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Diabetes & its Complications

The Value of Ankle-Brachial Index (ABI) Measurement in Hypertensive Diabetic Patients: A Case Report and Literature Review

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ABSTRACT

Introduction: *The ankle-brachial index (ABI) is a simple, non-invasive, and reproducible tool for screening for peripheral artery disease (PAD). In hypertensive diabetic patients, cardiovascular risk is increased, and arterial disease is often asymptomatic.*

Observation: *We report the case of a 69-year-old woman, followed for type 2 diabetes mellitus and hypertension, in whom systematic ABI measurement led to the diagnosis of subclinical PAD, prompting a reassessment of overall cardiovascular risk and intensified treatment. The ABI has major diagnostic and prognostic value in hypertensive diabetic patients. Its predictive value for cardiovascular events is demonstrated, independent of other risk factors.*

Conclusion: *Systematic ABI measurement should be integrated into the cardiovascular assessment of hypertensive diabetic patients to optimize secondary and enhanced primary prevention.*

Keywords: *Systolic blood pressure index, Peripheral arterial disease, Cardiovascular risk, Internal Medicine.*

Introduction

Peripheral Arterial Disease (PAD), as defined by the French National Authority for Health (HAS) in 2006, is a narrowing of the arteries supplying the lower limbs, leading to a loss of hemodynamic pressure, with or without clinical manifestations. The best indicator of PAD is a drop in the ankle-brachial index (ABI) below 0.9 [1]. It results from the development of atherosclerotic lesions that progressively obstruct the lumen of the arteries and create a barrier to distal blood flow to the lower limbs [1]. It is a serious complication of diabetes and the leading risk factor for major amputation.

It is a common manifestation of atherosclerosis in the elderly, diabetics, and patients with multiple cardiovascular risk factors [2]. The prevalence of PAD is significantly higher in diabetic and hypertensive patients. The development of PAD begins with an asymptomatic phase, followed by preferential distal arterial involvement, with a risk of progression to ulceration, gangrene, and then limb amputation [2]. In most cases, PAD can be detected through patient history and physical examination, including measurement of the ankle-brachial index.

It is now accepted that the presence of peripheral artery disease (PAD) is associated with an increased risk of cardiovascular morbidity and mortality, making early detection of PAD of paramount importance. Measurement of the ankle-brachial index (ABI) using continuous-wave Doppler is a relatively simple, inexpensive, and non-invasive method that allows for the early detection of PAD and the prediction of cardiovascular risk [2,3]. It is recommended by several learned societies, namely the European Society of Cardiology and the American Heart Association (AHA), and is defined as the ratio of systolic blood pressure measured at the ankle to that measured at the upper arm [3]. An ABI < 0.90 is diagnostic of PAD [4].

Early diagnosis allows for the identification of asymptomatic individuals with other cardiovascular conditions and the implementation of appropriate measures for the prevention of cardiovascular morbidity and mortality [4]. We report a clinical case of asymptomatic PAD in a hypertensive diabetic patient, illustrating the value of ABI measurement in cardiovascular risk stratification.

Observation

We report the case of a 69-year-old woman, followed for type 2 diabetes mellitus for 12 years on a regular regimen of vidalgliptin 50 mg + metformin 1000 mg, one tablet daily at midday with a meal, and Mixtard 30 mg: 20 units subcutaneously in the morning and 16 units subcutaneously in the evening; hypertension for 15 years on a regular regimen of perindopril 10 mg + indapamide 2.5 mg, one tablet daily; mixed dyslipidemia on a regular regimen of rosuvastatin 10 mg daily.

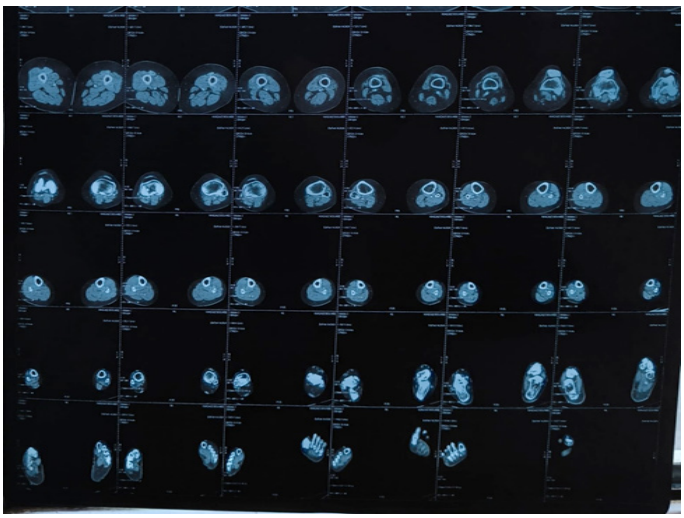
The patient reported no intermittent claudication or lower limb pain at rest. Physical examination revealed capillary blood glucose above target levels, blood pressure of 167/96 mmHg, and a BMI of 29 kg/m². Examination of the vascular axes revealed no palpable left and right posterior tibial pulses, and weak bilateral dorsalis pedis pulses without associated trophic disorders. A pathological monofilament test indicated a moderate podiatric risk (grade II).

As part of the annual cardiovascular check-up, an ankle-brachial index (ABI) was performed, revealing: Right ABI of 0.57 and Left ABI of 0.71

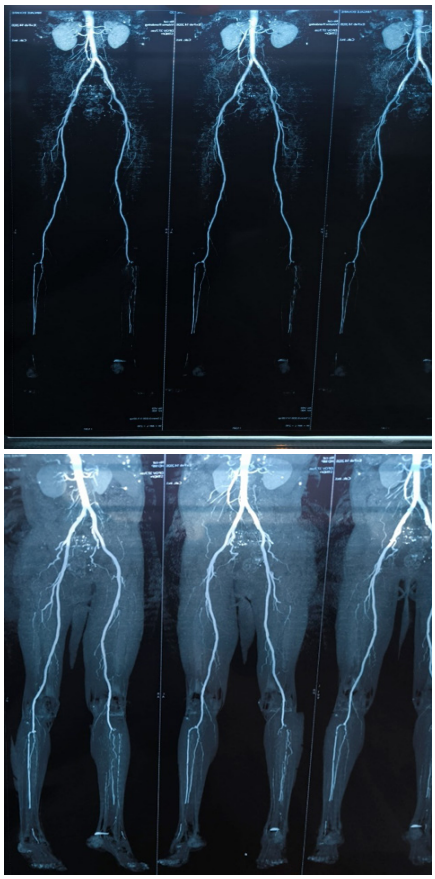
These values confirmed moderate asymptomatic peripheral arterial disease (PAD). A Doppler ultrasound of the lower limbs showed diffuse atherosclerotic lesions in the infrapopliteal region. Biochemical tests revealed abnormalities including a glycated hemoglobin level of 13.5%, total cholesterol of 3.09 g/L, LDL cholesterol of 2.36 g/L, HDL cholesterol of 0.71 g/L, and 24-hour microalbuminuria of 100.8 mg/24h.

A CT angiogram of both lower limbs (Pictures 1 and 2) revealed:

- Diffuse infiltration extending to all arteries of the lower limbs
- A bead-like stenosis of the anterior tibial and right fibular arteries in the middle and upper thirds
- Occlusion of the lower third of the anterior tibial and right fibular arteries
- Occlusion of the upper third of the right posterior tibial artery with stenosis of the middle and lower thirds
- Occlusion of the lower third of the left posterior tibial artery with stenosis of the middle and lower thirds



Picture 1: CT angiography of both lower limbs showing atherosclerotic lesions, thickening of the arterial walls and obliteration of the vascular lumen of both lower limbs.



Picture 2: CT angiography of both lower limbs showing diffuse stenoses in both lower limbs.

The therapeutic approach to this discovery was one of intensified treatment :

- Reinforced patient and family education
- Adjustment of insulin doses according to the patient's glycemic targets
- Optimization of blood pressure levels
- Increased lipid-lowering medication with a target LDL cholesterol < 0.55 g/L
- Introduction of an antiplatelet agent : Acetylsalicylic acid 100 mg daily
- Supervised physical activity program
- Angiological management was recommended

Discussion

This observation reports a case of asymptomatic peripheral artery disease (PAD) in a diabetic and hypertensive patient receiving regular care but outside of her specific therapeutic objectives. Rada, in his study, identified 32.4% of PAD cases on the ABI, of which 77.5% were asymptomatic, and among these, 19.4% had compensated PAD, as in our observation [3]. Koné, in his study, found that 52.6% of patients with arterial disease were detected at the asymptomatic stage, among whom 68.4% of patients had well-compensated PAD on the ABI [4]. This is an increasingly common situation that necessitates optimization of overall management, highlighting the importance of measuring the ankle-brachial index (ABI) and reassessing cardiovascular risk factors.

Atherosclerosis is the most common arterial disease and the leading cause of peripheral artery disease [4]. However, it is important to distinguish between atherosclerosis and arteriosclerosis, which is a disease of the muscle fibers of the arterial media, primarily associated with aging. Atherosclerosis is defined by the WHO as a variable combination of changes in the intima of large and medium-sized arteries, consisting of a focal accumulation of lipids, complex carbohydrates, blood and blood products, fibrous tissue, and calcium deposits, all accompanied by changes in the arterial media [5-8].

Two hypotheses attempt to explain the development of atherosclerotic plaque [8]:

- **The lipid theory:** This is the result of an accumulation of LDL (low-density lipoprotein) lipids related to a dysfunction in cholesterol metabolism (Figure 1).
- **The hemodynamic theory:** This corresponds to repeated microtrauma to plaques at arterial bifurcations, which lead to local or locoregional disturbances in coagulation balance. There is also an inflammatory theory and a viral theory, which are recent.

Atherosclerosis is responsible for a narrowing of the arterial caliber leading to plaque expansion, stenosis and arterial occlusion (Figure 2). It can lead to acute phenomena: cholesterol or thromboembolism, thrombosis whose clinical manifestation is tissue ischemia [8].

The first clinical classification of PAD is that of Leriche and Fontaine, proposed at the 1st Congress of the European Society of Cardiovascular Surgery in 1952. The original text was as follows [3]. “We define as:

- **Stage I:** arterial occlusions without symptoms;
- **Stage II:** exertional ischemia (during weight-bearing) manifesting in the lower limbs as pure claudication, absence of symptoms at rest;

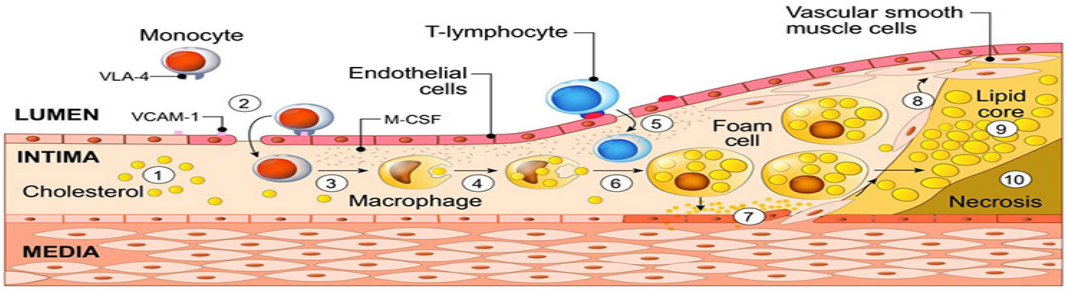


Figure 1: Schematic of atherogenesis [8].

Notes: The oxidized-LDLs induce the activation of endothelial cells and the expression of various leukocyte adhesion molecules (such as VCAM1) and consequentmonocyte adhesion to the endothelium (1,2); subsequent transmigration of monocytes into the intima, where they differentiate into macrophages (3,4); T lymphocytes joinmacrophages in the intima during plaque evolution (5); macrophages, incorporating modified lipoproteins, become lipid-rich foam cells (6); the inflammatory responsestimulates migration and replication of vascular smooth muscle cells, which accumulate in the plaque to form a fibroproliferative lesion (7,8); macrophages in the plaqueshow abnormal lipid metabolism with a reduction of the cholesterol efflux, (9) which leads to accumulation of apoptotic bodies and necrotic debris, forming a necrotic core (10).

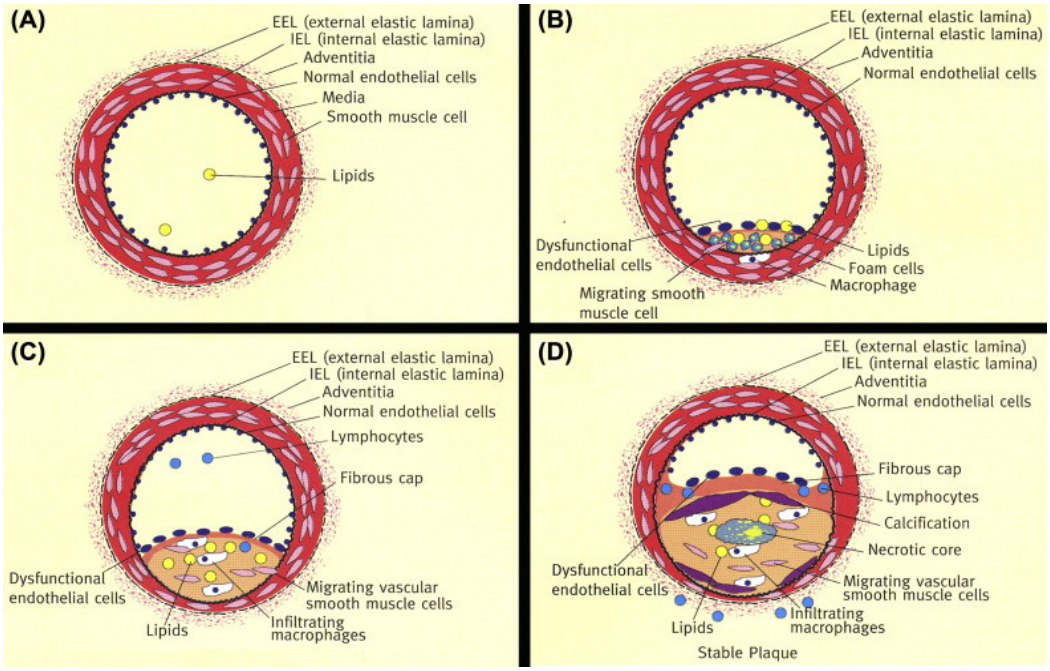


Figure 2: Pathophysiology of Atherosclerosis [5].

- **Stage III:** ischemia with complaints appearing even at rest (rest pain);
- **Stage IV:** stage of trophic ulcers and gangrene (IV.A: Limited trophic disorders, IV.B: Extensive gangrene)". This simple and pragmatic clinical classification has drawn several criticisms: it is not suitable for diabetic PAD, which often manifests from the outset as a trophic disorder, without claudication, or even without prior rest pain.

The current classification of the French National Authority for Health (HAS) presents 4 chronic forms of PAD from a hemodynamic-clinical and prognostic point of view [4], these 4 forms or stages are:

- **The subclinical stage** corresponds to peripheral artery disease (PAD) without hemodynamically significant lesions (normal Doppler signals, distal pressures, ankle-brachial index (ABI), reactive hyperemia tests, and treadmill test with post-exercise ankle pressure measurement).
- **The stage of exertional ischemia or exercise-induced ischemia (from walking)** corresponds to: PAD without clinical manifestations under the patient's usual activity conditions despite the presence of hemodynamically significant occlusive lesions (abnormal distal Doppler signals or a low ABI at rest in supine position; abnormal reactive hyperemia test or treadmill test with post-exercise ankle pressure measurement). - Peripheral arterial disease (PAD) with painful intermittent exertional claudication of varying degrees (same validation criteria)
- **The stage of permanent ischemia or threat to the viability of the affected limb** corresponds to : PAD with acral pain when lying down, relieved by the foot being elevated (validation criteria: ankle systolic pressure < 50 mmHg, loss of digital pulse, digital pressure < 30 mmHg, TcPO2 when lying down < 35 mmHg); - PAD with distal trophic disorder, minor (refractory ulcer, focal gangrene, diffuse foot ischemia) or major (extensive foot gangrene) (same validation criteria).
- **Chronic critical limb ischemia** is defined by one of the following two criteria: Ischemic pain at rest requiring analgesics, persistent or recurrent for more than 2 weeks, with ankle systolic pressure ≤ 50 mmHg (or even < 70 mmHg) and/or toe pressure ≤ 30 mmHg; Ulceration or gangrene of the toes or foot with ankle systolic pressure ≤ 50 mmHg (or even < 70 mmHg) and/or toe pressure ≤ 30 mmHg. Chronic critical limb ischemia thus appears as a more severe subgroup of the permanent ischemia stage.

Peripheral artery disease (PAD) is a marker of systemic atherosclerosis; it is associated with an increased risk of cardiovascular disease and vascular death [3]. It is a common but underestimated disease because it often remains asymptomatic for a long time, hence the importance of early screening. The frequency of PAD has increased significantly over the past fifteen years, in parallel with the aging of the population; consequently, screening for asymptomatic PAD is now a public health issue, addressed by the vast majority of developed countries [3]. One of these screening tools is the ankle-brachial index (ABI); its measurement is a simple and effective method for screening for peripheral artery disease and is also valuable in assessing cardiovascular prognosis.

The ankle-brachial index (ABI) is defined, for each lower limb, as the ratio of the systolic blood pressure (SBP) measured at the ankle to the brachial/brachial systolic pressure (ankle SBP/arm SBP) [9]. The ABI value is obtained by averaging two or three successive measurements taken on a subject lying supine and at

rest for a few minutes. The average measurement time is 8 minutes [4]. It is calculated as the smallest ratio found between the highest tibial systolic pressure and the highest brachial systolic pressure. However, the ankle-brachial index should not be considered a constant, but rather a biological variable fluctuating within a certain range [6]. The coefficient of variation for ankle pressure measurements averages 6 to 8%, regardless of the artery studied [4]. The coefficient of variation for brachial pressure measurements is approximately 5% [3].

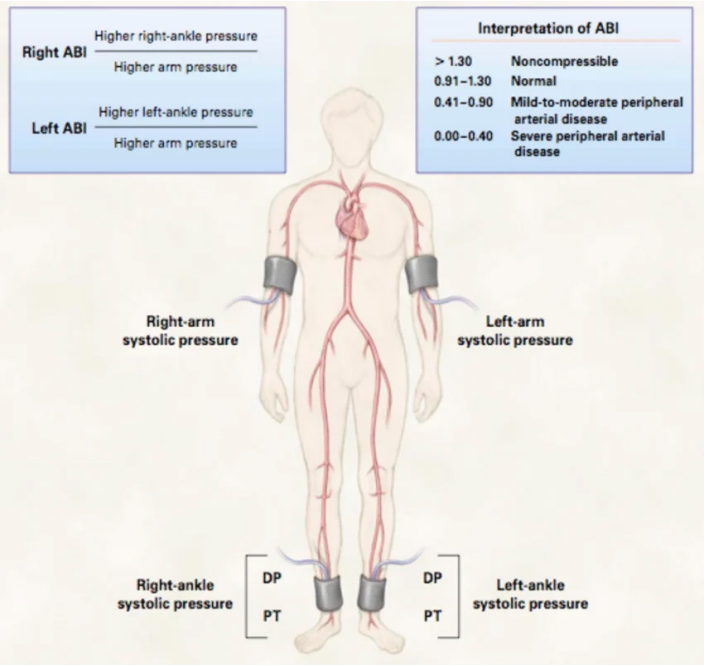


Figure 3: Method for measuring and interpreting the ABI [6].

The ankle-brachial index (ABI) is a simple, inexpensive, and reproducible test. It has a sensitivity of 79–95% and a specificity of 95–100%. The detection of asymptomatic peripheral artery disease (PAD) through a simple test like ABI measurement is an important and readily available medical procedure [3]. However, in diabetic patients, medial calcification can lead to arterial stiffness and falsely increase the ABI (>1.30). This sometimes necessitates additional measurements (digital pressure, forearm-to-toe index).

Diagnostic delay in PAD is significantly associated with a high amputation rate [3]. In a series from the city of Marrakech, 20% of amputations were secondary to untreated peripheral artery disease [3]. In the ELLIPSE study, which included 2,146 asymptomatic patients at high vascular risk hospitalized in cardiology, diabetology, geriatrics, internal medicine, and neurology departments, the prevalence of peripheral artery disease (PAD) was estimated at 41.1%. An ankle-brachial index (ABI) < 0.90 is associated with a 2- to 4-fold increased risk of major cardiovascular events and a significant increase in overall mortality [9-11]. The REACH Registry study showed that patients with PAD had a cardiovascular risk comparable to that of patients with coronary artery disease. The ABI improves risk stratification beyond the Framingham Risk Score [12].

In diabetic patients, peripheral artery disease (PAD) develops earlier and is more severe, primarily affecting the distal and deep femoral arteries. Asymptomatic forms are common, and atypical presentations (burning, paresthesia) are more frequent (neuropathy), with a high risk of amputation [4]. Skin involvement is more frequent and more severe (associated neuropathy and microangiopathy) [4]. Infections are more frequent (risk of major distal gangrene) and often asymptomatic [4]. In diabetic patients, an assessment of diabetic neuropathy should include the qualifier "life-threatening lesion" or "hemodynamically threatening lesion" [4]. The ankle-brachial index (ABI) is possibly overestimated by medial calcification [5].

Hypertension potentiates arteriosclerotic progression via increased stress, endothelial dysfunction, and vascular remodeling [1]. The 2019 ESC guidelines on peripheral arterial disease highlight the value of screening by ABI in high-risk patients, particularly diabetics over 65 years of age [1].

Non-invasive arterial testing plays an important role in cardiovascular risk assessment, based on several key considerations. Alterations in arterial function and structure precede the manifestations of obliterative atherosclerosis; these abnormalities tend to be widespread and are not limited to a single arterial bed [10]. These changes result from the cumulative effects of known and unknown vascular risk factors that promote the formation and progression of atherosclerotic lesions and may also increase the vulnerability of atherosclerotic plaque [10]. Identifying these abnormalities in accessible peripheral arteries provides a means to detect pre-symptomatic vascular disease and improve cardiovascular risk stratification [11].

Methods used to improve cardiovascular risk prediction, particularly by non-invasive and low-cost means, are of considerable interest as they would allow more people at increased risk of cardiovascular disease to be screened in order to receive aggressive therapy against risk factors and thus reduce coronary events and strokes [9].

Conclusion

This case report illustrates the importance of routinely measuring the ankle-brachial index (ABI) in hypertensive diabetic patients, even in the absence of suggestive symptoms. The ABI is :

- A powerful diagnostic tool
- An independent prognostic marker
- A lever for optimizing treatment

Its integration into the standard follow-up of hypertensive diabetic patients could contribute to reducing cardiovascular morbidity and mortality.

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