CHAPTER 1

INTRODUCTION

1.1. Motivation and significance

The trend of recent important health diseases in Thai population has changed from commutable diseases to chronic non-commutable diseases. Chronic non-commutable diseases are diseases of long duration and generally slow progression which mainly include cardiovascular diseases, blood hypertension, cancers and diabetes. These diseases could be called as lifestyle diseases since they are in turn of a personal background, lifestyle and environment. In Thailand, major diseases of chronic non-commutable diseases are vascular diseases which are very important public health problem because of their high mortality whereas they are considered preventable. According to statistical information between years 1999-2008 (Technical support group in Bureau of Non Communicable Disease THAILAND, 2011) on situation of chronic non-communicable diseases and injuries (Whole country) reported in year 2011 by technical support group in Bureau of Non Communicable Disease THAILAND, an important population mortality of country is cardiovascular diseases which represent mortality of 58 per hundred thousand persons by the mortality of cardiovascular diseases are the second top rank in a decade they had studied. Moreover, the rate of admission in the hospital under the Ministry of Public Health in case of cardiovascular diseases continuously increase from 614.3 per hundred thousand persons in year 1999 to 1927.0 per hundred thousand persons in year 2008 and major diseases are included hypertension and ischemic heart disease

where rate of the admissions of hypertension and ischemic heart disease continuously increase from 216.6 per hundred thousand persons in year 1999 to 860.5 per hundred thousand persons in year 2008 and from 81.9 per hundred thousand persons in year 1999 to 276.8 per hundred thousand persons in year 2008, respectively.

Arterial system is one of important system of cardiovascular system acted as network of conduits of blood which supply to body and return blood adulterated waste out from tissues. The largest and strongest vessel which conducts blood from heart is aortic vessel. Aortic vessel function is to conduct blood from left ventricle of heart to flow through to arterial network and consequently to arteriole, capillaries and finally to tissues. Aortic vessel has important role on conducting blood from heart and serving to adapt pulsatile flow of blood pumped by heart to steady flow in peripheral vessels. If aortic vessel cannot complete its function blood would not able to be supplied through the body. Tissues in insufficient blood supplied area would out of their functions and then die resulting to insufficient blood supplied for that body. One of the implications of the structural changes is the change in mechanical properties of the aorta, e.g. stress and strain. The assessment of aortic mechanical properties is hence particularly important in understanding the mechanisms of diseases and abnormalities which could be occurred with the aorta.

As state above it is evident that the abnormal changes would result in abnormal aortic properties changes which could imply to initiating of vascular diseases. Despite advantages in medical technology allow increasing of survival of patients from vascular diseases, these patients still have change of health condition that causes physiological suffering for a long time. The vascular diseases could be significant cause of morbidity and mortality and are also required a treatment from

people with specific skills as well as medical technologies that have high costs. And as mentioned above that vascular diseases is a disease that can be prevented if we know the properties of these aortic vessel before. Hence, in the recent the importance of the properties of aortic vessel that affect initiating of vascular diseases is interesting to study.

In clinical diagnosis, it requires information that can indicate the characteristics of mechanical behavior properties of blood vessel in order to diagnose precisely and qualitative data obtained from experiments such as the magnetic resonance imaging (MRI) are not sufficient to indicate the characteristics of mechanical behavior clearly. We hence attempt to compose qualitative study with quantitative study by using the relationship between stress and strain of aortic blood vessel to illustrate stress and strain distributions which affect functions of aortic vessel along a cardiac cycle in systolic and diastolic phases for more precise clinical diagnosis. It means that, mathematical equations are used including with quantitative parameters which are used as indicator of a normal or abnormal of the blood vessel. And, the knowledge to construct the model can extend to predict quantitative results that characterize the mechanical behavior of blood vessel. Moreover, the model could be applied to engineering work for example medical device or prosthesis to aid in the diagnosis and medical treatment to be convenient and more accurate.

Imaging technology is taken into consideration as part of model to improve the model of characteristics for the aorta. The model should be developed in three dimensions for more realistic approach. However, it is also requires the data validation. The visualization techniques such as the ultrasound scanning are method that can be taken into account to obtain the model which is valid according to the

nature of the aorta. Ultrasound imaging can obtain visualized image and it is *in vivo* non-invasive method which no surgery is required. So, patients have no pain and suffering by this method and it is suitable for further apply to use with patients. This research so attempts to develop three-dimension mechanical model for stress and strain of aortic wall based on *in vivo* non-invasive information.

1.2. Objectives of the study

1. To construct constitutive equations for three dimensional stress and strain relationship model of aortic vessel
2. To predict stress and strain distribution in aortic vascular wall

1.3. Scopes of the research

- Consider the aortic vessel which is subjected to a load of blood flow along cardiac cycle using experimental data in mouse and consider in partial part of aortic vessel.
- Consider aortic vessel which is deformed by combine load of inflation and extension using strain energy function relevant with three dimensional material parameters.
- Validate luminal pressure from the model based on displacement data in vivo non-invasive aortic vessel imaging technique in mouse to luminal pressure from experiment.

Following chapter, structure of arterial wall, general context and literature reviews of anatomy, histology and physiology of arterial wall as well as material model of arterial wall are presented.

The third chapter presents methodology of experiment and new mechanical model to understand in details of the assumptions employed in the model to predict stress and strain distribution across the aortic wall and rupture risk.

Results and discussion on stress and strain distribution in aortic vessel wall from mechanical model which its constitutive equations are constructed for three dimensional multilayer stress and strain relationship of aortic vessel are presented in the fourth chapter.

In the fifth chapter, the limitations, possible practical applications, suggested solutions to problem and suggested concepts or new topics for further research are expressed.

The last chapter, the sixth chapter, finally shows the conclusion of the study. Preliminary studies involving the research, additional information about experiments are presented in appendices.