependent on the referral information. Place the cuff around the calf just above the medial malleolus. Place the hand held Doppler probe at an angle (ideally between 45º and 60º) to locate the posterior tibial artery close to the ankle. Audible assessment should be made of the pulsatility and phasicity of the signal taking into consideration key descriptors and modifiers which may alter the diagnostic conclusion12. Inflate the cuff until the artery is occluded and the audible signal disappears and record the systolic pressure as the audible Doppler signal returns.

Repeat for the anterior tibial artery with the Doppler probe over the anterior tibial artery at the ankle or the dorsalis pedis artery on the dorsum of the foot. This method can also be used for the peroneal artery if this is part of your local protocol.

Calculate the ratio of each ankle pressure to the highest brachial pressure.

The audible Doppler waveforms should be documented.

Potential Sources of Error with ABPI Measurements [8]

The following list of potential sources of error includes suggested methods to minimise and which may need acknowledging in the report:

- Patients not able to lie supine; patient encouragement will often resolve this– if not, the pressures may be artefactually raised or depressed due to the height differences between the limb and heart and consequent effect of hydrostatic pressure – acknowledge the inaccuracy in the report
- Cardiac arrhythmias; wait for the heart rate to stabilise if temporary – acknowledge potential inaccuracies in report

- Insufficient patient rest time; allow the patient sufficient time to rest, consider assessing the Doppler waveforms at both ankles before taking any pressure measurements to extend the rest time
- Patient anxiety; explain the importance of not talking and remaining calm and quiet throughout). Anxiety can be exacerbated by the audible Doppler sounds (use headphones and if these are not available, delay switching the Doppler on until you have gelled the probe and located it on the skin
- Poor Doppler technique which results in 'slipping off' the vessel; ensure a stable hand position by gently resting the side of your hand on the limb/foot
- Excessive Doppler probe pressure; this can occlude diseased vessels – use gentle probe pressure
- Repeated or prolonged cuff inflation; this can alter the measured pressure – don't inflate the cuff until you're sure you have a good Doppler signal
- Inappropriately sized cuff; check it against the limb before starting – you may need a different one for the arms – get everything ready beforehand
- Wrong Doppler probe; use a lower frequency probe for large limbs
- Signal difficult to hear; use headphones
- Incorrectly positioned cuff; ensure bladder over artery and cuff not twisted
- Calcified incompressible arteries; may result in artefactually high ABPI readings (acknowledge in the report).

Exercise test: Perform resting ABPI. The exercise test is designed to bring about the patient's symptoms. This part of the protocol is open to variation and local departmental policies may differ depending on the facilities available and the ability of the patient. Ideally, the type and intensity of exercise for claudicating patients will result in the patient becoming symptomatic. If a treadmill is available, the following can be used: Set treadmill at 10% incline and set the pace according to the needs of each individual patient.

Exercise the patient for 3 to 5 minutes until claudication symptoms prevent them from going any further. On completion of exercise, the ankle pressure measurements should be repeated. This should be carried out as quickly as possible (within 45 seconds) starting with the symptomatic leg or the leg with lowest resting ABPI. The arm pressure (using the arm with the highest pressure before exercise) is then measured. Measurements may be repeated to document the recovery time. If the patient is unable to use the treadmill or a treadmill is not available then a 'corridor walk', step test or rapid calf raises ('tip-toe test') can be used until the desired symptoms are bought on. If the patient exercises for more than 5 minutes without symptoms, then the test should be stopped.

It is important that the protocol within each unit is standardised and clearly documented and that this includes an assessment of risk factors.

Reporting

The report is a recording and interpretation of observations made during the assessment. It should be written by the person undertaking the examination and viewed as an integral part of the whole examination.

The report should be written as soon as possible following the assessment and include correct patient demographics, date of examination, examination type and the name and status of the person reporting the examination. Where a computer generated reporting system is used, the locally agreed verification and authorisation procedure should be followed.

If an exercise test has been performed record the type of exercise used and post exercise indices. When using a treadmill report the walking distance, incline and speed. For all types of exercise test it is important to make a note of symptoms (location and time of onset) experienced during exercise and the reason for premature cessation of exercise eg. calf claudication, chest pain.

It should be noted that an exercise test as a standalone investigation does not exclude popliteal entrapment[24].

The report should include:

- The measured blood pressures including units of measurement
- The calculated ABPI
- Analysis of the Doppler waveforms
- Any limitations of the assessment
- The type and duration of exercise, including details of symptoms experienced
- The post exercise pressures
- An interpretation of the results

Interpretation: The greater the difference between the systolic pressures at the brachial and ankle the lower the index and the more significant the disease. In a patient with peripheral arterial disease the pressure at the ankle will be lower, although care should be taken when interpreting ABPI measurements from diabetic patients as the calf arterial walls may be calcified and incompressible.

$$\text{ABPI} = \frac{\text{Highest ankle systolic pressure (mmHg)}}{\text{Highest brachial systolic pressure (mmHg)}}$$

Table1: Interpretation of resting ABPI readings [7 11 2]

Resting ABPI	Severity of disease (suitability for compression treatment)
>1.4	Incompressible indicating calcified vessels
>1.0	Normal (apply compression)
1.0-0.81	Mild peripheral arterial disease (apply compression)[2]

0.8-0.5	Moderate/severe arterial disease (compression under specialist advice and with strict supervision)[2]
<0.5	Severe disease (compression contraindicated)
<0.3	Critical ischaemia (compression contraindicated)

Due to inter and intra-observer variation, a difference or change in ABPI of 0.15 is considered to be significant 11 13. False high systolic pressure readings may be obtained in diabetics, this occurs when the cuff is unable to compress calcified distal vessels 11. If required, toe pressures may be used for these patients.

Post exercise in the absence of disease the ABPI may reduce slightly due to vasodilation in the exercising muscles, or remain the same as at rest. In peripheral arterial disease the ankle pressure decreases, the more severe the disease the greater the reduction in the ABPI reading 9. A post exercise pressure decrease of 30 mmHg or a post exercise ABPI decrease of 20% is considered significant [9].

Referral of critical ABPI results should be made to the referring consultants or appropriate medical/surgical team (as per local protocol) prior to the patient being discharged so that treatment plans can be developed, enforced or expedited accordingly.

Toe Pressures [14-18]:

Toe Pressures (TP) are a useful alternative technique to ABPI to assess peripheral perfusion in circumstances where ABPI is not possible. Toe Pressures can be used to assess distal circulation and has particular utility in diabetic patients where calcified tibial vessels can falsely elevate ankle pressure readings.

Systolic Toe Pressures are generally 20 to 40mmHg lower than Ankle Pressures (AP) [21]

Toe Pressures are typically used in the following circumstances:

- In non-diabetic or diabetic patients where an ABPI is not possible due to incompressibility of vessels, wound location or where ABPI is too painful.
- In diabetic patients where an ABPI appears falsely elevated

Toe Pressure reference ranges can vary according to machine and method of testing (manual or automated), however absolute pressure of <50mmHg (and an index of <0.7 if used) can indicate abnormal distal circulation.

Table 2:

Comparison guide to values as stated in the Global Vascular Guidelines on the management of Chronic Limb Threatening Ischaemia [21]

ABPI	Resting AP	Resting TP

>0.8	>100mmHg	>60 mmHg
0.6-0.79	70-100mmHg	40-59mmHg
0.4-0.59	50-70mmHg	30-39mmHg
<0.39	<50mmHg	<30mmHg

As with ABPI measurements there is a risk of falsely elevated results which must be considered on a case by case basis in accordance with the clinical picture. Toe Pressure measurements should be taken from the hallux or second toe depending on which a cuff can be adequately fixated, and which toes are present in cases of previous amputation. The available cuff size also needs to be considered, with the toe pressure cuff large enough to ensure even compression of the toe.

Both ABPI and TP values are used in establishing a WiFi score (Wounds, Ischaemia and Foot Infection) which can stage the severity of limb threat.[21]

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