

# THE INFLUENCE OF THE POSITION ANGLE OF THE ARTIFICIAL BILEAFLET VALVE ON THE FLOW IN THE CORONARY ARTERIES

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## Introduction

Ischemic heart disease (IHD) is one of the leading causes of mortality worldwide [1]. Some patients with IHD also have other diseases, including aortic stenosis and aortic valve dysfunction. The abnormal valve function causes disturbed blood flow. Often the only effective solution is artificial aortic valve implantation. This study aims to verify the influence of the position angle of the artificial bileaflet valve on the flow in the coronary arteries in patients with IHD since clinical studies do not report on the optimal orientation of the prosthesis [2,3].

## Methods

The geometrical model of blood was generated in Mimics software from CT images of a patient with left coronary artery stenosis. The model consisted of the aortic root, Valsalva sinuses and coronary arteries. The bileaflet aortic valve was placed under the sinuses in four different angle positions: 0°, 90°, 120° and 240°.

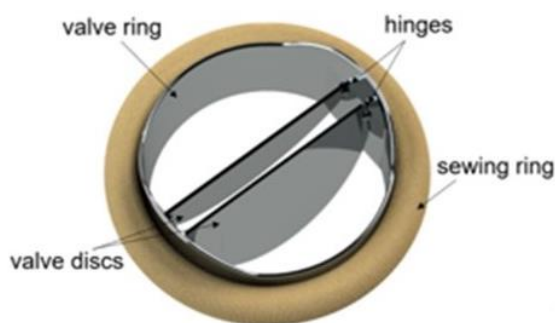


Figure 1: The bileaflet aortic valve

The blood flow was determined using ANSYS 2020 R2 software. Flow velocity at maximum valve opening was determined on the basis of a Doppler ultrasound examination. The value of 0.97 [m/s] was set at the system's inlet. The zero gauge pressure was set at the aortic and coronary arteries outlets. The blood flow was adopted as Newtonian.

## Results

As a result of the simulations, we obtained blood flow in the aorta and coronary arteries. Figure 2 shows the flow velocity distribution in a stenosis cross-section in four different implantation angle positions of the bileaflet valve.

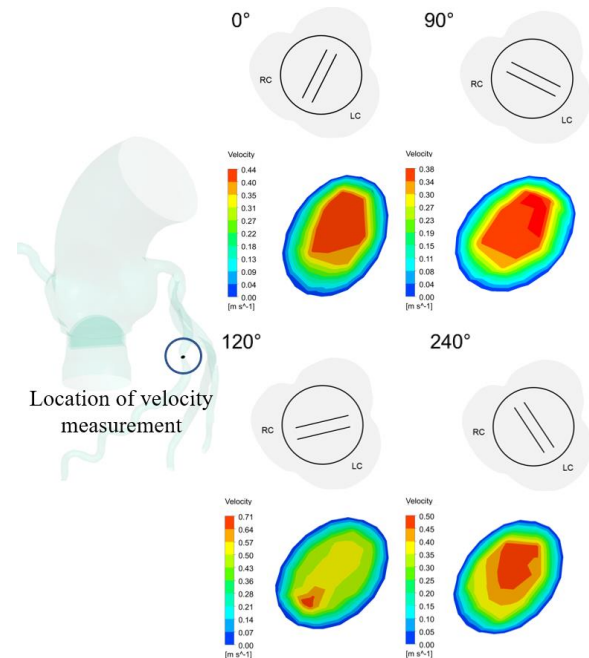


Figure 2: The blood velocity in stenosis in four different angle positions of the valve

## Discussion

The angle position of implantation of bileaflet aortic valve has a significant impact on the blood flow velocity in coronary artery stenosis. This means that in some cases, wrong implantation could lead to difficulties in blood transport through coronary arteries and to myocardial infarction.

The angular position of the valve could also affect flow pattern, valve closure, and shear stress downstream of the valve. This requires further research. We expect that the conducted research will allow determine the methodology of assessing the optimal angle of valve implantation for a specific condition of a given patient.

## References

1. Fossan FE et al, Cardiovasc Eng Technol, 9:597-622, 2018.
2. Kleine P et al, J Thorac Cardiovasc Surg, 124(5):925-932, 2002.
3. Haya L et al, J Fluid Mech, 806:129-164, 2016.

