Influence of prosthetic mitral valve orientation on left ventricular flow
Stijnen, J.M.A.; van de Vosse, F.N.; Baaijens, F.P.T.

Published: 01/01/2002

Document Version
Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

Please check the document version of this publication:
- A submitted manuscript is the author's version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher’s website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

Link to publication

Citation for published version (APA):

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.
- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

Take down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Download date: 04. Jan. 2019
Influence of prosthetic mitral valve orientation on left ventricular flow

J.M.A. Stijnen, F.N. van de Vosse, F.P.T. Baaijens
Eindhoven University of Technology, Department of Biomedical Engineering, j.m.a.stijnen@tue.nl

Introduction
The valves of the heart direct the blood pumped by the cardiac muscle from venous to arterial side. Due to pathological changes, the function of a valve may be compromised to the extent that it needs to be replaced. In many cases a mechanical prosthesis will be chosen due to its high durability (figure 1). Prosthetic mitral valve orientation affects ventricular flow and consequently might affect mitral-aortic valve-valve interaction and related cardiac output. As depicted in figure 2, two different valve orientations result in a significantly different vortex structure. In these preliminary computations the valve was modeled as a rigid obstacle.

Objective
- In this work the influence of prosthetic mitral valve orientation on left ventricular flow is studied.
- Furthermore, valve dynamics, resulting mitral-aortic valve-valve interaction and related cardiac output will be looked into. To this end a more sophisticated valve model is needed.

Methods
A 3D computational model is developed using an arbitrary Euler-Lagrange finite element method to solve the instationary Navier-Stokes equations for Newtonian fluids. The velocities of the valves and the fluid are coupled using a fictitious domain method. Experimental validation was done with Particle Image Velocimetry measurements.

Results
The computational method was applied to a 2D aortic valve model with sinus cavity and validated with PIV measurements (figure 3). Next, the computational method was used to study interaction between valves in a simplified ventricle geometry. A physiologically relevant flow rate and transvalvular pressure gradient were applied. The results (figure 4) show that a certain amount of fluid regurgitates during valve closure, affecting the cardiac output.

Conclusions and Discussion
- A preliminary 3D model shows that a 90° rotation of a simple valve in the mitral orifice results in a significantly different ventricular flow field.
- A fictitious domain method was successfully used to model moving rigid valves in a fluid with a high transvalvular pressure gradient in closed state.
- The results also show that the cardiac output depends on the dynamics of the valve.
A realistic 3D model will enable the prediction of optimal prosthetic mitral valve orientation for specific patients preoperatively and allow for improved cardiac performance after implantation. Furthermore, the 3D model can be used to improve and optimize new and existing valve designs.