UNIVERSITI TEKNOLOGI MARA

PREDICTION OF IMPLANT STABILITY IN TOTAL HIP ARTHROPLASTY

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Thesis submitted in fulfillment
of the requirements for the degree of
Master of Science
(Mechanical Engineering)

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Total Hip Arthroplasty (THA) is one of the most successful and common procedures in orthopaedic surgery to treat the advanced stage of osteoarthritis. It is well-known that THA is a successful orthopaedic procedure by replacing the damage bone to restore the function anatomy and improved quality of life which promoting long term survivorship. However, THA has its own risk and complication that lead to poor outcomes due to implant stability during surgery. Thus, the Finite Element Analysis (FEA) was demonstrated to predict the implant stability by computational analysis of biomechanical behaviour. A 3D model of femoral bone was developed from Computed Tomography (CT) images of 54 years old patient. The cementless finite element model of THA was constructed at varus and sagittal from -3° to 3° to present the implant stability. The material properties of femur and prosthesis stem were assigned as cortical (E=17 GPa, ν=0.33) and Titanium alloy, Ti-6AL-4V (E=110 GPa, ν=0.3). The type of prosthesis stem design is an Anatomic Modularly Locking (AML) which specific for cementless hip arthroplasty. The static analysis was performed using finite element model of cementless THA with various implant position at varus and sagittal from -3° to 3° under loading condition of stair climbing. The results of maximum principle stress of cortical bone at varus and sagittal were compare with normal implant position. The maximum stress of proximal region at varus and sagittal were 102.20 MPa and 80.99 MPa whereas distal region were 82.76 MPa and 65.35 MPa. The effect of implant stability at varus is more significant compare to sagittal. The state of stresses based on implant stability at proximal and distal region where the cortical bone is bonded with implant. In analysis of implant stability, the stresses of varus and sagittal increases up to 75% and 39% respectively with respect to normal condition which are 58.26 MPa and 47.24 MPa. The average stresses of varus and sagittal at proximal and distal tip of prosthesis were 70% to 80% and 59% - 66%. The Von Mises stresses of prosthesis stem under stair climbing involved critical position at varus and sagittal (3° and -3°) were analysed. All the stresss state of cementless prosthesis stem were in range 310 MPa – 360 MPa. Therefore, all the results of stress were significantly lower than yield stresses of cortical bone and Titanium alloy which indicates no risk of fracture and failure.

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