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Conference Abstract

YI 2.5 Direct Measurement of Stiffness Index β of Superficial Arteries Without Blood Pressure Estimation

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Keywords

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ABSTRACT

Background: Arterial stiffness index (β) is a clinically accepted vascular metric, calculated from arterial pressure and diameter obtained simultaneously from a single arterial site [1]. Hence, accurate measurement of β can only be performed on arteries where pressure can be recorded along with the diameter. We present a method to evaluate β from superficial arteries using arterial force (F) and diameter (D) waveforms, employing mathematical models (shown below) exploiting the non-linear pressure-diameter relationship [2], without requiring absolute pressure.

Methods: Pilot functionality assessment was performed on eight participants (24 ± 5 years). A custom-developed frequency-matched system, combining single-element ultrasound and force-sensing transducers, was used to measure D and F waveforms from the common carotid artery. A hemodynamic-loop was formed from these measures and optimised to eliminate viscous components, and evaluate the elastic stiffness index β. Traditional β-formula [2] yielded reference values for comparison.

$$f_e(t) = f_{mx} \times \left(\frac{e^{\beta\left(\frac{D(t)}{D_d}-1\right)} - 1}{e^{\beta\left(\frac{D_s}{D_d}-1\right)} - 1} \right)$$

$f_e(t)$: Viscosity eliminated arterial force

f_{mx}: Maxima of viscosity eliminated arterial force

β: Stiffness index

$D(t)$: Arterial diameter

D_s: Systolic diameter

D_d: Diastolic diameter

Results: The system captured high fidelity D and F waveforms, adequate for reliable β evaluation. Measured group-average β (4.7 ± 0.8) was concurrent with literature. The measured β values statistically agreed (LoA = ±0.83 and bias = –0.32; non-significant $p > 0.05$) and strongly correlated ($r = 0.93$, $p < 0.001$) with the reference values. Further, they exhibited acceptable beat-to-beat repeatability (variation <7%) and accuracy (RMSE = 0.53).

Conclusion: The proposed method demonstrated the functionality by estimating reliable carotid β. Its key advantage is the applicability to superficial arteries, especially from sites where direct pressure measurement is challenging. Further studies demonstrating its potential for clinical and research applications are underway.

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