



In Vivo Verification of Different Hip Joint Center Estimation Methods in Gait Analysis for Healthy Subjects

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Abstract: Hip joint is one of the most stable joints in human body. It has intrinsic stability provided by its relatively rigid ball and socket configuration. The hip joint also has a wide range of motion, which allows normal locomotion and daily activities. Location of hip joint center (HJC) is an important parameter in gait analysis, biomechanical and clinical research laboratories to calculate human lower extremity kinematics and kinetics. Inaccuracies in estimation of hip joint center are shown to propagate errors in kinematic and kinetic calculations of lower extremities. In literature there are different methods to determine HJC. Although invasive methods like radiography, computed tomography and magnetic resonance imaging may be used to determine the location of HJC, in gait analysis laboratories, non-invasive functional and/or predictive methods are generally found to be more advantageous. Calculation of gait parameters from stereophotogrammetric data requires utilization of classical mechanics together with biomechanical models which represents human body as a mechanical system. Obviously, procedures employed in these calculations are directly associated with the experimental protocol. Adaptation of various joint center estimation methods to Middle East Technical University (METU) gait analysis system Kiss (*Kinematic Support System* in English, *KasİskeletSistemi* in Turkish) and investigation of the effects of joint center location on kinematic results undoubtedly require modifications to be introduced to the experimental protocol, and consequently, to the calculation methodology. METU gait analysis system, utilizes one of the predictive methods, the Davis method to determine hip joint center location. This method is very straightforward and easy to use. However, in this method the determinations of the position of anatomical landmarks depend on the experience of the conductor and anatomical properties of the specimens (any anatomical variations of the specific subject will cause errors). One of the major sources of error propagation in kinematic and kinetic calculations is due to misplacement of hip joint center. This study aims to experimentally verify different HJC estimation methods with those obtained from MRI in healthy subjects for the purpose of demonstrating and validating the contribution of MRI procedure in METU gait analysis system. Also combination of Bell's method in posterior direction, Davis method in distal direction and Bell's method in medial direction was analyzed and the results were criticized for the accuracy.