THE SOCIETY FOR VASCULAR TECHNOLOGY OF GREAT BRITAIN AND IRELAND

Vascular Technology Professional Performance Guidelines
Ankle Brachial Pressure Index Assessment (ABPI): Resting and Post Exercise

Introduction

This guideline was prepared by the Professional Standards Committee (PSC) of the Society for Vascular Technology (SVT) as a template to aid the clinical vascular scientist / vascular sonographers and other interested parties. It can be used in conjunction with local protocols agreed between sonography and vascular departments. It may be used in part or in its entirety with suitable additions made by local policy implementers, and should be read in combination with the following SVT guidelines when setting up a service to provide ABPI measurements:

- Vascular Ultrasound Service Specifications[1]

Suggestions for improving this guideline are welcome, and should be sent to the Chair of the PSC; see www.svtgbi.org.uk for current Chair details.

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 recommends that compression bandaging should be avoided where the ABPI < 0.8 [2]. The Royal Society of Medicine, in conjunction with the Vascular Society and the Society for Vascular Technology has more recently recommended that a figure of 0.9 may be more appropriate [3].

Common Indications
Common indications for performing this examination include:

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

Contraindications and Limitations
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) [4] or superficial thrombophlebitis, protocols should reflect local thrombosis management guidance.
- 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 maybe 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 (MI; within 2 days)
- Unstable angina not previously stabilised by medical therapy
- Uncontrolled cardiac arrhythmias causing symptoms or hemodynamic 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 progression of disease. 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 [5]. Compressions 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 ABPIs 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 ABPIs and Exercise Testing although access will be required to the patient's ankle, feet and arms. The patient should be supine and rested for 10-15 minutes [5, 7] before taking any measurements, in order that systemic blood pressure has stabilized and consistent baseline pressure can be made. 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 [5 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 [10].
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: here 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 held Doppler probe over a distal artery (e.g. the brachial artery) at an angle

(ideally between 45^{o} and 60^{o}) to detect the signal. Inflate the cuff until the audible signal disappears and the artery is occluded. Deflate the cuff slowly (at a rate of approx. 4mmHg per second) and record the systolic pressure as the audible Doppler signal returns. 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 45^{o} and 60^{o}) to locate the posterior tibial artery close to the ankle. Audible assessment should be made of the pulsatility and phasicity of the signal. Inflate the cuff until the artery is occluded and the audible signal disappears. Deflate cuff slowly (at a rate of approx.. 4mmHg per second) 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.

Where there is access to a Duplex scanner or hand held Doppler with a spectral trace, a record of the waveform shape is a useful addition.

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 (patients encouragement will often resolve – 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 arrhythmia (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 patients 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.

The cuffs are usually left on the ankles to allow the post-exercise pressures to be measured quickly. Exercise the patient for 3 to 5 minutes until claudication symptoms prevents 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.

The report should include:

- The measured blood pressures including units of measurement
- The calculated ABPIs
- Analysis of the Doppler waveforms, if local policy
- 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 [11 12]

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 with caution/reduced compression)
0.8-0.5	Intermittent claudicant indicating moderate/severe arterial disease

	(compression contra-indicated)
<0.5	Severe disease (compression contra-indicated)
<0.3	Critical ischemia (compression contra-indicated)

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 desired toe pressures may be used for these patients.

Post exercise in the absence of disease the ABPI will reduce slightly due to vasodilation in the exercising muscles, or remain the same as at rest. The ankle pressure then increases rapidly to reach the pre-exercise level within 1-2 minutes. 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 0.3 mmHg or a post exercise ABPI decrease of 20% is considered significant [9].

Writing the report: The report is a recording and interpretation of observations made during the ABPI examination; it should be written by the CVS undertaking the examination and viewed as an integral part of the whole examination.

The report should include correct patient name, demographics; date of examination; and examination type. Include the absolute pressures of the ABPI, the pressure index and phasicity of the Doppler signal waveform.

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.

Referral of critical ultrasound 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 Pressure Brachial Index [14-18] (TBI):

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

TBI is 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

TBI 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 can indicate abnormal distal circulation. 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.

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