UNIVERSITI PUTRA MALAYSIA

FINITE ELEMENT METHOD PREDICTION OF HIP PROSTHESIS IN BONE RESORPTION ENVIRONMENT

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Total hip replacement (THR) is normally done for the failure of hip joint caused by osteoarthritis. It is performed to relief pain and to improve functionality. Issues related to the study include method to reduce fixation failure, means to improve the longevity of the prosthesis, methods to reduce the factors contributing to probability of failure such as cement strength, implant interface strength, and loosening. The present work focused on failure related to stress related only. The main aim of this work is to study the inner failure stress for THR and to suggest recommended functional activities for patient whom undergoes THR. By knowing the stress for the inner bone, the failure mechanisms of THR for different dynamics loadings can be predicted more objectively. For this study, ANSYS Workbench version 11.0 was used for the Finite Element (FE) analysis. The values of stress and strain distributions in anterior (A), posterior (P), medial (M) and lateral (L) positions of the healthy femoral bone and THR were obtained. The stress and strain distributions of inner healthy femoral bone surface subjected to standing were studied. The effect of materials on the variations of stress and strain of the outer and inner surface of the

healthy bone were studied and determined. Hip prosthesis and hip prosthesis with bone resorption for different functional activities such as standing, walking, stair-climbing, single-legged stance, abductor, and adductor loads was studied. Failure mechanisms of hip implant were determined and THR life was predicted. The values of von Mises stressess and strains for inner surface of the femur and consideration of bone resorption are essential for the study of Total Hip Replacement (THR). The restricted types of activities for the patient who undergoes THR surgery were recommended. From this study it was found that the THR the patient should not do activities such as stair climbing and adduction. The data for inner stress can be used as a guide for future implant design and surgical procedure.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia

sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

RAMALAN ALAT GANTI TULANG PEHA DALAM PERSEKITARAN PENGECUTAN TULANG MENGGUNAKAN KAEDAH UNSUR TAK TERHINGGA

Oleh

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Pengerusi: Profesor Ir. Barkawi bin Sahari, PhD

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Prosedur menggantikan tulang peha dilakukan terhadap tulang paha yang menghidap penyakit osteoartritis. Tulang peha digantikan bagi menghilangkan kesakitan dan membantu meningkatkan fungsi gerakan. Dalam kajian alat ganti tulang peha, terdapat beberapa isu penting, antaranya teknik mengurangkan kegagalan pelekat, tatacara memanjangkan hayat, teknik mengurangkan faktor-faktor penyebab kegagalan seperti jenis beban, kekuatan simen, kekuatan antara muka implan, dan tatacara meramalkan kelonggaran alat ganti tulang peha pada jangka masa tertentu. Skop kajian ini bertumpukan kegagalan yang berkaitan dengan tegasan sahaja. Objektif utama kajian ini ialah mengkaji kegagalan tegasan pada bahagian dalam tulang peha dan mencadangkan aktiviti yang sesuai bagi pesakit yang menjalani pembedahan tulang peha. Dengan mengetahui nilai tegasan pada bahagian dalam tulang peha, mekanisma kegagalan bagi pelbagai beban dinamik dapat diramal dengan lebih objektif. Untuk kajian ini, perisian ANSYS Workbench versi 11.0 digunakan. Nilai taburan tegasan dan terikan bagi tulang peha yang sihat pada kedudukan anterior (A), posterior(P), medial (M) dan lateral(L) telah diperolehi. Taburan tegasan dan terikan bagi tulang peha yang sihat semasa berdiri diperolehi. Perubahan tegasan dan terikan bagi penggunaan bahan berbeza juga dikaji dan diperolehi. Bagi analisis untuk tulang peha dengan implan, dan

tulang peha mengecut dengan implan pula, pelbagai aktiviti telah dilakukan seperti berdiri, berjalan, menaiki tangga, angkat kaki sebelah, abduksi dan adduksi. Nilai tegasan bagi pelbagai aktiviti diperolehi dan dibentangkan. Mekanisme kegagalan telah dikaji dan diperolehi. Nilai-nilai tegasan dan terikan bagi permukaan dalam tulang peha mengecut amat penting untuk diketahui. Pesakit perlu menghadkan pergerakan mereka setelah pembedahan. Pesakit juga dinasihatkan untuk mengurangkan aktiviti menaiki tangga dan adduksi. Maklumat bagi tegasan mekanikal ini amat berguna sebagai panduan merekabentuk alat ganti tulang peha dan prosedur pembedahan.

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TABLE OF CONTENTS