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Ankle Brachial Index (ABI) in the Management of Chronic Ulcers of Lower Limb: A Novel Non-Invasive Screening Tool

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ABSTRACT

Background: Chronic leg ulcers (CLU) are very difficult to heal. Along with history and clinical examination, the ankle brachial index (ABI) is a simple, non-invasive tool used to screen peripheral arterial disease (PAD).

Objective: This study sought to evaluate the association between abnormal ABI and clinical outcomes in patients with lower limb ulcers.

Material and methods: A thorough review of the available medical literature was undertaken, exploring the full range of investigations available to screen the peripheral arterial disease. This article reviews the procedure for measuring ankle brachial pressure indices using Doppler.

Results and conclusion: ABI is a safe, non-invasive, relatively cheaper and reliable method of screening of PAD. All patients with an ABI of less than 0.8 should be referred for specialist assessment to avoid future complications.

Keywords: Chronic leg ulcers (CLU), Ankle brachial index (ABI), Peripheral arterial disease (PAD)

INTRODUCTION

Lower-extremity ulceration does not only affect the patient directly but also has a great impact on the economy of the country since significant healthcare resources are spent to treat, prevent or decrease the progression of the disease. It decreases the productivity by debilitating the person [1-3].

Foot ulcers are especially common in people who have one or more of the following health problems:

Circulatory problems: Venous/arterial (PAD)

Risk factors for PAD: Age>70 years; Age>50 years if atherosclerosis risk (Smoking, Diabetes, Hypertension, Dyslipidemia).

Peripheral neuropathy: Diabetes is the most common cause in middle aged and elderly. Abnormalities in the bones or muscles of the feet [4-7]

Abnormalities in the bones or muscles of the feet [4-7]

Clinical examination of the lower extremities must be combined with noninvasive or invasive assessment of the circulation to solidify the clinical impression [8,9].

The ankle-brachial index (ABI) is a simple, noninvasive tool used to screen for peripheral arterial disease (PAD), a vascular condition associated with significant morbidity and mortality. Despite its prevalence and cardiovascular risk implications, only 25% of PAD patients are undergoing treatment. As only about 10% of patients with PAD present with classic claudication — 40% of patients are asymptomatic — clinicians need to have a high level of suspicion for this disease in their adult patient population [9]. According to American Heart Association (AHA) guidelines, an ABI should be conducted on patients presenting with risk factors for PAD so that therapeutic interventions known to diminish their increased risk of myocardial infarction (MI), stroke and death may be offered at the right time [8-12].

Major international medical societies recommend calculating the ABI by dividing the highest pressure in the leg by the highest pressure in the arm. PAD severity in each leg is assessed according to the levels of ABI [13-18]:

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0.91-1.30: normal;

0.70-0.90: mild occlusion;

0.40-0.69: moderate occlusion;

<0.40: severe occlusion; and

>1.30: poorly compressible vessels.

Mostly this occlusion is due to atheromatous plaques/thrombus in the lumen, until this obstruction is managed the ulcer would not heal.

The American Diabetes Association recommends measuring ABI in all diabetic patients older than 50 years or in any patient suffering from PAD symptoms or having other CV risk factors [8,9].

OBJECTIVES

The present study was undertaken:

- To study the clinical profile of patients of lower leg and foot ulcers
- To establish the role of ABI in prediction of vascular insufficiency

MATERIALS AND METHODS

An extensive review of the available medical literature was undertaken, exploring the full range of investigations to screen the peripheral arterial disease. The keywords Chronic leg ulcers (CLU), chronic wounds, Ankle brachial index (ABI), Peripheral arterial disease (PAD) were used as search strings, and secondary references found via bibliographic links were also retrieved. Non-English language papers were excluded from the review. A total of 35 articles reporting on technique of ABI, its availability, feasibility ,showing association between abnormal ABI and clinical outcomes in patients with lower limb ulcers were found—all were included in the review.

ABI CALCULATION

Tools needed for measuring ABI:

- Sphygmomanometer with appropriately sized cuff(s) for both arm and ankle
- Handheld Doppler device with vascular probe
- Conductivity gel compatible with the Doppler device
- Software package for recording of velocity/time waveforms of arteries.

Each ankle systolic pressure is divided by the brachial systolic pressure [16,17].

ABI Key: Abnormal: <0.9 or >1.3

REVIEW OF LITERATURE

Chronic ulceration of the lower limbs is a relatively common condition amongst adults. Chronic leg ulcers are usually associated with significant morbidity, high cost of healthcare, loss of productivity and reduced quality of life.

Peripheral artery disease is a serious health condition that increases an individual's risk for heart attack, stroke, and leg amputation. While PAD is highly prevalent in primary care settings and is easily detected with the ABI during a routine OPD visit, the procedure is underutilized. ABI is a low cost and effective screening technique for identifying PAD in patients with cardiovascular risk factors. It should be adopted into primary care and specialty care settings. Furthermore, newly identified PAD patients could be targeted for prevention measures such as treatment with antiplatelet drugs, ACE inhibitors, and statins, decreasing their overall risk of cardiovascular events while increasing functionality and quality of life. With the combined high risk that PAD represents and the availability of effective treatment, systematic use of screening using the ABI to identify patients with asymptomatic PAD is warranted in patients with cardiovascular risk, and is critical to reduce overall morbidity and mortality. Peripheral artery disease (PAD) is characterized by symptoms of intermittent claudication or critical limb ischemia [19-32].

As per literature available these are the factors that increase risk of developing peripheral artery disease

- Smoking
- Diabetes
- High blood pressure
- Increasing age, especially after 50 years of age
- A family history of peripheral artery disease, heart disease or stroke [28-33].

The Ankle Brachial Pressure Index (ABPI/ABI) using a hand held Doppler ultrasound and sphygmomanometer can be carried out for more accurate assessment of arterial perfusion. The results are used to determine the likelihood of arterial insufficiency and can be used to guide the management plan. The ABI is an accurate and reliable test of PAD. The sensitivity, specificity and accuracy of the ABI as a PAD diagnostic tool are well documented. Lijmer et al. [28] demonstrated a sensitivity of 79% and specificity of 96%.

An abnormal ABI may be an independent predictor of mortality, as it reflects the burden of atherosclerosis. A low ABI is not only diagnostic of PAD, but is also an effective biomarker or measure of more systemic atherosclerotic disease. Majority agree that a normal ABI is >0.9. An ABI <0.9 suggests significant narrowing of one or more blood vessels in the leg. The majority of patients with claudication have ABIs ranging from 0.3 to 0.9. Rest pain or severe

occlusive disease typically occurs with an ABI<0.5. ABIs<0.2 are associated with ischemic or gangrenous extremities. Conditions such as diabetes mellitus or end stage-renal disease can give falsely elevated ABIs (1.3-1.5). The ABI test approaches 95% accuracy in detecting PAD. However, a normal ABI value does not absolutely rule out the possibility of PAD. Some patients with normal or near-normal ABI results may have symptoms suggesting PAD. If the resting ABI is normal, an exercise ABI can be conducted [9,16,18].

The evidence from the medical literature indicates that a "normal" ABPI is 0.92 or greater, a ratio below this indicating arterial disease. Cornwall et al. [24] suggested the use of Doppler ABPI measurement in the assessment of patients with leg ulceration. These suggestions were supported by Kulozik et al. [10] from Oxford.

Cornwall et al. [24] considered that an ulcer occurring in a limb with an ABPI of less than 0.9 should be considered ischaemic and that a pressure index below 0.75 had a significant impact on clinical management. This paper was the first reference linking ABPI to compression therapy.

Callam et al. [5] reported on the incidence of skin necrosis and amputation due to compression and recognized both the concept of "mixed" ulceration, i.e., venous ulceration in a limb with arterial disease, and the need for reducing the compression levels in patients with an ABPI of 0.7 or less.

According to the study conducted by O'Brien et al. [19] in Ireland the prevalence of chronic leg ulcers was 0.12% but it was 1.03% in the patients aged 70 years and over. Women were twice as likely to be affected. Venous disease accounted for 81% of ulcers and arterial disease for 16.3%, while ulceration due to diabetic neuropathy and rheumatoid vasculitis was unusual. Leg ulcers are an important source of morbidity in the ageing population. While there are few Indian studies on the epidemiology of chronic wounds, Shukla et al. [34] estimated the prevalence at 4.5 per 1000 population. The incidence of acute wounds was more than double at 10.5 per 1000 population.

Vowden [17] performed a study on Doppler assessment and ABPI. Interpretation in the management of leg ulceration and concluded that Doppler ABPI remains one of the cornerstones of the assessment process. This study aimed at reducing bandage pressure damage, but it is only one element in the overall assessment of the patient and must not be used in isolation. An ankle brachial pressure Grail of leg ulcer index (ABPI) of 0.8 is seen by some as a definitive decision-making number and it has almost become the 'Holy assessment'.

Norman et al. [33] concluded that the ankle-brachial pressure index (ABPI) is a simple, non-invasive bedside tool for diagnosing PAD - an ABPI less than 0.9 is considered diagnostic of PAD. About half of patients with PAD (defined by an abnormal ABPI) have symptomatic coronary or cerebral vascular disease. The ABPI is an independent predictor of coronary and cerebrovascular morbidity and mortality.

Silvestro et al. [35] conducted a study in chronic limb ischemia patients and found that falsely high ABI is an independent predictor of major amputation in patients with chronic critical limb ischemia (CLI). They studied 229 patients (74+11 years, 136 males, 244 limbs with CLI) were followed for 262+136 days. Incompressibility of lower limb arteries (ABI>1.3) was found in 45 patients and was associated with diabetes mellitus (p=0.01) and renal insufficiency (p=0.035). Limbs with incompressible ankle arteries had a higher rate of major amputation (p=0.002 by log-rank). This study showed that falsely high ankle-brachial index (ABI) values are associated with an adverse clinical outcome in diabetes mellitus [35].

Hopf et al. [27] formulated guidelines (minimum standards) for the treatment of arterial insufficiency ulcers of the lower extremities.

An advisory panel of academicians, private practice physicians, nurse clinicians, and research nurses was chosen to develop guidelines (minimum standards) for the treatment of arterial insufficiency ulcers of the lower extremities.

Previous guidelines, meta-analyses, PubMed, MEDLINE, EMBASE, The Cochrane Database of Systematic Reviews, recent review articles of arterial ulcer treatment, and the Medicare/CMS consensus of usual treatment of chronic wounds were all searched and reviewed for evidence. Guidelines were formulated, the underlying principle(s) enumerated and evidence references listed and coded.

- Guidelines have been formulated in seven categories for the treatment of arterial ulcers of the lower extremities.

The categories are:

Diagnosis, Surgery, Infection control, Wound bed preparation, Dressings, Adjuvant therapy (device, systemic, local/topical), Long-term maintenance.

Spentzouris et al. [26] performed a study on evaluation of lower limb ulcers and concluded that the ulcers have different characteristics, which may be differentiated by the history and clinical examination of the patients. However, objective documentation for the ulcer etiology is necessary prior to instigating treatment. The methods for diagnosing the causes for the ulcers include- plethysmography, ultrasound, angiography, computed tomography, magnetic resonance imaging and skin biopsy. All these tests should be used in conjunction with the clinical presentation of the patient. They should be performed in a cost-effective manner to avoid delays in diagnosis and reduce costs and usage of resources.

Potier et al. [8] conducted a study on Use and Utility of Ankle Brachial Index in Patients with Diabetes. Ankle brachial index (ABI) is a simple method to screen peripheral arterial disease (PAD) and to evaluate cardiovascular (CV) prognosis in the general population. Measuring it requires a hand-held Doppler probe but it can be done also with an automatic device. ABI is an effective tool for clinical practice or clinical studies. However, in diabetic patients, it has some specific caveats. **Sensitivity of the standard threshold of 0.9 appears to be lower in diabetic patients with complications**. Moreover, highly frequent arterial medial calcifications in diabetes increase ABI. It has been demonstrated that measurements >1.3 are well correlated with both an increased prevalence of PAD and CV risk. Therefore, **ABI thresholds of less than 0.9 and more than 1.3 are highly suspicious for PAD and high CV risk in diabetic patients**. However, when there is concomitant clinical peripheral neuropathy or high risk of arterial calcification, the efficiency of ABI seems to be limited. In this case, other methods should be applied, toe pressure, in particular. Thus, the ABI could be used in patients with diabetes, but values should be interpreted with precision, according to the clinical situation. This study concluded that highly frequent arterial medial calcifications in diabetes increase ABI. Measurements >1.3 are well correlated with both an increased prevalence of PAD and cardiovascular risk [8].

Agale [6] reviewed the literature and discussed the Aetiopathogenesis and Management of chronic leg ulcers. Chronic leg ulcer is defined as a defect in the skin below the level of knee persisting for more than six weeks and shows no tendency to heal after three or more months. Chronic ulceration of the lower legs is a relatively common condition amongst adults, one that causes pain and social distress. The condition affects 1% of the adult population and 3.6% of people older than 65 years. Leg ulcers are debilitating and greatly reduce patients' quality of life. The common causes are venous disease, arterial disease and neuropathy. A correct diagnosis is essential to avoid inappropriate treatment that may cause deterioration of the wound, delay wound healing, or harm the patient. The researchers are inventing newer modalities of treatments for patients with chronic leg ulceration, so that they can have better quality life and reduction in personal financial burden [6].

DISCUSSION

Comprehensive history and examination help to identify the cause of chronic leg ulcers. PAD is one of the causes of CLU and it can be easily identified by screening the patients for ABI. All patients with abnormal ABI values should be thoroughly investigated by experts to avoid further complications. ABI is a non-invasive and relatively cheaper investigation which can suggest the severity of the PAD. Patients with abnormal ABI values can undergo further specific radiological investigations like CT Angiogram and MR Angiogram.

In developing countries like ours, affordability is a major limiting factor in healthcare, so with the use of ABI as a screening tool only screened individuals have to undergo the relatively costlier and specific investigations.

CONCLUSION

ABI value less than 0.9 was associated with poor wound healing and more history of recurrence. ABI is a safe and reliable method of monitoring peripheral arterial disease. With the help of ABI, we were able to diagnose vascular insufficiency (PAD) and we managed the patients accordingly. Compression therapy was used in the management of venous ulcers and it was used cautiously in cases of ABI value less than 0.8 to avoid vascular insufficiency. All patients with an ABI of less than 0.8 should be referred for specialist assessment. In those patients for whom high compression bandaging is contraindicated, reduced compression may be appropriate in selected cases with further arterial investigations if the ulcer fails to respond to treatment.

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