World Academy of Science, Engineering and Technology
International Journal of Biomedical and Biological Engineering
Vol:9, No:03, 2015

The Effect of Fibre Orientation on the Mechanical Behaviour of Skeletal Muscle: A Finite Element Study

Authors : Christobel Gondwe, Yongtao Lu, Claudia Mazzà, Xinshan Li

Abstract : Skeletal muscle plays an important role in the human body system and function by generating voluntary forces and facilitating body motion. However, The mechanical properties and behaviour of skeletal muscle are still not comprehensively known yet. As such, various robust engineering techniques have been applied to better elucidate the mechanical behaviour of skeletal muscle. It is considered that muscle mechanics are highly governed by the architecture of the fibre orientations. Therefore, the aim of this study was to investigate the effect of different fibre orientations on the mechanical behaviour of skeletal muscle.In this study, a continuum mechanics approach–finite element (FE) analysis was applied to the left bicep femoris long head to determine the contractile mechanism of the muscle using Hill's three-element model. The geometry of the muscle was segmented from the magnetic resonance images. The muscle was modelled as a quasi-incompressible hyperelastic (Mooney-Rivlin) material. Two types of fibre orientations were implemented: one with the idealised fibre arrangement, i.e. parallel single-direction fibres going from the muscle origin to insertion sites, and the other with curved fibre arrangement which is aligned with the muscle shape.The second fibre arrangement was implemented through the finite element method; non-uniform rational B-spline (FEM-NURBs) technique by means of user material (UMAT) subroutines. The stress-strain behaviour of the muscle was investigated under idealised exercise conditions, and will be further analysed under physiological conditions. The results of the two different FE models have been outputted and qualitatively compared.

Keywords : FEM-NURBS, finite element analysis, Mooney-Rivlin hyperelastic, muscle architecture
Conference Title : ICCB 2015 : International Conference on Computational Biomechanics
Conference Location : London, United Kingdom
Conference Dates : March 14-15, 2015