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Conference Abstract

# YI 2.5 Direct Measurement of Stiffness Index $\beta$ of Superficial Arteries Without Blood Pressure Estimation

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## ABSTRACT

**Background:** Arterial stiffness index ($\beta$) is a clinically accepted vascular metric, calculated from arterial pressure and diameter obtained simultaneously from a single arterial site [1]. Hence, accurate measurement of $\beta$ can only be performed on arteries where pressure can be recorded along with the diameter. We present a method to evaluate $\beta$ 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 $\beta$. Traditional $\beta$-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

$\beta$: 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 $\beta$ evaluation. Measured group-average $\beta$ (4.7 ± 0.8) was concurrent with literature. The measured $\beta$ 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 $\beta$. 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.

## REFERENCES

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