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Ankle Brachial Pressure Index		Feb 2022	1.2

Scope & 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, a comparison of these pressures are used to rapidly assess the blood pressure in reaching the lower limb and indicate severity of disease.

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

ABPI may also be used to determine if compression bandaging is suitable for patients with leg swelling or ulceration.

Common indications for performing this examination include:

- Intermittent claudication
- Ischemic rest pain
- Gangrene
- Ulceration
- Post-surgical intervention follow-up
- Suitability for compression

Personnel

Clinical vascular scientists (CVS), including trainees.

Principles / performance characteristics

To determine the presence or absence of peripheral arterial disease and to determine the need for any further investigations. In some cases it is used to determine the suitability for compression bandages.

Service users & background

Patients with suspected peripheral arterial disease may be referred as part of their diagnostic workup. This diagnostic investigation aims to establish if peripheral arterial disease is a possible cause for their symptoms and the patient's need for further investigations.

Contraindications for ABPIs may include:

- Severe pain in lower limb
- Bypass graft that extends into the lower calf
- DVT confirmed within the last six months

The following should be considered and maybe a contraindication for exercise testing– the list is not exhaustive and should only be used a starting point (use clinical judgement):

- Chest pain of recent onset
- Evidence of shortness of breath
- Recent myocardial infarction or CABG
- Unsteadiness when walking

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- Unstable angina (frequent use of GTN spray)
- Hypertension (>200mmHg)
- Acute pulmonary embolus or pulmonary infarction
 - Cardiac conditions (consider active plantarflexion (heel raises) vs treadmill)

Limitations for ABPI examination and exercise test may include:

- Calcification of arteries
- Casts, dressings, open wounds/ulcers
- 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), involuntary movements or intolerable pain

Facilities, equipment & special supplies

The examination couch should be height adjustable to minimise a compromised position for the Clinical Vascular Scientist (CVS) and must allow the patient to lie supine.

For a resting ABPI, a sphygmomanometer with a dial gauge, a blood pressure cuff (at least 50% wider than the diameter of the limb and a length of at least 80% more than the circumference of the limb in order to prevent over or under estimation) and ultrasound gel, are required. To obtain a Doppler signal a continuous wave hand held Doppler (with an 8MHz or 5MHz probe - if limb is obese/ oedematous) or an ultrasound machine transducer with pulsed wave capabilities can be used.

A treadmill may also be required when carrying out an exercise test.

Calibration

Annual calibration and safety checks are performed on the sphygmomanometer with a dial gauge, continuous wave hand held Doppler, treadmill and ultrasound machine by the Clinical Engineering Department.

Quality control

Second opinions from vascular scientist colleagues are requested routinely if clarification is sought.

Trainee vascular scientists have all ABPIs checked until they are signed off by a senior colleague for competency.

Environmental & safety controls

Infection control procedures followed in accordance with Trust infection control and risk assessment policies – Please see 'Personal Protective Equipment (PPE) for infection prevention and control' policy, 'Hand Hygiene' policy and 'Staff Risk Assessments' which are all available through the Trust Intranet.

Tristel wipes are for cleaning the ultrasound machines and probes after patient use. Universal Clinell wipes are for cleaning all other equipment. Where high risk infection presents or post-op wounds are present use probe covers with sterile gel or Tegaderm

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dressings, in addition to routine cleaning.

Ankle Brachial Pressure Index (ABPI) procedure

	<i>Preceding document:</i> VAS-MP-6 Patient management
1.	The patient is asked to adjust their clothing to expose their arms and their ankles. The patient should be supine and the equipment and limbs at heart level to reduce hydrostatic pressure inaccuracies; the patient should be fully rested for 10 minutes before the test.
2.	<p>Obtaining brachial systolic blood pressure: Perform test on both arms unless there are any contraindications for taking blood pressures in an arm (may include but not exhaustive: a haemodialysis fistula, a cannula inserted or had recent blood taken). If one arm is excluded, only record blood pressure in the contralateral arm. Place the cuff around the upper arm ensuring that the bladder of the cuff is over the brachial artery. Place the handheld Doppler probe or transducer over the brachial artery (Doppler beam at an angle ideally between 45° and 60°) to detect the signal. Record the phasicity (mono/bi/triphasic) of the waveform then inflate the cuff until the artery is occluded and the signal drops out. Inflate the cuff a further 20mmHg. Deflate cuff slowly (approx. 4mmHg per second) and record the systolic pressure as the Doppler signal returns (ref 1 and 2).</p> <p>If a pressure difference of ≥ 20mmHg (ref 3) between the two arms is noted, highlight the difference on the report and suggest further imaging may be required, for example 'significant difference in brachial pressures noted, may suggest significant upper limb arterial disease. If appropriate refer for further imaging.' You may wish to tell the patient to routinely take their blood pressure on the 'normal' side going forward.</p> <p>If the systolic pressure is recorded in both arms use the highest pressure for the calculation of the ABPI.</p>
3.	Obtaining ankle pressures: Perform test bilaterally. Place the cuff around the calf just above the medial malleolus. In turn listen to the Doppler signals in the posterior tibial and anterior tibial arteries. Locate the posterior tibial artery close to the ankle and place the Doppler probe over the anterior tibial artery at the ankle or the dorsalis pedis artery on the dorsum of the foot. Record the phasicity of the signal in each vessel and the systolic pressure by repeating the method of inflating the cuff to point of occlusion, inflating a further 20mmHg and slowly deflating, approx. 4mmHg per second (ref 1).
4.	<p>After completion of the resting ABPI, exercise testing should be performed if:-</p> <ul style="list-style-type: none"> The pressure index is >0.9 (but less than 1.4) and the patient has claudication symptoms, or if the test is deemed relevant. If the ABPI is ≥ 1.4 then note on the report that the ankle pressures are falsely elevated and that exercise testing is not valid under these circumstances.

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	<ul style="list-style-type: none"> The patient is deemed fit to use the treadmill (see contraindications). Consider alternative exercise testing if the treadmill is not considered safe or is not available. <p>If suitable for treadmill exercise and a treadmill is available: Set treadmill at 10% incline and set the pace according to the needs of the individual patient (i.e. 2-4 kmph, aim for 4kmph where possible). Exercise the patient for 3-5 minutes (aim for 5 minutes) until claudication symptoms prevent them from going any further. On completion of exercise both ankle pressures should be taken as quickly as possible (try and aim to be within 45 seconds) starting with the symptomatic leg or the leg with the lowest resting ABPI. The CVS should document any relevant symptoms that the patient mentions throughout the test, and if exercise is aborted before 5 minutes, the reason for this should be documented. If the patient can exercise for more than 5 minutes without symptoms then the test should be stopped once 5 minutes has been completed (ref 1). If the patient experiences symptoms throughout the exercise test, the time of onset of these symptoms can be documented on the report. The final time and speed that the patient exercised for must be documented on the report. If available on the treadmill, the distance the patient exercised for should also be documented. See safety precautions for using the treadmill to exercise patients in section 5 below.</p> <p>The post-exercise pressure should be taken from the highest pre exercise vessel or if both >1.0 then the vessel that elicits the best Doppler signal.</p> <p>Where treadmill testing is contraindicated or not available: The patient is asked to stand and 50 consecutive repetitions of active plantarflexion (heel raises) are performed. The knees should be kept fully extended and participants will be allowed fingertip support against a suitable structure to assist with balance. On completion of exercise both ankle pressures should be taken as quickly as possible (try and aim to be within 45 seconds) starting with the symptomatic leg or the leg with the lowest resting ABPI. The CVS should document any symptoms that the patient mentions throughout the test, and if exercise is aborted before completing the 50 consecutive repetitions, the reason for this should be documented (ref 4 and 5).</p> <p>The pressure measurements are recorded on the reporting template and a post exercise pressure change is calculated.</p>
5.	<p>Safety precautions for using the treadmill</p> <ul style="list-style-type: none"> Ensure the clinical area is well lit when using the treadmill. Remove any objects from behind the back of the treadmill. Ensure no loose electrical wires are around the treadmill or immediate area around it. Do not start the treadmill until the test has been fully explained to the patient, any contraindications have been verified and the patient is safely in the start position.

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	<ul style="list-style-type: none"> • Ensure the patient is aware of the treadmill safety bar and where to hold onto for balance/support if required during the treadmill test. • Ensure the patient is made aware of the emergency stop button on the treadmill which they can press at any time, and that the CVS may press the button if necessary. • Inform the patient that they may stop the test at any time but they must inform the CVS or press the emergency stop button, they are not to just stop walking whilst the treadmill is in motion. • Instruct the patient to inform the CVS if they have any chest pains, breathing difficulties or feel acutely unwell during the treadmill test. • The CVS must assess the patient as they are on the treadmill to determine if the patient is able to safely continue, if the CVS deems the patient at risk of falling at any point during the test the treadmill should be stopped. • Do not leave the patient unattended on the treadmill. • Do not use the treadmill if any faults are identified with the machine (including any damage to the treadmill belt). • Switch off the treadmill after use.
6.	<p>Potential Sources of Error with ABPI Measurements (ref 1)</p> <p>The following list of potential sources of error includes suggested methods to minimise and which may need acknowledging in the report:</p> <p>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).</p> <p>Cardiac arrhythmia (wait for the heart rate to stabilise if temporary – acknowledge potential inaccuracies in report).</p> <p>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).</p> <p>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).</p> <p>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).</p> <p>Excessive Doppler probe pressure (this can occlude diseased vessels – use gentle probe pressure).</p> <p>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).</p>

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	<p>Inappropriately sized cuff (check it against the limb before starting – you may need a different one for the arms – get everything ready beforehand).</p> <p>Signal difficult to hear (use headphones, if available).</p> <p>Incorrectly positioned cuff (ensure bladder over artery and cuff not twisted).</p> <p>Calcified incompressible arteries may result in artefactually high ABPI readings.</p> <p>Acknowledge in the report when necessary.</p>
7.	Subsequent documents: <i>VAS-MP-6 Patient management, VAS-MP-1 Results processing</i>

Reporting

The report is a record and interpretation of observations made during the ABPI examination; it should be written by the CVS undertaking the examination.

The report should include correct patient demographics, date of examination, examination type, the name and status of the CVS and any clinical history deemed relevant.

All pressure recordings and waveforms are documented on a reporting template.

The pressure indices are calculated as below (ref 1 and 2):

ABPI = Ankle systolic pressure (mmHg)/Highest brachial systolic pressure (mmHg)

The ABPI should be written to two decimal places.

Falsely high systolic pressure readings may be obtained in diabetics; this should be commented on the report.

If unable to detect a signal this should be documented on the report.

Normal pressure index should be $>1.0 \pm 0.07$. Thus progression of disease is indicated when the pressure index has dropped by >0.14 since a previous recording. A pressure drop of $>30\text{mmHg}$ post exercise is considered a significant result and indicative of peripheral vascular disease (ref 1 and 6).

Table1: Interpretation of resting ABPI readings (used in conjunction with waveforms) (PAD = Peripheral arterial disease) (ref 7 and ref 1)

Resting ABPI	Severity of disease
≥ 1.4	Suggests falsely elevated readings
1.39-0.9	Suggests no evidence of significant PAD
0.89-0.5	Suggests mild/moderate PAD

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<0.5	Suggests severe PAD
<0.3	Suggests critical ischemia

Any incidental findings should be documented and further imaging recommended when clinically appropriate.

When deemed clinically appropriate, urgent findings should be escalated to the referring clinician, for example acute symptoms and an ABPI of <0.3 - clinical judgement to be used.

References	
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4.	McPhail, I. Spittell, P. Weston, S. Kent, M, Bailey, R. (2001) Intermittent Claudication: An objective Office-Based Assessment. <i>Journal of American College of Cardiology</i> . 37:5
5.	VAS-ED-22. SVU – Lower Extremity Arterial Physiologic Evaluations – Vascular technology professional performance guidelines. (2019).
6.	Laing, S.P. and Greenhalgh, R.M. (1980). 'Standard exercise test to assess peripheral arterial disease', <i>British Medical Journal</i> , 280(6206), pp.13-16
7.	Sibley, R.C. et al. (2017). 'Non-invasive physiological vascular studies: a guide to diagnosing peripheral arterial disease', <i>RadioGraphics</i> , 37(1), pp. 346-357