PREFACE

This thesis details the investigation of total hip implant optimization driven by nitinol alloy, through finite element modeling and experimental validation. The thesis is virtually divided into two section. The first section deals with the novel design and its analysis of total hip implant components. Section second deals with the study of prevention of vascular injury caused by the eccentric cup holes, in which fixation of screw is made. Hence, the complete work is divided into four chapters.

Chapter 1 deals with the introduction and literature review of shape memory alloy, total hip joint, total hip replacement, implant components used in hip prosthesis and implant failure. The main purpose of this chapter is to highlight the relevance of the focus of this work (novel design of total hip implants) and select approaches and methods investigating the chosen focus. The chapter describes the purpose to select nitinol shape memory alloys; nitinol application in biomedical devices, and optimization through finite element analysis.

The decision to use the computer added design (CAD) and finite element modeling is prompted in the subsequent chapter 2. CAD design are 3D solid modeling of physical component. It interpolates the 2D sketches to 3D extrusions to achieve the desired model. These designed models are exported to the finite element analysis platform, which enables to perform the numerical analysis of these structures by providing the material properties from current available experimental data to achieve the desired stress and strain distribution when the models are subjected to forces. This chapter is detailed with the use of nitinol element in designing the novel design of acetabular cup and screws.

In continuation to chapter 2, chapter 3 possesses the mathematical modeling of nitinol behavior to make suitable algorithm for finite element analysis in ANSYS. Proceeding with this chapter, finite element analysis is performed in ANSYS software with the novel designs of total hip implants and its experimental validation.

The last and the largest chapter 4 deals with the study of possible vascular injury due to eccentric screw fixation in press fit acetabular cups during total hip replacement. The virtual cup and screws are designed, assembled to their anatomical positions and simulated with the regenerated pelvic bone with possible eccentricities. The screw configuration profiles are developed with all possibilities of screw angular rotation and these profiles are tested. The screw positions are analyzed statistically and outcomes of these analysis may provide a possible method to the surgeons to prevent vascular injuries with eccentric screws during total hip surgery.