# ANALYSIS OF BLOOD FLOW INTO THE MAIN ARTERY VIA MITRAL VALVE

MOHD AZRUL HISHAM BIN HJ. MOHD ADIB

UNIVERSITI TEKNOLOGI MALAYSIA

# ANALYSIS OF BLOOD FLOW INTO THE MAIN ARTERY VIA MITRAL VALVE

**MOHD AZRUL HISHAM BIN HJ. MOHD ADIB**

**A dissertation submitted to the Faculty of Mechanical Engineering in partial fulfillment of the requirement for the award of the degree of Master in Mechanical Engineering**

**Faculty of Mechanical Engineering**
**Universiti Teknologi Malaysia**

**APRIL 2010**

# DEDICATION

**Specially dedicated to my beloved and important person in my life :**

**My Wife**

Nur Hazreen Binti Hasni

**My Father**

Hj. Mohd Adib Bin Hj. Mat Yacob

**My Mother**

Hjh. Zawiyah Binti Hj. Md. Ariff

**My Brother**

Mohd Aidinniza Bin Hj. Mohd Adib

Mohd Sanusi Bin Hj. Abdul Fatah

**My Sister**

Noor Azliza Binti Hj. Mohd Adib

Noriza Binti Mohd Noor

**and others for all their love, support and understanding.**

## ACKNOWLEDGEMENT

With the name of Allah, the most Gracious and The Most Merciful. Selawat Salam to the Prophet Muhammad S.A.W. Alhamdulillah, thank you to Allah for His greatness and graciousness, allowing me to complete this thesis.

First of all, I would like to express my most sincere gratitude and appreciation to my supervisor, Associate Prof. Dr. Kahar Osman, for generously spending his precious and offering his available guidance and encouragement during the preparation of this thesis.

Sincere appreciation to my beloved family, my wife, my father, my mother and my brother and my sisters for unfaltering support and encouragement throughout this challenging study. Also to my precious friends who helped and supported me all the time and their helpful comments and tolerance towards the author's shortcoming throughout this project are deeply appreciated. I'll keep all the memories as time goes on.

Finally, I would like to thank for those who involved directly or indirectly in order to complete this thesis entitle *"Analysis of blood flow into the main artery via Mitral Valve"*.

## ABSTRACT

Mitral Valve failure causes death if it is not corrected surgically. Such surgical repair can be improved by understanding mitral biomechanics. A two-dimensional FSI model of the Mitral Valve was generated using the ADINA simulation. A simple approximation of the heart geometry was use, the valve dimensions were based on measurements made. The viscosity of blood and the elastic properties of the valve leaflets were obtained from the literature. In this study, numerical modeling was used to determine the correlation between the degeneration of the Mitral Valves rigidity and backflow problem based on several critical parameters of blood. Two stages of Mitral Valve simulation, systolic and diastolic stage and also with ventricle and without ventricle are investigated. Finally, conclude that rigidity of Mitral Valve antipodes to the backflow and Degeneration causing backflow will reach a constant value and agreed with results from experimental.

# ABSTRAK

Injap Mitral yang gagal akan menyebabkan kematian jika tidak menjalankan pembedahan dengan cara yang betul. Seperti pembedahan pemuliahan boleh diperbaiki dengan memahami Mitral Biomekanik. Model injap Mitral dua dimensi telah dihasil mengunakan simulasi ADINA. Angaran untuk geometri jantung dan injap adalah berdasakan pengukuran. Kepekatan darah dan kekenyalan injap diperolehi melalui bahan bacaan. Dalam kajian ini, model simulasi telah digunakan untuk menentukan hubungan diantara kekuatan injap Mitral dengan masalah aliran balik darah berdasarkan kepada beberapa parameter kritikal pada darah. Dua keadaan injap Mitral iaitu ketika mengembang dan mengecut dan juga model dengan ventricle dan tanpa ventricle telah dikaji. Akhirnya, dapat simpulkan bahawa keputusan kekuatan injap Mitral adalah berlawanan dengan aliran balik darah dan pengurangan kekuatan injap Mitral menyebabkan aliran balik darah akan mencapai nilai tetap dan sangat bersesuaian dengan keputusan daripada ujikaji.

# TABLE OF CONTENTS

# LIST OF TABLE

# LIST OF FIGURE

# LIST OF GRAPH

# LIST OF SYMBOLS

## SYMBOLS

| | |
|---|---|
| A | Area |
| E | Young's Modulus |
| Re | Reynolds Number |
| Q | Volume flow rate |
| T | Temperature |
| t | Time |
| U | Mean Velocity |
| ρ | Density |
| f | Friction Factor |
| μ | Viscosity |
| Ω | Voracity Vector |
| P | Pressure |
| η | Vortices Component normal to Streamline |
| ξ | Vortices Component tangent to Streamline\ |
| ν | Kinematic Viscosity |

# LIST OF APPENDICES

# CHAPTER 1

# INTRODUCTION

## 1.1 Background

In heart anatomy, flow into the arteries depends on the condition of the valves located inside the heart. The valves in the heart maintain the unidirectional flow of blood in the heart into the arteries by opening and closing, depending on the difference in pressure on each side. The valves are mechanically similar to reed valves. Basically there are four types of valves in the heart. The first one is two Atria Ventricular (AV) valves between the atrium and the ventricles. These are small Tricuspid Valve (TV) and Mitral Valve (MV) that prevent backflow from the ventricles into the atrium during systole. Second one is two Semi Lunar (SL) valves in the arteries leaving the heart. These Pulmonary Valve (PV) and Aortic Valve (AV) are located at the base of both the pulmonary artery and the two arteries taking blood out of the ventricles. These valves permit blood to be forced into the arteries but prevent backflow of blood from the atrium into the ventricles. During each heartbeat both of the atrium contract first to pump blood into the ventricles. Then both ventricles contract to pump blood out of the heart into the arteries. There are one way valves between the atrium and ventricles and also between the ventricles and the large arteries that take blood from the heart.

This project will focus only on Mitral Valve (MV). We will investigate the correlation between the degeneration of Mitral Valve rigidity and percentage of backflow. When the rigidity of the Mitral Valves degenerates, the one-way flow is very difficult to be maintained. Thus some backflow will occur. For this investigation, samples of 10 Asian people were selected to study and will validate with simulation using ADINA-FSI. The degeneration of their mitral valves and backflow is the main focus of investigation.

## 1.2 Statement of Problem

Mitral Valve is very important because it only valve that controls the blood through pulmonary vein from lung into the arteries and prevents backflow from the left atrium to the left ventricle. But today in medical practices they still don't have the specific method to know the percentage of backflow from their patient and just assume or base on their experience before.

Biomedical Journal entitles "*Mitral Valve Repair with the Colvin-Galloway Future Band"*. Regenerate the value of rigidity for support the repair techniques of the mitral valve and not replacement with artificial prostheses and to repair the mitral valve is considered to know the value of Mitral Valve rigidity [3].

## 1.3 Objective

The intention of this project is to determine the correlation between the degeneration of the Mitral Valves rigidity and backflow problem, based on critical parameter of blood via numerical modeling.

## 1.4 Scope

The scopes of this project had been established as :

(a). Actual diseased data mitral valves will be used.
(b). Correlation will be determined using numerical modeling.
(c). Model will be limited to two-dimensional (2D).