Finite Element Study: Effect of Emergency Brake on Total Knee Arthroplasty

Iskandar S. F.[1], Mas Ayu H.[2], Rosdi Daud[3], Tomadi S. H.[4], Shah A.[5]*

[1]*Engineering College, Universiti Malaysia Pahang, 26300 Gambang, Pahang, Malaysia*
[2]*Faculty of Manufacturing and Mechatronic Engineering Technology, Universiti Malaysia Pahang, 26600 Pekan, Pahang, Malaysia*
[3]*Faculty of Mechanical and Automotive Engineering Technology, Universiti Malaysia Pahang, 26600 Pekan, Pahang, Malaysia*
[4]*Department of Manufacturing and Materials Engineering, Faculty of Engineering, International Islamic University Malaysia, P.O. Box 10, 50728 Kuala Lumpur, Malaysia*
[5]*Faculty of Technical and Vocational, Universiti Pendidikan Sultan Idris, 35900, Kuala Kubu Bharu, Perak, Malaysia*
**masszee@ump.edu.my*

Keywords: Total knee arthroplasty, von mises stress, emergency brake impact, sorbothane, finite element analysis

Abstract

Patients often ask whether they may resume driving after total knee arthroplasty (TKA). Driving a vehicle is necessary for mobility, flexibility, and independence, but it is often hampered by discomfort, the use of walking aids, and partial weight bearing after lower limb surgery. As a result, patients usually enquire about recovery durations and when they will be able to safely drive again after total knee arthroplasty (TKA). The aim of this project is to highlight the relevance of using FEM along with TKA in performing emergency brake. In this study, we used two different design (commercially available in the market as a reference and newly proposes design) which were constructed using Solidworks software. The load (effect inertia of emergency brake) are applied to the tibial component and femoral component were created with fixed boundary condition. The femoral component were adjusted to 0^0, while the tibial component were adjusted to 120^0 to mimic the actual driving position. The currently available model and newly proposed model of TKA were used to compare the von mises stress distribution when it comes to the impact force during emergency braking situation. The maximum value of von mises stress for design 1 when comparing the 9.881x109 N/m^2was considerably significantly different with the value of 1.807x108 N/m^2 for design 2. It implies that the potential effect of the sorbothane in the design 2 which prominent as the impact absorber of the emergency brake. It can be concluded that the total knee arthroplasty (TKA) performed better with the sorbothane during emergency brake since the lower maximum stress in the TKA can reduce the possibility of failure of the polyethylene and thus can also reduce the possibility of failure of the tibia tray and loosening.

1 Introduction

Patients often ask whether they may resume driving after total knee arthroplasty (TKA). Driving a vehicle is necessary for mobility, flexibility, and independence, but it is often hampered by discomfort, particularly while performing an emergency stop, and may lead to TKA problems or failure. As a result, patients usually enquire about recovery durations and when they will be able to safely drive again after doing total knee arthroplasty (TKA). Total Knee Arthroplasty (TKA) also known as Total Knee Replacement, is a surgical procedure to resurface a knee damaged by arthritis [1]. Someone who has severe arthritis or a severe knee injury encouraged to do this surgery. The objective of knee replacement surgery is to resurface the part of the knee joint that have been damaged and to relieve knee pain that cannot be controlled by other treatment cause the patient suffering. Fig. 1 shown the metal and plastic components are utilised to cover the ends of the bones that make up the knee joint, as well as the kneecap, before replacing it with a prosthesis consisting of metal alloys, high-grade plastics, and polymers [1, 2]. If you have severe arthritis or a major knee injury, you may want to consider this operation.

The knee joint may be affected by a variety of arthritis forms. The degradation of joint cartilage and neighbouring bone in the knees may be caused by osteoarthritis, a degenerative joint disease that mostly affects middle-aged and older persons.

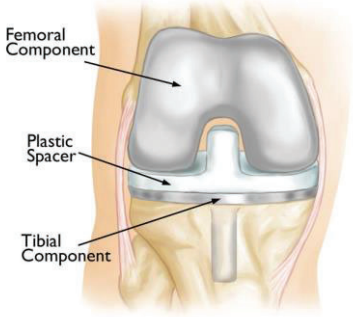

Fig. 1: Example of TKA Model [3]