Validation of non-invasive MRI-based assessment of central blood pressure in a population of repaired coarctation patients

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Introduction
Central blood pressure (CBP) is a highly prognostic cardiovascular risk factor. It can be accurately assessed invasively with catheterization, however, this is costly and has associated risks due to its invasive nature. It is therefore necessary to develop novel non-invasive techniques for accurate CBP estimation. We present the clinical validation of a new approach using Magnetic Resonance Imaging (MRI) and one-dimensional (1-D) hemodynamic modelling to non-invasively determine CBP.
Methods
CBP measurement were obtained by invasive catheterization in 8 patients (7 male, 20±9 years) following postnatal coarctation repair, directly followed by MRI. Gold standard invasive pressure was recorded at the ascending aorta over several breathing cycles. MRI scanning included: contrast-enhanced MRA of the chest (resolution 1.3±0.3 mm in-plane, 2.3±0.5mm slice thickness), and time-resolved 2D phase-contrast MRI at the level of the ascending and diaphragmatic aorta (89±46 time points, resolution 1.8±0.4 mm, thickness 7.6±0.7 mm). Arterial geometry, the ascending flow profile, and pulse wave velocity were all semi-automatically obtained from the MRI data. Those were used as inputs to a previously optimised 1-D hemodynamic model, combined with the mean and diastolic blood pressure. All analysis was performed within an integrated software prototype.
Results
The average absolute error in modelled systolic CBP was 4.9±4.2 mmHg, the error for diastolic CBP was 4.2±2.8 mmHg and for the pulse pressure 8.0±4.9 mmHg. R^2 correlation values between invasive and modelled pressures were 0.89 (systolic), 0.77 (diastolic) and 0.74 (pulse pressure). A more detailed analysis is shown in the Bland-Altman figures. The time required was 5-10 minutes for MRI analysis and less than 5 minutes to run the model.
Conclusions
It is possible to measure CBP non-invasively using MRI data and 1-D modelling, as shown by close agreement of this approach with invasive measurements.

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Bland-Altman Analysis