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| **DOCUMENT CONTROL PAGE** | | |
| **Title** | **Title:** Lower limb Arterial Assessment – Vascular Screening Practitioner (NIVA)  **Version: 3**.0  **Reference Number:** ARTvsp003 | |
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| **Minor**  **Amendment** | **Notified to: CMFT CVS and VSP**  Date: 13/1/19  Updated pt rested before test. | |
| **Author** | **Originated/Modified by:** H Edlin  Designation: Lead Clinical Vascular Scientist | |
| **Ratification** | **Ratified by:**  Date of ratification: | |
| **Application** |  | |
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**Reasons for performing the test:**

A reduction in the blood supply to tissues is called ischaemia. There are a number of risk factors that are strongly related to ischaemic events in the lower limb which include - smoking, diabetes mellitus, hypertension, increased cholesterol levels and cardiac disease. The majority of patients with chronic ischaemia of the lower limbs will have stenotic or occlusive arterial disease.

Ankle pressures are used to rapidly assess the blood pressure reaching the dorsal portion of the lower limb. They provide a reproducible and quantitative assessment of arterial disease of the whole lower limb. The more severe the disease, the lower the ankle pressure. Ankle pressure indices may also be used to follow-up patient’s progress, months or years after treatment.

**Common Indications**

Intermittent claudication

Ischemic rest pain

Gangrene

Ulceration

Post-surgical intervention follow-up

**Contraindications**

Severe pain in lower limb

Bypass graft that extends into the lower calf

DVT confirmed within the last six months or superficial thrombophlebitis (4) Discuss with senior member of staff.

**Contraindications for exercise test:**

Chest pain of recent onset

Evidence of shortness of breath

Previous myocardial infarction or CABG

Unsteadiness when walking

Uncontrolled angina

Hypertension (>200mmHg)

**Limitations**

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) or from

involuntary movements.

**Equipment used:**

Compliance with the Medical Devices Directive is necessary. Electrical safety testing is required annually, with regular maintenance & quality assurance testing to a specified level by qualified personnel. Review of in-service equipment should typically be undertaken four to six years after installation (1)The examination couch should be height adjustable to minimise a compromised position for the operator and must allow the patient to lie supine(2). For resting ABPI a sphygmomanometer with a dial gauge, a blood pressure cuff (at least 40% wider than the diameter of the limb and a length of at least 80% of the circumference of the limb(3)), and a continuous wave hand held Doppler with a 8MHz probe or 5MHz (if limb is obese/ oedematous) and ultrasound gel is required(4). For the exercise test, a treadmill can be used if available.

**CUFF SIZE AND PLACEMENT**

The most common error in blood pressure measurement is use of inappropriate cuff size. Considerable overestimation can occur if the cuff is too small. The bladder length recommended by the AHA is 80 percent of the patient’s arm circumference, and the ideal width is at least 40 percent. Error is minimized when the cuff width is 46 percent of the arm circumference, although for large adult and thigh cuffs this is not practical. In obese patients, longer, wider cuffs are needed to compress the brachial artery adequately. In children, cuff bladder width should be at least 40 percent of the arm circumference halfway between the olecranon and acromion; the cuff should then cover 80 percent or more of the arm circumference. Recommended cuff sizes are listed in[*Table 3*](https://www.aafp.org/afp/2005/1001/p1391.html#afp20051001p1391-t3).

#### Recommended Cuff Sizes for Accurate Measurement of Blood Pressure

| ***PATIENT*** | ***RECOMMENDED CUFF SIZE*** |
| --- | --- |
| Adults (by arm circumference) | |
| 22 to 26 cm | 12 × 22 cm (small adult) |
| 27 to 34 cm | 16 × 30 cm (adult) |
| 35 to 44 cm | 16 × 36 cm (large adult) |
| 45 to 52 cm | 16 × 42 cm (adult thigh) |
| Children (by age)\* | |
| Newborns and premature infants | 4 × 8 cm |
| Infants | 6 × 12 cm |
| Older children | 9 × 18 cm |

*Information from Pickering TG, Hall JE, Appel LJ, Falkner BE, Graves J, Hill MN, et al.; Subcommittee of Professional and Public Education of the American Heart Association Council on High Blood Pressure Research. Recommendations for blood pressure measurement in humans and experimental animals. Part 1: blood pressure measurement in humans. Hypertension 2005;45:142–61*.

The “80/40” **rule** states that in order to obtain an accurate **blood pressure** measurement, the **cuff** bladder length should be approximately 80% of the circumference of the upper arm and the **cuff** bladder width should be optimally 40% of the circumference of the upper arm.

**Consumables required:**

Ultrasound gel, tissue paper, roll for the couch

**Patient preparation:**

Ensure that the patient is correctly identified using 3 forms of ID – these are usually name, date of birth and first line of address (this can also include wrist band ID)

Identify yourself and ensure the patients are at ease by explaining the test to be carried out is a safe and painless procedure. Ensure patient can understand and they consent to the procedure, offering an interpreter and chaperone if one has not already been arranged.

# Procedure

Patient is rested for 15 mins before the test is performed. Patient should be in a supine position for the test (5, 6)

General technique - The continuous wave Doppler is placed directly above the vessel being examined at a 45° - 60° angle to the skin surface. Slow movements are used to identify the loudest volume signal, then adjustments are made to the angle to achieve optimum Doppler signal. When performing blood pressure measurements, ensure that the cuff bladder reaches around the limb and the width should be at least 50% greater than the limb diameter.

**ABPI**

Standard blood pressure cuff is placed around the upper arm.

NB DO NOT TAKE BLOOD PRESSURE IF THERE IS AN AV FISTULA IN THE ARM OR THE PATIENT HAS HAD A MASTECTOMY.

Brachial artery signal is obtained using 8MHz continuous wave Doppler probe. If the Doppler signal is of a good volume with a triphasic waveform, then the blood pressure cuff is inflated until the Doppler signal is lost. The cuff is then slowly deflated and the brachial systolic blood pressure is recorded when the Doppler signal is first heard. If the pressure in one arm is unusually low or abnormal brachial waveform is detected, then the blood pressure of the contralateral arm should be taken, using the highest reading to calculate the ABPI.

The standard blood pressure cuff is then placed around the ankle just above the medial malleous, and using the strongest ankle signal previously identified, the cuff is inflated as with the arm, and the ankle systolic pressure is recorded. If distal vessel disease is suspected from the waveform analysis then pressures should be taken in the AT and PT. The same is performed on the contralateral leg.

Discuss results with a vascular scientist to decide if the patient requires an exercise test or toe pressures and/or duplex.

**Waveform Analysis**

Bilateral assessment of the femoral, popliteal, posterior tibial, anterior tibial and dorsalis pedis arterial waveforms should always be assessed.

The common femoral artery is located in the groin using a 4MHz probe and the waveform shape (7) (triphasic, biphasic or monophasic) is noted along with any abnormality in the signal strength (weak, damped, turbulent etc.).

The patient’s leg is flexed to a 45° angle and the 4MHz probe is placed in the popliteal fossa. Again the waveform shape and signal strength are recorded.

An 8MHz probe is placed posterior to the medial malleous to locate the posterior tibial artery where the waveform shape and signal strength are recorded. The same probe is then used to identify, record waveform shapes and signal strength of the anterior tibial artery on the anterior aspect of the ankle and dorsalis pedis artery signal on the dorsum of the foot.

Waveform analysis is repeated on the contralateral vessels in the lower limb.

Discuss results with a vascular scientist to decide if the patient requires an exercise test or toe pressures and/or duplex.

**Exercise Test**

The best way to highlight arterial insufficiency is to 'stress' the arterial supply.

The stress test assesses the severity of the arterial obstruction by measuring the fall in pressure at the ankle after the challenge. Exercise testing is performed in conjunction with resting ankle pressure measurements in order to confirm or exclude presence of arterial disease, establish objectively the severity of disease, differentiate peripheral vascular disease from non-arterial aetiology (i.e. spinal stenosis, venous claudication, etc), and to investigate the contralateral limb as disease may be present but could be masked by the more rapid onset of symptoms in the symptomatic limb.

An exercise test is only required on patients who's ABPI is 0.9 or above, or if specifically requested. If an exercise test is indicated then a treadmill exercise test for 1 minute at a maximum of 4km/hr and with a 10° gradient or a heel raise test for up to 5 minutes, or up until the desired symptoms are brought on, can be performed (4).

The technologist/scientist should be aware of any heart conditions, breathing problems or any other problems the patient may have which could be brought on by exercise. Once the exercise is completed the patient returns to the couch and lies supine and pressures are retaken within 40 seconds.

IF RECOVERY TIMES ARE SPECIFICALLY REQUESTED - If there is a drop in the ankle pressure post exercise, then pressures should be taken every minute until the pressures have recovered. If the pressures have not recovered after 5 minutes, the test is stopped. Recovery time is not required for follow–up scans (including graft surveillance).

Please note that the treadmill should be stopped fully using the red stop button and lowered to flat position before the patient steps off.

Discuss results with a vascular scientist to decide if the patient requires a duplex.

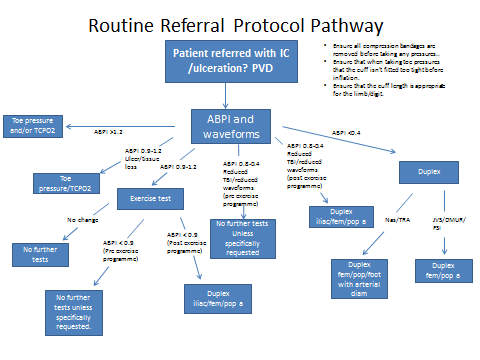
**Toe Pressures**

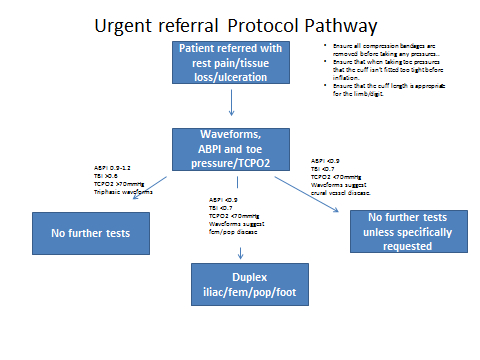
Toe pressures may be required when ankle pressures are significantly elevated in comparison to the brachial pressure suggesting incompressible lower limb arteries due to the presence of arterial calcification or oedema.

Hallux pressures should always be performed on all patients referred with critical limb ischaemia/tissue loss or if specifically requested.

Hallux pressures are performed using photoplethysmography (PPG) in place of continuous wave Doppler and should provide a more accurate reflection of limb perfusion. A small cuff is placed around the great toe and the PPG sensor is secured to a clean area of skin distal to the toe cuff. Check that arterial pulse is present, then cuff is inflated until the pulse signal is lost. The cuff is slowly deflated and the toe pressure is recorded when the pulse first returns. Care is required performing PPG measurements due to its sensitivity to movement. Ensure the cuff isn’t too tight around the toe to avoid compression/occlusion of the digital arteries.

Discuss results with a vascular scientist to decide if the patient requires a TCPO2 measurement and/or duplex.

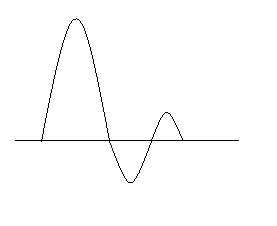




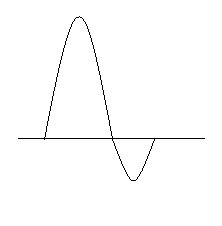
# Results

Spectral Doppler waveform characteristics

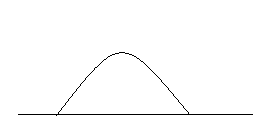
Triphasic waveform - normal flow



Biphasic waveform - abnormal or loss of last component due to increasing age



Monophasic waveform - disease present proximal to pulse point



The ankle brachial pressure index (ABPI) is calculated by: (3)

**ABPI = ankle systolic pressure**

**brachial systolic pressure**

Table1: Interpretation of resting ABPI readings

Resting ABPI Severity of disease (suitability for compression treatment)

|  |  |
| --- | --- |
| **ABPI** | **CLASSIFICATION** |
| > 1.4 | Calcification |
| > 1.0 | Normal (apply compression) |
| 0.81 – 1.0 | Mild disease (apply compression with caution/reduced compression |
| 0.8-0.5 | Moderate disease (compression contraindicated) |
| < 0.5 | Severe disease (compression contraindicated) |
| <0.3 | Critical ischemia (compression contra-indicated) |
|  |  |
| **TOE INDEX** | **CLASSIFICATION** |
| > 0.8 | Normal |
| 0.6 – 0.8 | Equivocal |
| 0.2 - 0.6 | Moderate disease |
| < 0.2 | Severe disease |

*Zweibel W J, Pellerito J S 2005 Introduction to vascular ultrasonography 5th edition. Esevier Saunders, Philadelphia.*

If the calculated ABPI > 1.4 this indicates that the vessels are calcified and unable to be compressed (8), toe pressures are performed (4). Stress testing is not carried out as there is no literature to support that this is of diagnostic use.

If the patient’s blood pressure is particularly high or low the patient should be informed, ask them if they are on any BP medication, if they get their BP checked regularly by their GP. If not, advise them to see their GP as a precaution explaining that it may only be raised because they are having the test done.

At the end of the test inform the patient that the consultant will give them their results at their next visit.

**Report**

The report should include correct patient name, demographics; date of examination; and examination type.

Document that consent was obtained and whether a chaperone was present

Include the absolute pressures 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 what stopped the patient from any further exercise e.g. calf claudication, chest pain.

IMPORTANT: If patient has no pedal pulses or you feel that the patient requires a medical opinion, let a senior member of staff know, keep the patient in the department whilst someone speaks with a member of the Vascular team.

Write on report that you have sought advice from the vascular team and what the outcome was.

**GP referrals**

If patient’s results show significant pathology, advise GP to refer patient to a vascular consultant.

**In-patients**

File report in notes under investigations and write in the case history that the test has been performed and where the results are filed, signing and dating your entry.

**OP** - informed who their results will be sent back to and an appropriate time scale for follow up.

**One stop** - Sent back to referrer with a copy of their results or informed who their results will be sent back to with an appropriate time scale for follow up.

**A+E** - Sent back with their results to the referrer in A+E/ACU as appropriate.

**Pitfalls**

Cuff size – ensure that the cuff length and width is adequate size for the limb/digit.

Room temperature - an environment that is too hot or too cold will cause vasodilation or vasoconstriction, which may affect ABPI, waveforms or toe pressure measurements.

Probe positioning - care is required in the positioning of the Doppler probe as waveform abnormalities can be produced by variations in probe angle relative to the plane of blood flow in the artery, and by variations across the artery lumen.

Confusion between poor arterial signals and venous signals - as patients with severe arterial disease and low ankle pressures may have poor Doppler signals around the ankle it is easy to confuse poor arterial signals with venous signals.

Presence of gross oedema can cause pressures to be elevated and therefore ABPIs will be inaccurate.

Patients with cardiac arrhythmia - for example, the usual characteristics of the Doppler waveform will be destroyed in patients with rapid atrial fibrillation.

Not all patients are able to lie flat. Elevation of the upper body may cause the pressure in the lower limbs to be falsely elevated.

**Patient and staff safety**

Electrical: Equipment must comply with Medical Devices Directive. A Post Purchase Questionnaire needs to be completed and safety tests are required on arrival.

Use output powers quoted by the manufacturer and in accordance to ALARA / AIUM criteria.

Infection control: Clean the gel off the probes with soft clean tissue between patients

The probe must be washed with soapy wipes when it has been in contact with blood or bodily fluids. (Note: Chlorine, phenol or alcohol based products should not be used)

When there is a patient with MRSA: Ensure the patient is last person to be scanned (preferably at the end of the day). Clean equipment with soapy wipes prior to contact with patients. Use sterile probe cover for barrier protection. After the scan, the ultrasound machine has to be wiped down with some soapy water and alcohol (Avoid alcohol contact with the matching layer). Strip the couch of linen and paper then wipe down with alcohol. Dispose of waste bin appropriately and evacuate the room for at least an hour.

For sterile procedures use sterile probe covers.

Ensure couch and chair adjusted to optimum height to avoid work related upper limb disorders.

**Equality Impact Assessment**

**References & Bibliography**

1 Standards for Ultrasound Equipment; Royal College of Radiologists, February 2005

[www.rcr.ac.uk](http://www.rcr.ac.uk)

2 Guidelines for Professional Working Standards Ultrasound Practice; United Kingdom Association of Sonographers (UKAS) October 2008 [www.sor.org/learning/document-library](http://www.sor.org/learning/document-library)

3 Zweibel W J, Pellerito J S 2005 Introduction to vascular ultrasonography 5th edition. Esevier Saunders, Philadelphia.

4 Vascular Laboratory Practice Part III, IPEM 1st Ed 2001.

5 Vowden K, Vowden P. (2001) Doppler and the ABPI: how good is our understanding? J Wound Care, 10(6):197–202.

6 Yao ST. Haemodynamic studies in peripheral arterial disease. Br J Surg. 1970;57(10):761–766.

7 AbuRahma A F 2000 Segmental Doppler pressures and Doppler waveform analysis in peripheral vascular disease of the lower extremities. In: AduRahma A F, Bergan J J

8 Al-Qaisi M., Nott D.M., King D.H., Kaddoura, S. (2009) Ankle Brachial Pressure Index (ABPI): An update for practitioners. Vascular Health Risk Management, 5: 833–841.