INFLUENCE OF INERTIAL FORCES IN MULTI-SCALE MECHANICS OF THE HIP JOINT

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Resumen
Development of multi-scale model of human gait must face the double proposition to integrate different scales and to translate a dynamic reality into static loads. The representation of inertial loads into static loads at a specific time point is poorly addressed. Hence, the goal of this study was to evaluate the influence of inertial forces on cartilage load in the hip.
A multi-scale approach combined a musculoskeletal rigid body (RB) model with a deformable Finite Element Model (FEM) of the hip joint. At the organ-tissue scales, a hip joint FEM was used [Sánchez, 2014]. The boundary loads on the FEM were automatically extracted from subject motion analysis through the RB model.
In order to convert the RB dynamics into a static problem for the FEM, the pelvis was fixed, and d'Alembert forces were applied to the femur as body forces. The influence of inertial forces on the FE calculations was studied, in addition to that of body weight and muscle forces.
In the stance phase simulation shows load distributions similar to experimentally measured contact stress distributions [Henak, 2013]. Inertial forces did not statistically affect this distribution. However, during the swing phase, the overall application of forces was completely reversed by the application of inertial forces showing a great influence of d'Alambert forces into the analysis of different gait phases. Finally results suggest that the analysis of cyclic cartilage loads during gait requires full multiscale coupling, including inertial loads.

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References
Henak, C. R. et al., J. Biomech. Eng. 2013;
Sánchez Egea et al., Clin Biomech, 2014;