

# ANKLE BRACHIAL PRESSURE INDEX, VALUE AND LIMITATIONS CONSIDERATIONS ABOUT ITS APPLICABILITY FOR DIABETIC INDIVIDUALS

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## **Abstract**

*Non-invasive ultrasound investigations are frequently used as a screening maneuver for peripheral vascular disease. The ankle to brachial pressure index (ABPI) it is a noninvasive hand-held Doppler test that is able to perform a peripheral vascular interrogation. It is thought to be reasonable accurate for the diagnosis of hemodynamical significant arterial disease, meaning that the advanced wall injuries are already set. When performing the ABPI investigation the lack of methodological standardization is challenging even in the nondiabetic population. In this review we highlight the ankle to brachial pressure index (ABPI) effectiveness and limitations comparing non-diabetic versus diabetic patients with peripheral arterial disease, trying a (re)consideration of its diagnostic accuracy. Almost 60% of peripheral arterial diseased patients are free of symptoms, probably because of collaterals network. The vascular disease is particularly high among diabetic individuals and suggests that multiple arterial beds are simultaneously affected. As we know, there is a general consensus about regular vascular assessment in diabetic population. The ABPI as a screening tool for lower limb arterial disease is less sensitive in diabetic individuals, mainly when neuropathy and vascular calcification exist. ABPI interrogation should therefore always be cautiously considered. Hand held Doppler assessment and ABPI results should be integrated in the clinical context of the patients. Either clinically symptomatic or silent (because of collaterals efficiency and neuropathy), lower limb arterial disease needs to be further and detailed interrogated. Color duplex investigation (CDI) seems to be a highly sensitive and accurate method of assessing arterial vasculopathy mainly in diabetics.*

**key words:** *peripheral arterial disease, hand-held Doppler, ankle brachial systolic pressure index (ABPI), diabetic population, color duplex investigation.*

## **Introduction**

Normally, systolic pressures of the lower limbs are with 10 - 20mmHg higher than those which are expressed by the central one (aortic or in our case the brachial ones). Measurements of bilateral brachial systolic pressure must be a rule for avoiding a

proximal subclavian artery stenosis. The highest value between comparable brachial values (no more than 15mmHg differences is accepted) and the highest value of the distal arteries, will be taken into consideration for assessing the ankle to brachial index pressure (ABPI). Normally, index pressure is >1.0.

Beyond to a significant arterial stenosis, meaning that more than 50% of vascular lumen is compromised, and according to the known Bernoulli's effect, the pressure will decrease. The hydrostatic pressure artifact has to be avoided by the patient's supine position. An appropriate width of cuffs is another specific condition for an accurate investigation. The majority considers that normal values are between 0.91-1.30. A mild arterial disease could be expressed by 0.9-0.7. A more severe peripheral artery disease is pointed out by 0.69-0.41. Below 0.4 it seems to be a general agreement upon clinical resting pain and critical ischemia [1]. Depending on the individual training, levels of pain tolerance or neuropathic comorbidities, intermittent claudication might be clinical between 0.2-1.0. Some authors are still debating upon normal values considering them between 0.98 (1.0)-1.30. The difference between the largely accepted values formerly presented and the lately ones, could be explained by the lack of consensus on the standardization of technique and methodology [2].

#### **Limitations emerging from methodology**

During inspiration about 3% of systolic pressure is falling. Both brachial systolic pressure and ankle arterial systolic pressure readings could be obtained during inspiration or expiration phase. The speed of inflation/deflation maneuvers or highly irregular pulse can also modify the final results [2].

The limitation given by a low flow rate (central systolic pressure <100mmHg), could be translated to an unrecordable Doppler signal. On the contrary, a systolic pressure >180mmHg will falsely rise poststenoses

values. Normal or near normal brachial systolic values are then required [3].

A physical comfort such as temperature (avoiding peripheral vasoconstriction) or the resting time needed before (as long as the number of stenoses are higher) could influence as well the interrogation [3, 4, 5].

We can observe, and researchers on this field take over that, there is no sharp delineation between different stages of arteriopathy on the basis of these overlap values [4, 5].

Even if all of these technical and methodological conditions would support a standardization the results will need thereafter to be cautiously interpreted [2, 6].

#### **Diagnostic effectiveness**

ABPI below the lowest normal value, express a significant stenosis of an axial lower limb artery. A significant stenosis means that more or at least 50% of the entire arterial lumen is affected.

#### **ABPI limitations and sources of errors**

ABPI can't discriminate between stenoses and occlusion because both of these situations are falling arterial pressure distally and there is no visualization of vasculature.

ABPI also makes no difference between the aortoiliac lesion distally followed by other stenoses. This means that the level, length, and number of lesions cannot be discriminated [3].

Level of the cuff reflects the level of pressure, so, distally no lesion could be interrogated. Distal infrapopliteal arteries severe stenoses or occlusions remain undetected.

When the large collaterals naturally bypass an occlusive lesion, the hand held

Doppler signal could be recordable alleviating the underlying mechanism and the severity of the disease itself [3, 7]. This is the case of lower limbs arteries stenoses with palpable peripheral pulse and even with an ABPI around 1.0. Almost 60% of arterial diseased patients are asymptomatic probably because of collaterals efficacy [8].

Some groups of patients such as: diabetics, renal diseased patients, advanced age individuals or those with connective tissue disorders are developing extensive vascular calcification (intimal calcification and medial sclerosis that could also be simultaneously) [5, 8].

Many of these patients even with maximum cuff inflation pressure, which is hardly bearable, have still incompressible arteries. So, hand held Doppler devices are useless for diagnosing [2, 9]. The waveform analysis is offered by using some new generations of hand held Doppler devices. A monophasic wave, generally distal to a significant stenosis, could also be hyperemic as a result of exercising. Vasodilators or a severe lower leg infection could also induce a monophasic Doppler signal. The advanced neuropathy can deal with a peripheral monophasic waveform too [3, 5, 10, 11].

#### **Could diabetics add to ABPI investigation some specific limitations?**

Diabetic patients, renal diseased and hemodialysed are frequently affected by vascular calcification. Either intimal layer, medial one (mediasclerosis) or frequently both, switch the ABPI to a non-diagnostic investigation. Incompressibility of calcified peripheral artery, even with a maximum cuff inflation pressure, could exceed ABPI normal

values much more than 1.30-1.50. Also some abnormal lower of ABPI values, could artificially rise within normal range. This means that ABPI is less sensitive in detecting peripheral arteriopathy in diabetics with neuropathy and vascular calcifications [1, 5, 8, 9].

Almost 30% of diabetic patients are supposed to share these conditions.

Only the visualization of the vascular wall can offer images about wall calcification or plaques (that can also be calcified). Therefore patients with even higher than normal ABPI values have to be specified to the gold standard color duplex investigation (CDI) [3, 5, 7].

Diabetic patients also accumulate other vascular risk factors. Many of these patients have multilevel lower limb arterial disease, showing from preclinical lesions (intima-media thickness, plaques, or mild stenoses), to clinically significant hemodynamic lesions. Only one significant stenosis or occlusion (with no discrimination in-between) and only one affected arterial level could be diagnosed by using ABPI. The tandem iliofemoral/popliteal or infrapopliteal levels cannot be diagnosed [1, 3, 7, 12, 14].

Non-smoking diabetic patients have a tendency to develop tibioperoneal distal arterial disease [13].

Whenever the distal segments are affected, the ABPI can provide no diagnosis. Below cuff, the distal infrapopliteal trunk and dorsalis pedis artery cannot be ABPI interrogated.

Smoking diabetics often have iliofemoral disease, level that is also beyond the ABPI accuracy.

As noted, people with diabetes could be subjects of other vascular risk factors, including hypertension, hyperlipoproteinemia or smoking.

This means that the aortoiliac, femuropopliteal and infrapopliteal trunks can simultaneously be affected [3, 12, 15, 16]. There is a tremendous need for offering more accurate answers with respect of diabetics' vascular disease and to grade it. There is an agreement upon further CDI below 0, 9 or over 1.30 ABPI values. The practitioners always keep in their mind that ABPI interrogation does not allow a sharp delineation between different degrees of arterial disease severity and could underestimate arterial lesions [2, 5, 14, 17, 18]. Even within the normal range (ABPI values of 0.91-1.30), the prevalence of peripheral arterial disease for diabetics at a high risk exceeds 55% [5].

Collaterals naturally bypassing arterial severe lesions offer distal pulsation and a recordable hand held Doppler signal, masking the underground disease [7, 19]. No accurate diagnosis can be made unless other imaging techniques will be used. For both revascularization procedures and conservative management a color duplex assessment, previously performed, is necessary.

The diabetic severe neuropathy can mask arterial disease by altering Doppler waveform or making recordable the weak pulsation of the poststenotic lesions. The difference between a neuropathic and a poststenotic monophasic waveform is offered by the waveform detailed analysis. A further CDI of the entire vessel is of great value. [5, 10]. The severe neuropathy can also suppress the exercise induced hyperemia [5].

Exercise testing is sometimes performed to unmask a significant arterial lesion. Some authors find it questionable and sometimes impractical since more than 15% of patients have exercise limiting comorbidities [2,3,19].

Technically speaking, peripheral edema, distal infections, intolerance of the maximum cuff inflation (claimed by wall calcifications) are more common in diabetics, being potential factors failing ABPI assessment.

Different vascular beds could be affected in diabetic patients at various degrees. Either clinically dominant and asking for medical assistance, or clinically silent, further and detailed investigations are needed [15,20,21,25].

#### **Unanswered ABPI questions and CDI effectiveness**

The risk for vascular disease is considerable high among diabetic population especially when other risk factors accumulate. A complex view of peripheral arterial status using CDI is mandatory [14,15,19,26].

The wall aspect, plaques, levels, length and, hemodynamic significance of stenotic/occlusion lesions, the waveform analysis, the quality of the in-flow, and of the distal run-off, need for revascularization or conservative maneuvers can be assessed [5, 7, 17, 19].

The sensitivity of ABPI falls to 53% in the presence of neuropathy. In the advanced vascular diseased diabetic population an ABPI <0.9 had only 54.4% versus 72.6% sensitivity in nondiabetics when CDI was the gold standard [27, 28].

The CDI monitoring of the progressive arterial disease in both pre and postoperative patients should be a rule. ABPI has a

sensitivity of 41% and a specificity of 84% in detecting arterial progression changes, compared to CDI and angiography [2, 7, 19].

### Conclusions

Vascular disease prevention is a common desire. In diabetic population, peripheral arterial disease it is more prevalent. Frequently asymptomatic because of a large collateral network or neuropathy, with distal infrapopliteal arteries involvement, and vascular calcifications, diabetic patients can be underdiagnosed by ABPI. At any degree of

vascular disease, CDI has been proven to be a highly accurate test of assessing and monitoring the lower limbs arterial disease [7, 17, 23, 24]. Once the diagnosis of peripheral arterial disease has been established it should be readily classified and set in the context of the patient's vascular disease.

As a consequence, color duplex ultrasound is used more and more frequently as first line assessment for peripheral vascular disease.

Conflict of interest: no conflict of interest.

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