

Evaluation of Left Ventricular Diastolic Function Using 4D Flow MR Imaging

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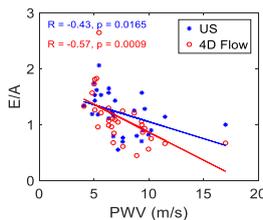
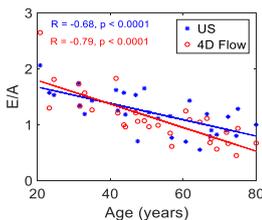
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Aim: Left ventricular (LV) diastolic dysfunction, which is related to an impaired LV relaxation, can lead to heart failure. Its current evaluation in clinical routine is based on ultrasound (US), especially through the ratio of transmitral flow early (E) to late (A) filling velocity peaks (E/A), which was shown to have a high prognostic value. Our aim was to assess the consistency of E/A ratio as calculated using 4D flow MRI, which allows both visualization and simultaneous quantification of three-directional velocities in the aorta and the heart.

Method: We studied 30 healthy subjects aged from 20 to 80 years (mean: 52 ± 17 years -15 women) who underwent MRI and a US exam on the same day. A custom software was used to segment the transmitral flow from 4D flow images throughout time while taking into account velocities in the 3 directions. Then, a flow rate curve was calculated in a plane located just under the mitral valve and perpendicular to the axis from the mitral valve to the apex. Finally, the E and A flow-rate peaks were automatically detected and the E/A ratio was computed. 2D cine MRI images in the aorta were also acquired to compute the aortic stiffness-related pulse wave velocity (PWV), through the Bramwell-Hill model based on distensibility.

Results: A significant and high correlation was found between 4D flow and US E/A ($R=0.71$, $p<0.001$). Besides, a higher correlation was obtained between E/A and both age and aortic PWV when using 4D flow than US (E/A vs. age: $R_{4D}=-0.79$, $p<0.001$, $R_{US}=-0.68$, $p<0.001$; E/A vs. PWV: $R_{4D}=-0.57$, $p<0.001$ vs. $R_{US}=-0.43$, $p=0.0165$).

Conclusion: 4D flow MRI provided consistent LV E/A measurements in terms of comparison against reference US, and was able to characterize expected ageing-related diastolic alterations as well as aorta/left heart coupling.



Relationships between mitral E/A ratio calculated using US (blue) or 4D flow MRI (red) and age (left) as well as aortic PWV (right)