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A Finite Element Analysis Pipeline for *In Silico* Annuloplasty on Barlow's Diseased Mitral valve

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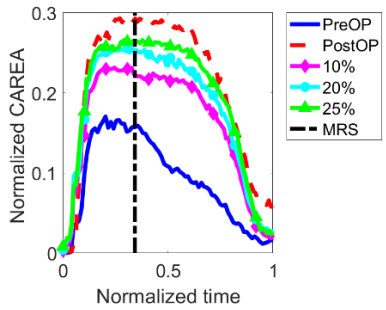
The mitral valve (MV) ensures unidirectional blood flow between the left atrium (LA) and left ventricle. Barlow's Disease (BD) affects the entire MV apparatus causing back flow into the LA [1]. Standard annuloplasty procedures, which consist of implanting an artificial ring at the border between the MV and the LA, lead to an average of 55% annular area reduction with respect to the end diastolic (ED) pre-operative (PreOP) annular area.
An *in silico* pipeline to perform annuloplasty by utilizing the pre- and -postoperative (PostOP) 3D echocardiographic recordings was developed. Our objective was to test the hypothesis that annuloplasty ring sizes based on a percentage (10-25%) decrease of the PreOP annular area at ED can result in sufficient valve leaflet contact area (i.e., coaptation) for BD MVs.

The patient specific MV geometry and finite element model was created by following the pipeline developed in [2]. The PostOP echocardiography was used to obtain the artificial ring geometry and displacements, and the motion of the papillary muscles after surgery. These were used as boundary conditions in our *in silico* annuloplasty finite element (FE) analyses. Then, the annuloplasty ring was scaled up to represent a 10%, 20% and 25% reduction of the PreOP ED annular area and aligned to the ED PreOP FE model. A total of five analyses were then run using Abaqus Explicit: PreOP, PostOP, 10%, 20% and 25%. Coaptation areas (CAREA) calculated from the FE-analyses were normalized with respect to segmented leaflet area and the timescale was normalized.



At the time of mitral regurgitation start (MRS) observed pre-operatively, the normalized CAREAs were 0.16, 0.29, 0.23, 0.25 and 0.26 for the PreOP, PostOP, 10%, 20% and 25% analyses, respectively. The lack of late systolic closure was eliminated for all *in silico* analyses.

The CAREA decrease was shown to be dependent on the annular dilation at late systole. Constraining the MV from dilating excessively can be sufficient to achieve coaptation throughout systole. The *in silico* analyses show that BD patients may benefit from an annuloplasty ring with only moderate annular reduction.

REFERENCES

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