대동맥 혈류유동 분석을 위한 경계 연결 FSI 기법 연구

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Investigation of FSI technique with boundary connected coupling for application to blood flow in aorta

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Abstract : Spiral blood flow patterns have been detected in human vascular system such as, aorta. Therefore, the actual mechanics of spiral blood flow has been studied using a 3D aortic model by employing a numerical simulation-based technique of Fluid Structure Interaction (FSI). The spiral-pulsatile flow velocity profile is obtained through a model of spiral graft and then mapped onto the inlet of ascending aorta model. The results show that the exterior interface of aortic arch is more likely to rupture because of the impact of centrifugal forces, applied pressure forces and secondary flow patterns. Hence, spiral flow can help eradicate the atherosclerosis plaques in human vascular system.

1. Introduction

Spiral blood flow patterns have been detected in human vascular system such as aorta[1]. Its twisted and curved structure is the reason of spiral pattern of blood flow[2]. Fluid Structure Interaction has been a topic of utmost importance since the increase in computational power occurred[3]. Hence, a complete FSI based study is done on the aorta.

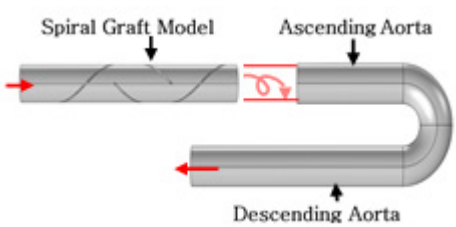

Fig. 1 Aortic Model With spiral graft mapping

2. Results and Discussion

In the present study, a simplified three-dimensional aortic model has been utilized (Fig 1). A spiral graft model is used to produce spiral flow pattern by using pulsatile velocity and pressure waveforms. This spiral flow pattern is then employed to map on the inlet of ascending aorta as a boundary condition of velocity. Furthermore, the k- turbulence model with Reynolds Averaged Navier-Stokes equations is used.

Spiral blood flow pattern gradually matures as the flow reaches from ascending to descending aorta. Fig 2 also shows the gradual even distribution of velocity throughout the exterior interface of aorta at systolic conditions thus it indicates the uniform distribution of pressure throughout aortic interface.

The geometrical orientation and centrifugal forces cause the secondary flow counter rotating vortices in the aortic arch. These vortices tend to vanish in the descending aorta. Hence, it can be concluded that the spiral flow is helpful in avoiding the diseases like atherosclerosis.

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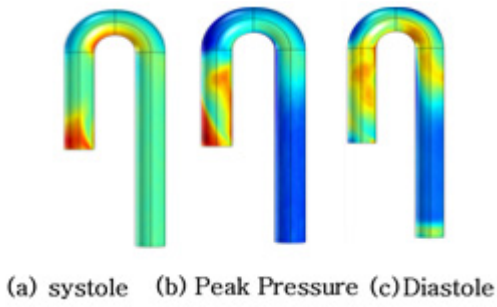

Fig. 2 Velocity magnitude at systole, Peak pressure and Diastolic conditions

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References

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