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Ankle brachial index importance in early diagnosis and proper management of peripheral artery disease of lower extremity with special reference to diabetes mellitus

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Abstract

- Peripheral artery disease (PAD) of lower extremities is a worldwide healthcare problem. Its prevalence is about 13% in patients over fifty years of age and 29% of people over age of seventy. It affects up to 50% of diabetic patients. This disease is due to partial or total obstruction of one or more the peripheral arteries distal to the aortic arch. It leads to ischemia of the lower extremity that may lead to leg or limb amputations. Also it is a strong predictor of cardiovascular diseases.
- It is one of the common complications of type 2 diabetes and has a more aggressive presentation as atherosclerotic plaques tend to be more diffuse in their distribution.

Early diagnosis of PAD is necessary to allow for early interventions to prevent the functional decline of the lower extremities and to properly manage any associated cardiovascular risk factors. The ankle brachial index (ABI) is the preferred initial screening test for its diagnosis and grading of the obstruction of arteries of lower extremity. ABI is measured by using Doppler ultrasound to obtain the systolic blood pressure of the brachial artery at the right and left arms and that of the dorsalis pedis artery and posterior tibial artery at the right and left ankles. Then the ankle reading is divided by the brachial reading to obtain the ABI measurements. The average normal for adults is ABI values of 0.9 to 1.4. Values lower than 0.9 are indicative of arterial stenosis, and those lower than 0.5 are associated with critical ischemia It is concluded that ABI should be performed for any patient at risk of peripheral artery disease including elderly patients, smokers, diabetics even if they are asymptomatic**.**

Keywords: Peripheral artery disease, Lower extremity, Ankle-brachial index.

1. Introduction:

Peripheral artery disease (PAD) of lower extremities is manifested initially by muscle pain during exercise relieved with rest; a symptom; called intermittent claudication. Its severe forms if untreated properly lead to several health problems in the lower limb including pain at rest, ulceration and gangrene that may lead to amputation of the limb **(Hirsch et al 2001, Conte et al 2019).** Peripheral artery disease (PAD) is due to atherosclerosis that leads to partial or total obstruction of one or more peripheral arteries distal to the aortic arch with decrease in blood flow to the lower limbs **(Dieter et al 2003, Norgren et al 2007, Conte et al 2019, Aday and Matsushita 2021 and Eid et al 2021).**

Peripheral artery disease is a worldwide healthcare problem, though it is under-diagnosed and undertreated **(Reinecke et al 2015).** It is very common among diabetic and elderly patients **(Casey et al 2019, Aday and Matsushita 2021 and Eid et al 2021).** It affects up to 50% of diabetic patients **(Stoberock et al 2021)**, and 29% of people over age 70 (**Selvin and Erlinger 2004**, **Reinecke et al 2015).** Blacks are more affected than whites **(Criqui et al 1992).**

The American Heart Association estimates that approximately 8 to 12 million Americans have PAD **(Marso and Hiatt 2006, Norgren et al 2007).** However, its prevalence varies based on the population surveyed and the methodology of its determination **(McDermot et al 2000 and Criqui 2001).**

The peripheral artery disease is not only a disease of the lower extremity but also it is a strong indicator of coronary artery or cerebrovascular diseases. **Kim et al (2012)** stated that about one-third to one-half of patients with PAD will have some degree of coronary artery or cerebrovascular disease**.**

This review article focusses on the diagnostic methods for peripheral artery disease (PAD) of lower extremities by measuring the ankle-brachial blood pressure index (ABI) to allow for its early detection and proper management of its associated cardiovascular risks.

2. Diagnosis of peripheral artery disease (PAD) of lower extremity

The symptoms of PAD result from decrease in blood flow to the lower extremity that occurs as a consequence of long-lasting arterial stenosis. This decrease in blood supply leads to muscle discomfort and intermittent claudication which is leg pain with walking that improves with rest within 10 minutes. However, most patients might have atypical leg symptoms or no symptoms at all (**McDermott et al 2001, Norgren et al 2007, Kim et al 2012).** Effective treatments are available for PAD including antiplatelet drugs, statins, and angiotensin converting enzyme inhibitors. These medications guard against any associated adverse cardiovascular events **(Gornik and Creager 2006, Gerhard-Herman et al 2017 and Rodway et al 2023).** Diagnosis of PAD early allows early interventions to prevent functional decline of the lower extremities and to properly manage any associated cardiovascular risk factors**.** Many tests are used for screening and diagnosis of PAD including ankle–brachial index (ABI), skin temperature, pulse waves, blood flow at rest and maximal blood flow in response to hyperaemia **(Wilkinson et al 2002).** However, among all these tests ABI is the preferred and commonly used initial screening test for diagnosis of PAD and grading of arterial obstruction of the lower extremity **(Frank et al 2019 and Rodway et al 2023)**. It is simple, noninvasive clinical test **(Gerhard-Herman et al 2017, Li et al. 2020)**. It has a high specificity and sensitivity with good acceptability by patients **(Aboyans et al 2012, Thurston and Dawson 2019, Ichihashi et al 2020).** It helps in the follow-up of management of lower extremity arterial disease **(Caceres-Farfan et al 2021 and McClary and Massey 2021)**, and commonly done to identify people at risk of amputation **(Jelinek and Austin 2006).** It may be done by various health professionals, from general practitioners to vascular specialists **(Al-Qaisi et al 2009, Haigh et al 2013).** It is performed by using a hand-held Doppler device to measure the blood pressure in both upper and lower limbs then divide the systolic pressure in the leg by that in the arm **(Kim et al 2012)**. However, it is an operator dependent test so the

experience and skills of the clinician may affect its reliability **(Nicolai et al 2009, Georgakarakos et al 2013).** Also, the type of equipment used and cuff size may result in different ABI measurements which may be affected by gender of the patient, its age and daily stresses and if the patient is diabetic or has abnormal blood pressure **(Carser 2001, Anderson 2002).**

3. Methods of ABI determination

Various devices are used to measure ankle and brachial blood pressures. These devices include Doppler ultrasound, stethoscope, or photoplethys-mography probe and/or the automated oscillometric devices. **Vowden and Vowden (2005), McClary and Massey (2021), Caceres-Farfan et al (2021)** reported that Doppler ultrasound is the preferred device in measuring ABI**.** The authors stated that the systolic blood pressure of the brachial artery at the right and left arms and that of the dorsalis pedis artery or tibialis posterior artery at the right and left ankles is measured by using Doppler ultrasound. Then the ankle reading is divided by the brachial reading to obtain the ABI measurements. However, **Rosenbaum et al (2012), Span et al (2016)** proposed that the automated oscillometric devices had better reliability than Doppler device. On the other hand, **Aboyans et al (2008), Chesbro et al (2011)** reported that in ABI measurements, Doppler evaluation was more reliable than the use of pulse palpation or stethoscope**. Caceres-Farfan et al (2021)** suggested that the brachial pressure is used as a substitute for central aortic pressure, which is not readily accessible. The brachial pressure is generally accurate unless there is an occlusive disease of the vessels supplying the upper limb**.** Regarding calculating ABI measurements, it is calculated by dividing the higher of the systolic arterial pressures at the ankle by the higher of the systolic pressure at the brachial **(Criqui et al 1992, Weitz et al 1996, Diehm et al 2004 and Vowden and Vowden 2005)**. However, **McDermott et al (2002**) proposed that dividing the lower of the two-ankle systolic arterial pressures by the lower of the two brachial pressures in obtaining ABI measurements is preferable than using the higher of the two pressures. Meanwhile, **Vogt et al (1993), Murabito et al (2003)** stated that in some epidemiological studies measurements of ABI are performed by dividing the average of the two ankle systolic pressures by that of the two brachial pressures. However, **Casey et al. (2020)** stated that for assessment of the lower limb vascular status using multiple methods is preferable than using ABI alone to avoid the error in its obtained measurement**.** ABI measurements should be considered together with other

assessment methods of lower limb vascular status rather than in isolation to form a more complete clinical diagnosis**.**

Moreover, there is lack of standardization regarding the method of ABI measuring and the cutoff point for its abnormal values (**Khan et al. 2008)**

Preparatory steps prior to performing ABI measurements must be fulfilled. The patients or participants had to rest for 5–15 min before doing the test **(Chesbro et al 2011**, **Alvaro-Afonso et al 2018).** They should prevent exercise before the measurement as exercises are likely to produce error in the obtained measurement and affect the test-retest reliability **(Chuter and Casey 2013).** Consuming alcohol, caffeine or tobacco should be abolished two hours before measuring the ABI (**Waring et al 2003, Pilli et al 2012).**

4. Interpretations of ABI results

The average normal of ABI values is 0.9 to 1.4 for adults. Values lower than 0.9 are suggestive of arterial stenosis. Values lower than 0.5 are associated with critical ischemia (**Kim et al 2012, Conte et al 2019 and Maruhashi et al 2020).** ABI values less than or equal to 0.5 are mostly associated with impaired walking abilities and lower extremity pain; even, at rest. Further decreases in ABI values in patients with PAD are associated with decreases in walking endurance **(McDermott et al 2002)**.

5. Benefits of routine ABI measuring

ABI is a strong predictor of atherosclerosis and cardiovascular diseases**.** Its repeated measuring helps to monitor and follow-up the efficacy of revascularization procedures of lower extremities (**Khan et al. 2008, Frank et at 2019, Caceres-Farfan et al 2021). Hiatt (2001)** suggested to perform ABI for any patient with peripheral artery disease and for those at risk including elderly, smokers, diabetics even if they are asymptomatic**.**

ABI measurements become increasingly important in the primary health care**.** However, its applications are still limited **(Caceres-Farfan et al 2021, Rodway et al 2023)**

6. ABI measuring in type2 diabetic patients:

Peripheral artery disease (PAD) of the lower limb is one of the common complications of type 2 diabetes. Also PAD has a more aggressive presentation in diabetic patients and atherosclerotic plaques tend to have a more diffuse distribution in those patients **(Aboyans et al. 2018, Gerhard-Herman et al. 2017, Li et al. 2020).** PAD in diabetes is shown to be

associated with higher mortality **(Li et al. 2020).** So early routine ABI screening for all diabetic patients should be performed as diabetic patients were at significantly higher risk of cardiovascular morbidity and mortality even with borderline ABI measurements. It should be measured in diabetic patients particularly if peripheral diabetic neuropathy is suspected or if they are diagnosed for diabetes for longer than 10 years, **(Natsuaki et al 2014, Chevtchouk et al 2017).**

However, in diabetic patients' measurements of the brachial blood pressure is less reliable **(Chuter and Casey 2013, Sonter et al 2015)**.

Diabetes mellitus leads to atherosclerotic changes and calcification in the walls of the peripheral arteries with consequent false ABI values. Hence, the diagnostic sensitivity of ABI among diabetic patients is low and caution should be taken when interpreting ABI results among diabetic patients (**Abouhamda et al 2019)**.

7. Conclusion:

Peripheral artery disease (PAD) of lower extremity is common and wide spread among elderly persons and diabetic patients. It is an indicator for hidden cardiovascular diseases. Ankle-brachial blood pressure index is an easy, simple, non-invasive test that allows early detection of PAD for early interventions to prevent deterioration of lower limb vascular status and to proper manage any cardiovascular associated conditions. It is preferable to perform this test routinely and regularly in diabetic patients and elderly adults even if they have no symptoms concerning decrease of blood supply to the lower extremity.

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