Plenary Lecture

ON THE EQUILIBRIUM AND STABILITY OF THE KNEE JOINT IN GAIT

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Keywords: Knee joint, Musculoskeletal model, Gait, Stability, Anterior cruciate ligament, Contact forces

Summary: Improved understanding of the knee joint biomechanics and factors affecting it in gait as the most common activity in human life is essential in prevention and treatment managements of joint disorders. Musculoskeletal models often make a number of crucial assumptions when attempting to estimate muscle forces and joint loads. The knee is routinely idealized as a planar 2D joint in the sagittal plane with no consideration of out-of-plane motions and equilibrium, the joint passive properties are overlooked, the joint center is assumed to coincide with the joint center of reaction at all gait periods, fixed locations for contact points at both condyles are taken when estimating medial/lateral contact forces, and the joint stability in intact and injured conditions is totally neglected. Large scatter exists in reported gait kinematics-kinetics that are due to inter-subject differences, marker arrangements-placements, joint coordinate system and skin artifact. We present here a lower extremity hybrid musculoskeletal model driven by gait kinematics-kinetics to compute muscle forces and internal loads in the stance phase of gait. Effects of changes in tibial posterior slope, coactivity in muscles, joint planar assumption, input kinematics-kinetics and ACL presence on muscle/contact/ligament forces, centers of pressure on each plateau and joint stability are then computed.
Results highlight the substantial effect of variations in foregoing parameters on equilibrium and stability results. Large unbalanced out-of-sagittal plane moments reaching peaks of 30 Nm abduction moment and 12 Nm internal moment at 25% stance period are overlooked in a planar 2D model resulting in lower muscle, ACL and tibiofemoral contact forces when compared to the 3D reference model. The location of contact centers on each plateau also noticeably alters. Changes (by ±SD) in the knee flexion-extension and varus-valgus rotations have more effects on results compared to similar changes in their moments which are due partly to the substantial alterations in the knee passive resistances. The computed effects on ACL forces of changes in flexion-extension rotation are similar to those of alterations in the posterior tibial slope. The joint stability is mainly affected by input flexion-extension rotations and moments and joint compression forces.
Acknowledgement: supported by NSERC-Canada.