Double Gaussian Propagation Model to Assess Local Pulse Wave Velocity

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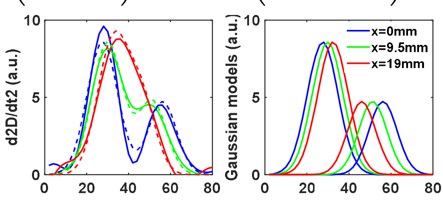
Objectives. Local pulse wave velocity (PWV), a direct measure of arterial stiffness, can be measured using the systolic foot of the arterial distension waveform. Confluence of incident and early reflected waves disturbs proper identification of the systolic foot and biases the local PWV estimate. We investigated whether fitting of a Double Gaussian Propagation Model (DGPM) can counteract these disturbances.

Methods. Ten subjects (7 males, age 38 ± 10 y) were measured 3 times in 3 weeks. In each 2 min measurement, 32 simultaneously recorded waveforms were obtained over a 19 mm wide segment (*X*) of the carotid artery using ultrasonography. Systolic blood pressure (SBP) was obtained with a volume clamp technique. For each beat, $PWV_{regression}$ was calculated using spatial position (x) as independent and timing of the systolic foot as dependent variable. The DGPM (eq) was fitted on the 2nd derivative of distension (d^2D/dt^2). The model describes all 32 waveforms by fitting two Gaussians with only 8 parameters: *a* (peak amplitude), *b* (peak time), *c* (peak duration) and *v* (PWV) for respectively the forward (1) and backward (2) propagating Gaussian.

$$\mathrm{d^2D/dt^2}_{predicted}(t,x) = a_1 \exp\left(\frac{t-\left(b_1+\frac{x}{v_1}\right)}{c_1}\right)^2 + a_2 \exp\left(\frac{t-\left(b_2+\frac{(X-x)}{v_2}\right)}{c_2}\right)^2$$

Results. Visual inspection of the fitted d^2D/dt^2 reveals that the shape of the waveform is described by the DGPM. PWV_{DGPM} (7.2 ± 4.1 m/s) is higher than the $PWV_{regression}$ (5.7 ± 2.8 m/s; p = 0.05). Importantly, the expected correlation of PWV with SBP, is much better for PWV_{DGPM} (r^2 = 0.50) than for $PWV_{regression}$ (r^2 = 0.08)



Left: d^2D/dt^2 measured (solid) and predicted (dashed). Right: individual Gaussians

Conclusions. The proposed DGPM captures confluence of forward and backward propagating waves as observed in the 2nd derivative of the distension waveforms. The PWV obtained from DGPM showed improved correlation with SBP, suggesting that DGPM counteracts the underestimation of the PWV measured with e.g. regression analysis in the presence of forward and backward propagating waves.