

**ANKLE BRACHIAL INDEX (ABI)****Jinal Pandya\***, **Kartik Patel \*\***, **Neeraj Mahajan\*\*\*** ,

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**Abstract:** ABI is a form of physiological measurement that provides valuable information about the functional status of peripheral arteries and predicts the risk of cardiovascular disease. It works by calculating ratio of systolic blood pressure of one of the arteries of ankle and that of brachial artery in the arm. Normal values have been established by various multi centric trials and values above or below normal have been demonstrated to be associated with specific cardiovascular diseases like lower extremity peripheral arterial disease. The following review article shades some light on the topic.

**Key words:** ABI, Cardiac Physiology, Systolic blood pressure, PAD, Cardiovascular disease

**Abbreviation:** ABI = Ankle Brachial Index, PAD = Peripheral Arterial Disease, SBP = Systolic Blood Pressure, DP =DorsalisPedis, PT = Posterior Tibial

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**Introduction:**

Physiological assessment of cardio-vascular disease is becoming increasingly more important in both clinical and research applications. The ankle-brachial index (ABI), ratio of the blood pressure at the ankle to the blood pressure in the upper arm (brachium), is an efficient tool for objectively documenting the presence of lower-extremity peripheral arterial disease (PAD)<sup>(1),(2)</sup>. It is a simple, reproducible, and cost-effective assessment that can be used to detect lower-extremity arterial stenosis in the primary care setting..

Additionally, ABI is an indicator of generalized atherosclerosis. In population cohort studies<sup>(3)</sup>, a low ABI has been related to an increased incidence of total and cardiovascular (CV) mortality. The ABI related to increased CV risk has been shown to be independent of baseline CV disease and risk factors, suggesting that the ABI might have an independent role in predicting CV events<sup>(4)</sup>.

Considering the increasing burden of atherosclerotic disease and its mortality, and also the usefulness of non-invasive, easy and practical methods for identifying atherosclerotic risk factors for prevention or early treatment of atherosclerotic diseases, the major global cardiovascular societies have advised measurement of ABI in primary health care that

may help in early diagnosis of cardiovascular diseases and therefore reducing their prevalence.

**What is ABI? And ABI measurement**

The Ankle Brachial Index (ABI) is systolic blood pressure difference ratio between ankle and arm. Systolic blood pressure is always higher at ankle than in arm physiologically.

The blood pressure waveform amplifies as it travels distally from the heart, resulting in a progressive increase in SBP. The most widely accepted model used to explain the SBP amplification relies on retrograde wave reflection from resistant distal arterioles, which is additive to the anterograde wave<sup>(5)</sup>. Several lines of evidence indicate that reflected waves occur at various sites in the vascular bed<sup>(6)(7)</sup> with some attenuation along the arterial system<sup>(8)(9)</sup>. Also, in the legs, remodeling of vessel structure occurs, resulting from increased intraluminal pressure, characterized by increased wall thickening and unchanged inner radius<sup>(10)(11)</sup>. The changes in wall thickness resulting from increased hydrostatic pressure in the lower extremities with walking (vertical position) occur during the second year of life and plausibly explain why the ABI is 1.00 in the newborn and increases to adult values at 2 to 3 years of age<sup>(12)</sup>. Therefore, both reflected waves and changes in vessel wall thickness and

consequently stiffness contribute to higher pressure at ankle.

#### Technique of measurement

The ABI is performed by measuring the systolic blood pressure from both brachial arteries and from both the dorsalispedis and posterior tibial arteries after the patient has been at rest in the supine position for 10 minutes. The systolic pressures are recorded with a handheld 5- or 10-mHz Doppler instrument.



**Doppler instrument for SBP recording**

A standard blood pressure cuff is tied to patient's lower calf (immediately above the ankle). It is recommended to begin with the right arm, then the right leg, then the left leg, and finally the left arm, as the blood pressure may drift during the exam, and the two arm pressures at the beginning and end of the exam provide for some quality control.

#### Measuring the Brachial pressure

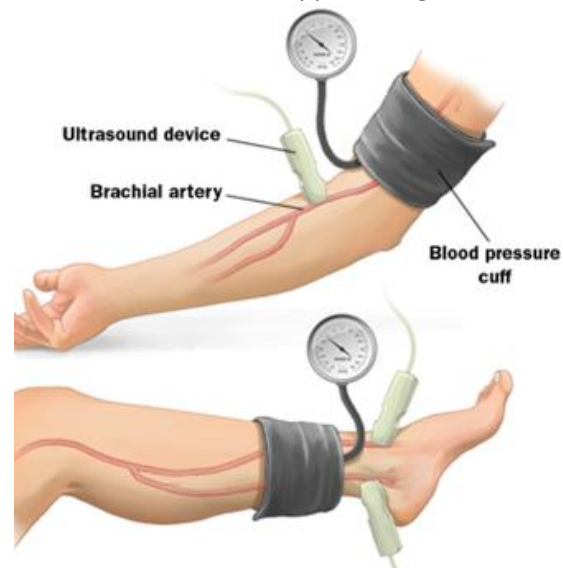
The patient should be in the supine position. Place the blood pressure cuff on the arm, with the limb at the level of the heart. Place the ultrasound gel in the antecubital fossa over the patient's brachial pulse. Place the transducer of the handheld Doppler on the gel, and position the transducer to maximize the intensity of the signal. Inflate the cuff to about 20 mmHg above the expected systolic blood pressure of the patient. The Doppler signal should disappear. Then slowly deflate the cuff, approximately 1 mmHg/sec. When the Doppler signal reappears, record the pressure as the brachial systolic pressure.

#### Measuring the ankle pressures

Place the cuff immediately proximal to the malleoli. Place ultrasound gel on the skin overlying the dorsalispedis (DP) and posterior tibial (PT) arteries in the foot. Using a standard

hand-held Doppler probe, locate the signal from the DP. Slowly move the Doppler until the strongest signal is found. To measure the systolic pressure at the DP artery, inflate the cuff until you no longer hear the signal. Then slowly deflate using the same technique used in the arms until the Doppler signal reappears. Record the measurement.

Next, measure the systolic pressure of the PT artery. The PT signal is detected posterior to the medial malleolus. Once again, using the Doppler with ultrasound gel, locate the signal, and follow the process described above to measure the PT systolic pressure. Repeat both measurements on the opposite leg.



**Illustration of the measurement of ABI**

#### Precautions

The best ABI results are obtained when the patient is relaxed, comfortable, and has an empty bladder. To enhance the patient's relaxation and comfort explain the procedure. Remove tight clothing so that the blood pressure cuff can be easily applied to the arms and lower legs. Place the patient in a flat, supine position for a minimum of 10 minutes prior to the test. Ask patients about recent caffeine intake, alcohol intake, smoking, pain, and heavy activity as these can all affect blood pressure readings.

### Calculating the ABI

An ABI is calculated for each leg. The ABI value is determined by taking the higher pressure of the 2 arteries at the ankle, divided by the brachial arterial systolic pressure. In calculating the ABI, the higher of the two brachial systolic pressure measurements is used. In normal individuals, there should be a minimal (less than 10 mm Hg) inter-arm systolic pressure gradient during a routine examination. A consistent difference in pressure between the arms greater than 10mmHg is suggestive of (and greater than 20mmHg is diagnostic of) subclavian or axillary arterial stenosis, which may be observed in individuals at risk for atherosclerosis.

Calculated ABI values should be recorded to 2 decimal places.

#### Right ABI

$$\frac{\text{Higher of the right ankle systolic pressure (dorsalis pedis or posterior tibial)}}{\text{Higher brachial systolic pressure (Left or right arm)}}$$

#### Left ABI

$$\frac{\text{Higher of the left ankle systolic pressure (dorsalis pedis or posterior tibial)}}{\text{Higher brachial systolic pressure (Left or right arm)}}$$

### Interpretation

Persons who have an ABI of 0.9 or less, or 1.4 or greater, are at increased risk of cardiovascular events and mortality, regardless of the presence of PAD symptoms or other cardiovascular risk factors.

- An ABI between 0.91 and 1.0 is considered borderline for cardiovascular risk.
- Normal ABI ranges from 1.0 — 1.4
- A value below 0.9 is considered diagnostic of PAD.
- Value less than 0.5 suggests severe PAD.

- Value between 0.8 to 0.9 suggests mild PAD and between 0.5 to 0.8 suggests moderate PAD<sup>(13)</sup>.

### Indications

In the primary care setting, an ABI is useful in the following 2 settings:

In a symptomatic patient, to diagnose PAD.

In an asymptomatic patient, to assess the vascular risk for PAD<sup>(14)</sup>.

In all patients age > 65

In diabetics and cigarette smokers age > 50

Patients undergoing debridement or compression therapy.

### Contraindication

Patients who are unable to remain supine for the duration of the examination are not candidates for an adequate ABI. ABI measurement is also contraindicated in a patient in whom the use of an occlusive sphygmomanometer cuff may worsen the extremity injury.

### Discussion

The ABI is a validated and widely used measure to detect the presence of PAD. Because PAD is considered a coronary heart disease risk equivalent<sup>(15)</sup>, the ABI is also a simple tool that can identify those at risk of major adverse cardiovascular events (MACE).

### Physiological conditions affecting ABI

Age, sex, height, weight, body mass index can affect the ABI. Cross-sectional and longitudinal population studies indicate that the ABI decreases with age, probably because of the increased prevalence and progression of PAD<sup>(16)(17)</sup>.

Sex differences in ABI have been reported in many population studies<sup>(16)(18)(19)(20)(21)</sup>. Among participants without traditional CVD risk factors in the San Luis Valley Diabetes Study<sup>(22)</sup>, the average ABI was 0.07 less in women than in men.

There is no significant association between BMI and prevalent low-ABI<sup>(23)</sup>.

### ABI and its relation with various risk factors

ABI values are associated significantly with cardiovascular risk factors. The significant association between a low ABI and cardiovascular risk factors such as smoking

habits, hypertension, and diabetes is consistent with the findings of previous studies.

DM is a very strong independent risk factor for critical limb ischemia and amputation, as well as incident PAD in population studies<sup>(24) (25)</sup>.

Cigarette smoking is one of the most important risk factors for PAD<sup>(24)</sup>. The prevalence of current smoker is higher in low ABI than intermediate ABI values.

#### **ABI and coronary artery disease**

There are studies correlating low ankle brachial index with CAD and all of them shows increasing risk of CAD with low ankle brachial index.<sup>(24) (25) (26)</sup>

#### **Conclusion**

ABI is an inexpensive and suitable means of identifying individuals at high risk of PAD and coronary involvement. ABI has diagnostic as well as prognostic value in the management of PAD. Abnormal ABI has been independently associated with the risk of multivessel coronary artery disease.

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