UNIVERSITI TEKNOLOGI MARA

INFLUENCE OF DENTAL IMPLANT DESIGNS ON STRESS DISTRIBUTION AND MICROMOTION OF MANDIBULAR BONE

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ABSTRACT

The significant effects of biomechanical dental implant designs have been realised by some researchers, however, the studies were restricted on the discrete invariability of designs and geometries of dental implants on the primary stability of immediately loaded implants. Moreover, restricted procedure and limited software ability to develop a comprehensive 3D model of mandibular bone make the in vitro studies on dental implants relatively unreliable. This research was conducted to provide a feasible method for reconstructing the 3D model of mandibular bone to undergo finite element analysis. This study also examines several design features of dental implants based on commercially available products. Then, the highest performance dental implant design was evaluated, and the significant design parameters were studied in order to determine the optimal combination of design parameters. Computerised Tomography scan was conducted to generate head images for bone reconstruction process. MIMICS software 8.0 and 3-matic software were used to develop the 3D mandibular model. The reconstructed mandibular model was then assembled with five different 3D models of dental implants. Feasible boundary conditions and material properties were assigned to the developed muscle areas and joints. The results of the maximum von Mises stresses, shear stresses and deformations were analysed, and the best design was selected. Next, grey based Taguchi method was used to identify several design parameters influences such as conical hollow height, thread thickness, cutting-edge angle and cutting-edge depth. The second model appeared to exhibit the highest performance in this bone remodelling prediction simulation. Lastly, the optimal combination of design parameters calculated in this study were 5 mm of conical hollow height, 0.3 mm of thread thickness, 30° of cutting-edge angle and 6 mm of cutting-edge depth. In conclusion, this research provides a systemic approach to develop segmented 3D mandibular bones with quality meshing in order to prevent error in finite element analysis. Based on this study, the suggested optimal combination had improved the dental implant and bone performance.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

The replacement of lost teeth has always been an important practice in humankind existence. In 2010, approximately 158 million people or 2.3% of the world population were reported to have edentulous problems [1]. Edentulism can lead to bad effects on a person. It will affect their self-esteem, public relationship and dietary habits due to low confidence levels and doddering looks. Before the development of dental implants, people had been using complete denture to overcome the edentulous problem [2]. In the past two decades, dental implants have become a significant remedial approach after Branemark conducted and coined the term 'osseointegration' referring to the direct contact between titanium material dental implants and bone tissues of the mandible [3]. Dental implantation in dentistry practice has been transformed. As shown in Figure 1.1, there are several implant systems which have been used in the market over the years such as 'the all-on-four', 'multiple dental implants' and 'single dental implant'[4].

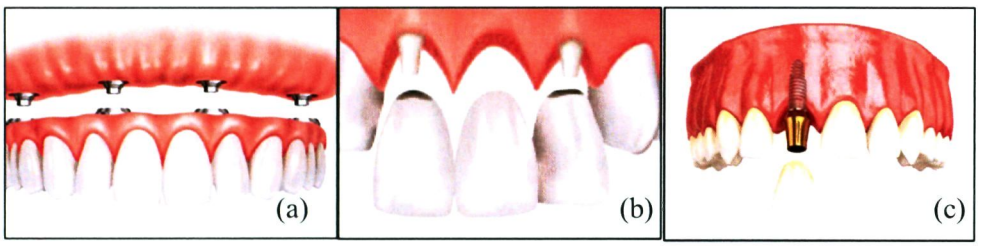

Figure 1.1 (a) The All on Four (b) Multiple Dental Implant
(c) Single Dental Implant [4]

Patients need prosthetic restoration of endosseous implant for teeth loss. Basically, dental implant is a tiny screw developed using titanium. Other types of implant materials are polymer, ceramic and ceramic coated as well as carbon compound implant. The length of the screw is about 5 mm to 12 mm and it is placed in the jawbone as shown in Figure 1.2. Usually, a normal tooth contains a tooth root and a crown. The crown is covered with white enamel which is the visible section by