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ORIGINAL ARTICLE

Automated determination of the ankle-brachial index using an oscillometric blood pressure monitor: validation *vs.* Doppler measurement and cardiovascular risk factor profile

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The ankle-brachial index (ABI) is a method used widely for peripheral arterial disease (PAD) diagnosis and cardiovascular risk prediction. This study validated automated ABI measurements taken using an oscillometric blood pressure (BP) monitor allowing simultaneous arm–leg BP measurements. A total of 93 patients (hypertension 83%; dyslipidemia 72%; diabetes 45%; cardiovascular disease 23%; smoking 15%) were submitted to Doppler and automated ABI measurements, performed using a professional oscillometric BP monitor (Microlife WatchBP Office; triplicate simultaneous arm–leg BP measurements), in a randomized order. The mean difference between the Doppler reading (1.08 ± 0.17) and (1) the first oscillometric ABI reading was 0.03 ± 0.11, (2) the average of two oscillometric readings was 0.02 ± 0.10 and (3) the average of three oscillometric readings was 0.02 ± 0.09 ($P<0.01$ for all). Strong correlations were found between oscillometric and Doppler ABI (r 0.80, 0.85 and 0.86 for single and average of two and three oscillometric readings, respectively; $P<0.001$ for all). Agreement between oscillometric and Doppler ABI in diagnosing PAD (Doppler ABI <0.9) was found in 95% of cases (κ 0.79; agreement in diabetics: 94%, κ 0.79). A receiver operating characteristic (ROC) curve revealed area under the curve at 0.98, with a 0.97 oscillometric ABI cutoff for optimal sensitivity (92%) and specificity (92%) in diagnosing PAD. Average time for automated ABI measurement was 5.8 *vs.* 9.3 min for Doppler ($P<0.001$). Doppler and oscillometric ABI were associated and predicted (multivariate regression analysis) by the same cardiovascular risk factors (pulse pressure, smoking and cardiovascular disease history). Automated ABI measurement using a professional BP monitor allowing simultaneous arm–leg BP measurements appears to be a reliable and faster alternative to Doppler measurement.
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INTRODUCTION

Peripheral arterial disease (PAD) is a frequent manifestation of atherosclerosis, particularly in the elderly, in patients with diabetes and in those with multiple cardiovascular risk factors.[1,2] Even in its asymptomatic form, the presence of PAD has been shown to be associated with an increased risk for cardiovascular morbidity and mortality.[3] The Doppler-measured ankle-brachial index (ABI) is a relatively simple and noninvasive method for the assessment of PAD and the prediction of cardiovascular risk.[1,4–6] Current guidelines provided by the European Society of Hypertension–European Society of Cardiology endorse the ABI measurement as a 'recommended' test in hypertensive patients, with values <0.9 indicating advanced atherosclerosis and increased cardiovascular risk.[7] However, its clinical application is limited by the need for specialized equipment and the time required for measurement, which leads to underdiagnosis of asymptomatic PAD.[8,9]

Oscillometric determination of blood pressure (BP) has emerged as a simple, accurate and widely available technique for measurement in the doctor's office, at home or with ambulatory monitoring.[10] Recent studies have shown that automated determination of ABI using oscillometric BP monitors appears to be a useful alternative to the conventional manual measurement by Doppler.[11–14] However, there is evidence that in diabetic patients, who often have underdiagnosed PAD, oscillometric ABI does not correlate as closely with Doppler ABI as in non-diabetics.[12] In addition, oscillometric ABI values have not been validated in terms of their clinical relevance.

This study was designed to validate automated ABI measurement using a professional oscillometric BP monitor that allows simultaneous arm–leg BP measurements. We compared these results with those obtained using the reference manual method with Doppler in diabetic and non-diabetic patients. The validation process consisted of two parts: (1) measurement validation, which compared Doppler and

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