Hip Center Edge Angle and Alpha Angle Morphological Assessment Using Gait Analysis in Femoroacetabular Impingement

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Disclosures:

Introduction: Symptomatic femoroacetabular impingement (FAI) is a morphological disorder of the hip characterized by pain, soft tissue damage, and decreased function. The proximal femur and/or acetabulum mark the irregular hip anatomy and are thought to lead to the labral and articular cartilage damage. Kinematic and kinetic gait deviations have been observed in subjects with FAI and other disorders of hip morphology.(1-3) Hip morphology is routinely evaluated by the alpha angle, measuring femoral head asphericity,(4) and acetabular overcoverage of the femoral head and neck is measured by the center edge angle.(5) Despite emerging research, the nature of the relationship between hip morphology and gait is still unclear. The purpose of this study was to examine possible associations between routine radiographic measures such as the alpha angle or center edge angle and variables obtained through quantitative gait analysis in symptomatic FAI cohorts. Our hypothesis is that when FAI is diagnosed through alpha angle and/or center edge angle, significant associations with gait variables will be also present. Ultimately, the long term goal is to establish a new instrument for FAI diagnostics and functional assessment using gait parameters.

Methods: This IRB-approved study recruited 15 subjects scheduled for hip arthroscopy due to FAI (age 32±8 y, 11F/4M, BMI 23.8±5 kg/m^2, Hip Outcome Score-Activities (HOS) of Daily Living subscale 66±15, HOS Sport subscale 42±22). All subjects prior to testing completed informed consent. Subjects with prior back or lower extremity injuries or surgeries were excluded. A single observer (the senior clinician author in this study) measured alpha angle (58.9±9.2, range 37-75.5°) and center edge angle (35.9±12.4, range 24.5-67°) values on AP pelvis and Dunn lateral view radiographs, respectively. Gait analysis was performed using standard published methods.(6) An optoelectronic camera system (Qualisys, Gothenburg, Sweden) recorded the 3D position of passive retroreflective markers placed bilaterally on lower extremity bony landmarks (the most superior point of the iliac crest, anterior superior iliac spine, the greater trochanter, lateral knee joint line, lateral malleolus, lateral most point on the calcaneus, and the second and fifth metatarsal). A multicomponent force plate (Bertec, Columbus, OH) measured ground reaction force and location by inverse dynamics. Spatiotemporal parameters were calculated the hip, knee, and ankle about the 3D position of the markers and anthropometric measures were employed to find the joint centers relative to marker placement, and the ground reaction force’s magnitude and location. Subjects completed 15 trials per limb at 5 slow, 5 normal, and 5 fast selected speeds. For this study, we averaged data collected from the surgical-side for the 5 trials at each subjects’ normal speed. We selected the dynamic hip, knee, and ankle range of motion in the sagittal plane and peak external moments (normalized to subject body-weight×height) about the lower extremities. Pearson correlations were used to evaluate relationships between radiographical parameters and the gait variables. An alpha level of 0.05 was used to detect significant differences analyses.

Results: The data showed significant and inverse correlations between the center edge angle and the maximum hip flexion angle (R=-0.534, p=0.040; Figure 1A) and the peak external hip adduction moment (R=-0.547, p=0.035; Figure 1B), indicating higher center edge angles correlated with decreased maximum hip flexion and a reduced peak external hip adduction moment. There was a moderate correlation between the alpha angle and the maximum ankle flexion angle, smaller alpha angles correlated with greater dorsiflexion (R=-0.475, p=0.074; Figure 1C). Other correlations were not as strong but maintained its inverse nature (R≥-0.482, p=0.111-0.946).

Discussion: Despite the small sample size the strong relationships seen with this preliminary data are encouraging and support the hypothesis that the hip morphological abnormalities are directly related to planar kinematic and kinematic gait variables. The peak external hip adduction moment, related to morphology, represents the net activity of hip abductors. The maximum hip and ankle flexion angles are related to the flexion end range of motion, respectively. The results here parallel some previous literature noting variations in range of motion and moments, thus suggesting deficits in kinematic and kinetic variables leading to decreased functional activity in FAI cohorts.(1-3) Further investigation is needed to continue to illuminate the nature and importance of these relationships.

Significance: The results of this study elucidate the relationship between morphological and functional impairment in FAI using the gait analysis as a dynamic assessment. A better understanding of these relationships could help optimize diagnostic techniques and surgical and nonsurgical management of morphological disorders.
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