Apical versus parasternal view measurements of the natural shear waves induced after aortic valve closure in healthy volunteers

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Background, Motivation and Objective

Changes in myocardial stiffness are found to be related to cardiac disease. Different studies showed the potential of tracking natural shear waves induced by aortic valve closure (AVC) and relating them to myocardial stiffness. Either parasternal or apical views were used, mainly measuring the transversal or longitudinal tissue motion respectively. But, if different wave modes are induced simultaneously, the wave mode measured could depend on the imaging view. Earlier we found higher propagation speeds from the longitudinal wave motion than from the transversal wave motion induced by AVC in open-chest pigs. In this study, we make the next step to clinical translation by studying whether higher propagation speeds are also measured transthoracically in healthy volunteers when comparing apical to parasternal view.

Statement of Contribution/Methods

High-frame rate (1000 Hz) measurements were performed in long-axis parasternal (5 measurements per volunteer) and 4-chamber apical view (1 measurement) in 10 healthy volunteers (Zonare ZS3, P4-1C probe, Mindray, San Jose, CA). A one-lag autocorrelation technique was used to obtain axial tissue velocities from beamformed IQ data. A 15-100 Hz bandpass filter was applied. A Radon transform was used to obtain propagation speeds along 10 lines over the inter-ventricular septum. The measurements were repeated on a second day. Propagation speeds above 10 m/s were considered non-physical and excluded.

Results/Discussion

For all session and all volunteers, we obtained higher median propagation speeds in apical than in parasternal view (see Fig A, Wilcoxon signed-rank rank test, n=17, $p<0.01$). If different types of SWs having different propagation speeds were measured in the 2 views, both speeds would still be linked to myocardial stiffness. Strikingly, we found no correlation between the propagation speeds in the 2 views (see Fig B, $r=0.37$, $p=0.14$). Furthermore, a small inter-volunteer variability is expected among these healthy volunteers. We found a unexpectedly large range in apical view (3.3 – 9.0 vs 2.6 – 4.9 m/s in parasternal view), although this could be partly caused by non-optimal image quality. Thus, these results suggest that the propagation speeds measured in apical view are not representative for myocardial stiffness, and should therefore be used with caution.

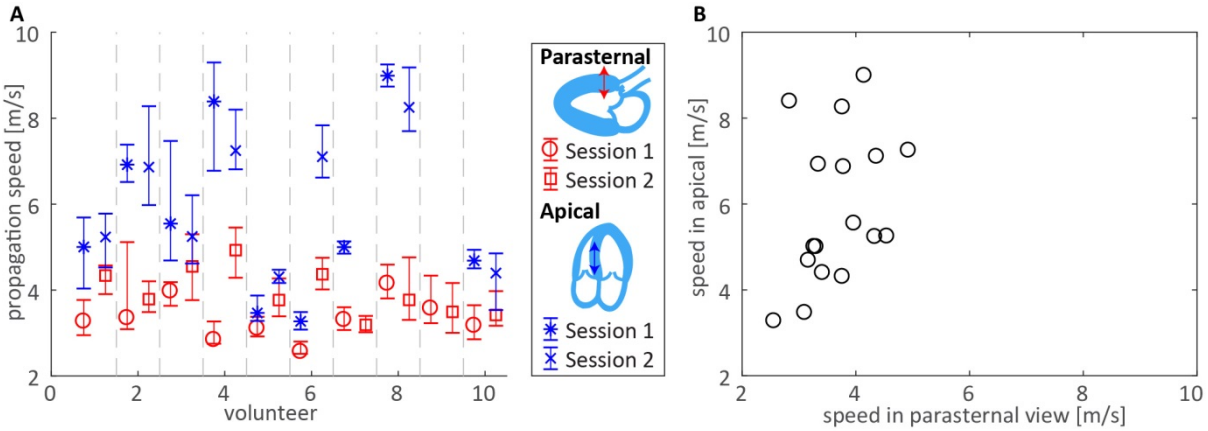

Fig A) Overview of the median and inter-quartile ranges of the propagation speeds obtained for 10 healthy volunteers in two different sessions. Higher propagation speeds were found in 4-chamber apical view than in long-axis parasternal view. B) Propagation speeds found in apical versus those found in parasternal view. No correlation was found between the 2 views.