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University of Applied Sciences

Master of Biomedical Engineering

Thesis title: Study of the influence of different inflow configurations on Computational Fluid Dynamics in mechanical heart valve prostheses

Abstract

Background

Application of Computational Fluid Dynamics (CFD) is a method in development of medical devices for test analysis and result visualization in a time and cost effective way. But in previous computational fluid dynamics studies, in order to ease the problem and simulations, geometry of sub-aortic section had often been considered as an uniform tubule with no cross-sectional changes. The aim of this study was to illustrate the influence of different left ventricle geometries at the aortic valve entrance.

Method and results

Based on a mold model from a pig heart left ventricle, a 3D model for further simulation via NX Unigraphix had been introduced. By implementation of CFD solutions on different cross-sectional areas on this model, alteration of the fluid flow pattern over mechanical heart valves was studied. Five different geometry models under two volume flow rates (*3* and *18 L/min*) were designed. All CFD simulations applied on a three leaflet mechanical heart valve, which was developed by our experts at University of Luebeck. This investigation demonstrated that non-uniform geometries with left ventricle diameter of *38mm* and *48mm* according to low pressure loss, thin boundary layer in vicinity of valve frame, passing more blood volume through the valve orifice and lower flow separation over the leaflets, were superior to uniform configuration (tubular). Further, in comparison to uniform configuration, by increasing the left ventricle diameter stagnation area over the leading edge became wider. This might affect the initial opening force of the leaflets and should be evaluated for further studies.

Conclusion

By choosing more reliable flow geometry models (similar to anatomical structure), the mechanical heart valve can better be assessed and the effect of external false boundary conditions can be reduced. The outcome from more realistic evaluations may help to prevent patients having to undergo long-term anti-coagulation therapy or even reduction of later re-operation.

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