ABSTRACT
This thesis consists of two parts. Part I of this thesis is "Quantification of pulse wave velocity of aorta of diabetic patients with phase contrast magnetic resonance imaging." Part II is "In-vitro study of aortic wall shear stress with phase contrast magnetic resonance imaging." In Part I, Compliance of the aorta is an important factor of heart load and a clinically predictor of long-term prognosis in patients with diabetes mellitus and hypertension. Pulse wave velocity (PWV) of aortic blood flow is considered a surrogate for aortic compliance. In this study, a new, noninvasive method to estimate PWV based on the wave theory in gasdynamics were developed, in which spatial and temporal profiles of axial velocity along the thoracic aorta were analyzed. Phase contrast MRI (PC-MRI) were used to obtain the aortic geometry and flow information in the sagittal plane. Healthy volunteers and diabetic patients were studied and compared. Correlation studies were conducted with statistics. Furthermore, aortic compliance were derived from PWV. It is show that the PWV and aortic compliance for health volunteers were 6.49±1.49 m/s and 6.58 m³s⁻²/kg respectively. On the other hand, the PWV and aortic compliance were 12.76±0.66 m/s and 1.57 m³s⁻²/kg respectively, for diabetic patients, The PWV of diabetic patients are much higher than that of health volunteers. The aortic compliance of diabetic patients is worse than that of health volunteers. A clinically useful index to assess cardio-vascular risk is established. In Part II, wall shear stress is an important prediction of the cardiovascular disease. In this study, we used MRI to obtains the velocity distribution along the aortic model under simulated the heart circulation condition, and observed the influences of wall shear stresses on the aortic model. The experiments were divided into three parts: (1) A circular pipe flow experiment; (2) Steady in-vitro experiment on aortic model; (3) Unsteady in-vitro experiment on aortic model. In the circular pipe flow experiment, we true to validate the vessel-wall searching method based on "no slip boundary condition" of the fluid mechanics. The preliminary result is promising. In the steady and unsteady in-vitro experiments on aortic model, the newly developed vessel-wall searching method was adopted to determine the correct wall positions and wall shear stresses. The research demonstrated that on the inner wall surface around the aortic arch, the wall shear stress has changed significantly; It similar situation happens on outer wall surface along the descending aorta . The results are consistent with the early investigations in many literatures.

Keywords : Compliance ; Pulse Wave Velocity ; Phase Contrast MRI ; Diabetes ; Aorta ; Wall Shear Stress ; Aortic arch ; No Slip Boundary Condition
References


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