Determining left ventricular rotation in aortic valve stenosis patients using speckle tracking

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Background, Motivation and Objective

The diagnosis and timing of treatment in aortic valve stenosis (AS) patients are currently predominantly based on hemodynamic parameters. However, the high left ventricular pressure in AS patients can lead to subendocardial hypoperfusion, potentially leading to irreversible myocardial damage caused by ischemia. Detection of subendocardial ischemia could improve timing of the intervention. This ischemia can be examined using left ventricular rotation, which represents mechanical equilibrium between subepicardial and subendocardial fibers. In this study, we investigate whether it is feasible to determine the rotation of the left ventricle from B-mode ultrasound images and whether this rotation can be used to examine subendocardial ischemia.

Statement of Contribution/Methods

The accuracy of rotation obtained by speckle tracking was investigated using a mathematical model of left ventricular kinematics. Simulated B-mode images were created using Field II software, on which speckle tracking was performed (**Fig 1A**). Next, rotation of the left ventricle was determined from B-mode images of healthy volunteers (n=4) and of AS patients (**Fig 1B**) before (pre, n=5) and immediately after (post, n=3) a TAVI procedure. From this, the relative apex-to-base rotation was determined (**Fig 1E**). To correct for a decreased total contractility, the parameter RRTC was introduced, which is the ratio of relative rotation to circumferential strain during the ejection phase **(Fig 1C)**.

Results/Discussion

In the simulated images, the rotation pattern determined with speckle tracking is similar in shape to the applied rotation (**Fig 1D)**. This shows that the rotation of the left ventricle can be determined during a heart cycle, however the amplitude is underestimated because of poor lateral displacement estimation.

In the patients, the average RRTC is 50° for the pre group, 42° for the post group and 29° for the healthy volunteers (**Fig 1F**). These results are in line with the expectations, but the number of patients is small and the variability of the data is large, precluding statistical analysis between the groups. However, this method seems promising to determine subendocardial ischemia in aortic valve stenosis patients, which can in the future be used to improve the timing of aortic valve replacement.

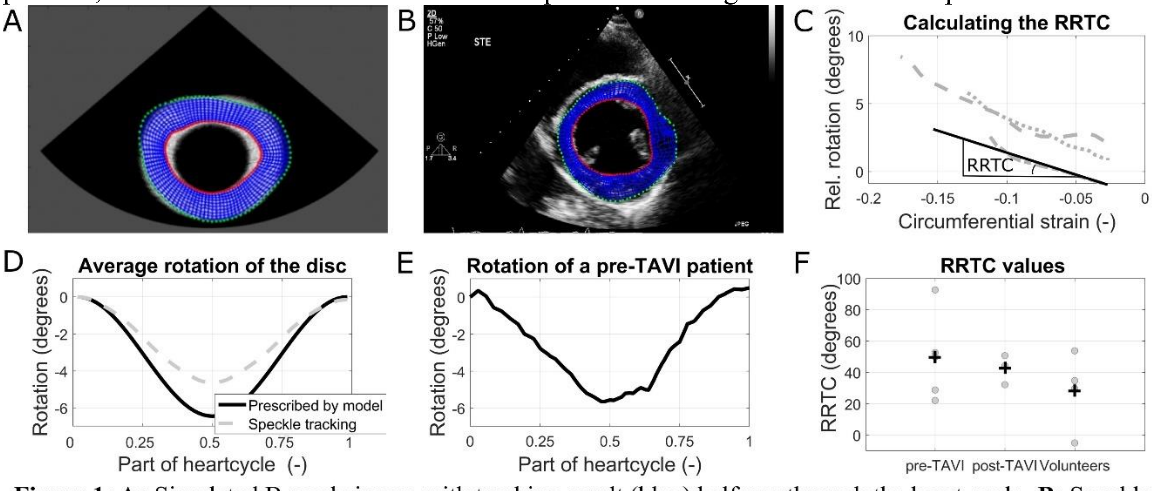

Figure 1: A: Simulated B-mode image with tracking result (blue) halfway through the heart cycle. **B:** Speckle tracking on a B-mode image of a patient. **C:** Calculation of the RRTC values, by determining the slope of the relative rotation – circumferential strain plot. **D:** The rotation prescribed by the model and the rotation determined using speckle tracking. **E:** Apex-to-base rotation in a pre-TAVI patient determined using speckle tracking. **F:** Individual RRTC values for the different groups, averages shown with the black crosses.