Sarvesh Kumar G et al., J Aeronaut Aerospace Eng 2014, 3:2
http://dx.doi.org/10.4172/2168-9792.S1.005

OMICS Group Conferences
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2nd International Conference and Exhibition on
Mechanical & Aerospace Engineering
September 08-10, 2014 Hilton Philadelphia Airport, USA

A study on 3d finite element analysis of anterior cruciate ligament behavior on full extension

Sarvesh Kumar G and **Adinarayana S**
MVGR College of Engineering, India

The present study deals with the force and stress distribution within the anteromedial (AM) and posterolateral (PL) bundles of the anterior cruciate ligament (ACL) in response to an anterior tibial load with the knee at full extension was calculated using a validated three dimensional finite element model (FEM) of a human ACL. The interaction between the AM and PL bundles, as well as the contact and friction caused by the ACL wrapping around the bone during knee motion, were included in the model. The AM and PL bundles of the ACL were simulated as incompressible homogeneous and isotropic hyperelastic materials. The validated FEM was then used to calculate the force and stress distribution within the ACL under an anterior tibial load at full extension. The AM and PL bundles shared the force, and the stress distribution was non-uniform within both bundles with the highest stress localized near the femoral insertion site. The contact and friction caused by the ACL wrapping around the bone during knee motion played the role of transferring the force from the ACL to the bone, and had a direct effect on the force and stress distribution of the ACL. This validated model will enable the analysis of force and stress distribution in the ACL in response to more complex loading conditions and has the potential to help design improved surgical procedures following ACL injuries.

sarvesh.gantala@gmail.com