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Stress Evaluation at Lower Extremity during Walking with Unstable Shoe

Authors : Sangbaek Park, Seungju Lee, Soo-Won Chae

Abstract : Unstable shoes are known to strengthen lower extremity muscles and improve gait ability and to change the user's gait pattern. The change in gait pattern affects human body enormously because the walking is repetitive and steady locomotion in daily life. It is possible to estimate the joint motion including joint moment, force and inertia effect using kinematic and kinetic analysis. However, the change of internal stress at the articular cartilage has not been possible to estimate. The purpose of this research is to evaluate the internal stress of human body during gait with unstable shoes. In this study, FE analysis was combined with motion capture experiment to obtain the boundary condition and loading condition during walking. Motion capture experiments were performed with a participant during walking with normal shoes and with unstable shoes. Inverse kinematics and inverse kinetic analysis was performed with OpenSim. The joint angle and muscle forces were estimated as results of inverse kinematics and kinetics analysis. A detailed finite element (FE) lower extremity model was constructed. The joint coordinate system was added to the FE model and the joint coordinate system was coincided with OpenSim model's coordinate system. Finally, the joint angles at each phase of gait were used to transform the FE model's posture according to actual posture from motion capture. The FE model was transformed into the postures of three major phases (1st peak of ground reaction force, mid stance and 2nd peak of ground reaction force). The direction and magnitude of muscle force were estimated by OpenSim and were applied to the FE model's attachment point of each muscle. Then FE analysis was performed to compare the stress at knee cartilage during gait with normal shoes and unstable shoes.

Keywords : finite element analysis, gait analysis, human model, motion capture
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