Photoplethysmography and Continuous-wave Doppler Ultrasound as a Complementary Test of Ankle Brachial Index in Detection of Stenotic Peripheral Arterial Disease

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Summary
With advent of interventional therapy, early detection of PAD is critical for prevention of limb loss. We evaluated role of photoplethysmography (PPG) and continuous-wave Doppler ultrasound (CWD) as a complementary test of ankle brachial index (ABI) in detection of stenotic peripheral arterial disease. ABI, PPG, and CWD have similar sensitivity and specificity in detection of stenotic PAD and are complementary for each other. Early detection of stenotic PAD can be facilitated by combination of ABI with PPG or CWD.

Introduction
Peripheral artery disease (PAD) is a leading underlying cause of lower limb amputations and nonhealing diabetic ulcers in developed countries. With advent of appropriate interventional therapy, the timely and accurate noninvasive assessment of PAD is critical for prevention of limb loss and cardiovascular event. Currently, ankle-brachial index (ABI) is most widely used initial evaluation method for a screening of PAD. Although ABI provides several benefits, it may not be accurate in non-compressible pedal arteries in diabetic and elderly patients. Considering the potential harm of invasive vascular evaluation in these patients, increment of sensitivity and specificity of noninvasive assessment would be mandatory. Among several noninvasive vascular diagnostic tools, we focused on photoplethysmography (PPG) and continuous-wave Doppler ultrasound (CWD) for their easy applicability and reproducibility. We evaluated the sensitivity and specificity of ABI, PPG, and CWD in the detection of anatomically stenotic PAD and tried to determine a complementary role of PPG and CWD in detection of stenotic PAD.

Methods
Total 225 patients who had coincidentally undergone CT angiography (CTA), ABI, PPG, and CWD in two years (2007-2008) were retrospectively reviewed and 97 patients (194 legs) were included in present study. CT angiography was performed with 64channel MDCT scanner using contrast dye and interpreted by cardiovascular section of diagnostic radiology department. ABI, PPG and CWD was measured according to the consistent protocol using one instrument (Vasoguard P84, VIASYS healthcare, USA). We measured sensitivity and specificity of ABI, PPG and CWD in comparison with CTA findings for the detection of PAD.

Results
Total 97 patients (194 legs) were included in this study. Among 194 legs, 163 (84%) legs had stenotic PAD on CTA. The sensitivity of ABI, PPG, and CWD for stenotic PAD was 79.8%, 81.6%, and 90.8%, respectively. The specificity of ABI, PPG, and CWD was 77.4%, 77.4%, and 64.5%. Subgroup analysis regarding diabetes, hypertension, smoking history showed that ABI, PPG, and CWD had similar sensitivity and specificity in these subgroups. Combination of ABI with PPG or CWD could increase sensitivity up to 95.7% and specificity up to 93.5% for the detection of stenotic PAD.

Conclusions
ABI, PPG, and CWD have similar sensitivity and specificity in detection of stenotic PAD and are complementary for each other. Considering ABI's limitations, early detection of stenotic PAD can be facilitated by combination of ABI with PPG or CWD, which would enable timely interventional therapy with hidden PAD patients such as nonhealing diabetic ulcers.