Importance of Time Delay Estimation Methods for Aortic Pulse Wave Velocity Assessment with Phase-Contrast MRI

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Background: Pulse wave velocity (PWV) is a validated measure of arterial wall stiffness. Assessments of PWV are highly dependent on pulse transit time estimations between 2 points. No systematic assessments have been performed regarding the best method to assess pulse travel time using phase-contrast MRI.

Aim: To compare the relationship between MRI-derived PWV (distance/transit time) measured by different methods and: (1) Age; (2) Carotid-femoral PWV (CFPWV) assessed with arterial tonometry, the "gold standard" index of arterial stiffness.

Methods: We measured aortic flow using in plane phase contrast MRI in the "candy cane" aortic view among 261 adults. Transit time between the proximal ascending aorta and the distal thoracic descending aorta were assessed from flow velocity curves using various methods for pulse upstroke detection (table).

Results: Aortic PWV assessed based on the peak second derivative of flow demonstrated the best correlation with both age and tonometric CFPWV. The method based on 20% of the upstroke amplitude provided results comparable to the peak second derivative. On the other hand, the cross-correlation method (which is currently the most commonly used) demonstrated weak relationships and often resulted in non-physiologic PWV values (up to >200 m/sec) due to non-parallel up-slopes resulting in falsely short delays between cross-correlated upstrokes. Other methods provided intermediate correlation coefficients with age and CFPWV.

Conclusions: The method to compute the onset of the flow pulsatile upstroke using phase-contrast MRI markedly impacts the assessment of PWV. The peak of the 2nd derivative is the most robust method for PWV estimations. The use of the cross-correlation method, which is most frequently used at present, should be abandoned.

	Age	CF PWV
Method	**R value (P value)**	**R value (P value)**
2nd derivative	0.43 (<0.0001)	0.48 (<0.0001)
Cross-correlation	0.12 (0.11)	0.41 (<0.0001)
DPDT	0.29 (<0.0001)	0.44 (<0.0001)
20% PH	0.42 (<0.0001)	0.46 (<0.0001)
10%	0.22 (0.001)	0.38 (<0.0001)
40%	0.34 (<.0001)	0.46 (<0.0001)
Intersecting tangents	0.35 (<0.0001)	0.42 (<0.0001)