BASIC STUDY OF INTERFERENCE SCREW FIXATION STABILITY IN ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

BY:

ABDUL HALIM ABDULLAH
JAMALUDDIN MAHMUD
HELMI RASHID
MUHAMAD FAUZI OTHMAN
ALIAS MOHD SAMAN

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Contents

2. Letter of Offer (Research Grant)

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PEMENANG Anugerah Kualiti Perdana Menteri 2008

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En Abdul Halim Abdullah
Fakulti Kejuruteraan Mekanikal
Universiti Teknologi MARA
40450 SHAH ALAM

Y. Bhg. Prof/Prof. Madya/Dr./Tuan/Puan

KELULUSAN SKIM GERAN PENYELIDIKAN FRGS FASA 02/2010

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Dengan hormatnya perkara di atas adalah dirujuk.

2. Sukacita dimaklumkan pihak Kementerian Pengajian Tinggi melalui surat JPT.S(BPKI) 2000/011/010 Jilid. 4 (4) telah meluluskan cadangan penyelidikan Y. Bhg Prof/Prof. Madya/Dr./Tuan/Puan untuk di biayai di bawah Skim Geran Penyelidikan Fundamental (FRGS) Fasa 02/2010.

3. Bagi pihak Universiti kami mengucapkan tahniah kepada Y. Bhg. Prof/Prof. Madya/Dr./Tuan/Puan kerana kejayaan ini dan seterusnya diharapkan berjaya menyiapkan projek ini dengan cemerlang.

4. Untuk tujuan mengemaskini, pihak Y. Bhg. Prof/Prof. Madya/Dr./Tuan/Puan adalah di minta untuk mengisi borang setuju terima projek penyelidikan dan menyusun perancangan semula bajet yang baru seperti yang diluluskan. Sila lihat lampiran bagi tatacara tambahan untuk pengurusan projek.

Sekian, harap maklum.

"SELAMAT MENJALANKAN PENYELIDIKAN DENGAN JAYANYA"

Yang benar

MUSTAFAR KAMAL HAMZAH
Ketua Penyelidikan (Sains dan Teknologi)

5.2 Enhanced Executive Summary

The failure of anterior cruciate ligament (ACL) produces abnormal kinematics of the knee joint and leads to knee instability. Graft fixation is the critical issue in the ACL reconstruction especially during the primary post operative period. Interference screw has become as one of the most common used fixation methods for ACL reconstruction.

The objectives of this research are to develop the mechanical concept and finite element model of interference screw fixation in ACL reconstruction. Also, to investigate the fundamental mechanical factors that contribute to the primary stability of the fixation such as material properties of screws, screws geometry and screw positioning and alignment.

Finite element analysis are conducted and discussed with respect of stress distribution and total displacement. Results show that all investigated factors do influenced the primary stability of the ACL reconstruction. Proper stress distribution and total displacement at the interference screw fixation will enhance the primary stability of the ACL reconstruction. Interference screws with different materials will reflect the graft fixation in the tunnels. Screws with dedicated bio-absorbable materials are believed to represent the best choice in terms of displacement and stress development. In the second case study, the root of the thread of the interference screw is found out to develop more stress under loading compared to other regions. The results obtained show that the more thread the interference screw posses; the stronger the fixation will be and also, the fixation improved with a larger diameter of screw size. Finally, the 3rd study represent the effects of different positioning during the ACL reconstruction procedure. The maximum tunnel and screw deformation occur in 90 degree knee flexion fixation. Minimum tunnel and screw deformation was observed in 60 degree knee flexion fixation. The maximum tunnel and screw stress has been found in 90 degree knee flexion fixation and decreases proportionally to the load and angle of fixation to 60 degree.

Outcomes of the study shows that the mechanical factors are important to predict the primary stability of the interference screw fixation of ACL reconstruction.

5.3 Introduction

Stability of the knee is controlled by several ligaments so-called anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), medial collateral ligament (MCL), lateral collateral ligament (LCL), and other supporting tissue structures (joint, capsule, muscle, tendons, and menisci. The menisci functions as to restraints anterior posterior translation and is important in ACL deficient knee (Swenson and Harner, 1995). ACL is the primary restraint preventing posterior displacement of the femur relative to tibia and acts as a secondary restraint to varus-valgus rotation and internal-external rotation (Dienst et al., 2002).

The ACL consist of two bundles group together named anteromedial and pasteromedial bundles. These two bundles are under variable stress during the flexion-extension motion of the knee (Dienst et al., 2002). Due to anterior tibial translation, the anteromedial is under constant load when the flexion–extension motion is applied while posteromedial undergone near maximum extension (Maestro et al., 2010). The ACL is also under variable stress when the tibia is rotating and the knee is taken away by force (Hashemi et al., 2010).

Some activities may cause the ACL ligaments to tear and rupture. For examples, conditions of rapid deceleration, sharp or sudden change in direction (cutting), heavy or stiff-legged landing and twisting or turning the knee while landing. This rupture will produces abnormal kinematics of the knee, which may contribute to knee instability, particularly during cutting and pivoting, recurrent injury, damage to the menisci and the articular cartilage and also, osteoartrosis. The damage of the progression of intra-articular can be overcome by restoring the stability of the knee (Hashemi et al., 2010; Meisterling et al., 2009).

Different approaches of treatment were developed to treat the ruptured ACL and to restore knee stability. Conventional approaches involved reconstruction with inadequate graft material and extra-articular procedures are technically inferior. Consequently, the usage of a biologic graft is currently the treatment choice to reconstruct them (Fu et al., 1999). The femoral tunnel is drilled through the tibial tunnel. It is drilled into the bone at the spot where the ACL is normally attached to the femur. A guide pen is used to pull the ACL graft through the tibial tunnel across the joint and into the femur. Knee is fully flexed and the interference screw is secured into the femoral tunnel. At the same time, it also secured the graft in the femoral tunnel (Kousa et al., 2003).