Sagittal Plane Leg Kinematics Following Total Hip Arthroplasty During Stair Ascension and Descension

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INTRODUCTION: The direct anterior approach (DAA) is a relatively novel orthopedic surgical technique in total hip arthroplasty (THA). There are conflicting conclusions regarding the efficacy and outcome of DAA compared to other methods of THA. It is thought that DAA causes decreased pain and shorter recovery time.[1-3] No radiographic difference has been seen in hip abduction and anteversion when compared to the posterior approach.[2] Some studies have found an increase in complications, such as, neuropraxia of the lateral cutaneous nerve, aseptic stem loosening and decreased time between primary and revision.[4,5] On stairs specifically, DAA has shown reduced hip extension, flexion and power during stair ascension and descension compared to controls, but no analysis compared anterior to posterior approach groups.[6] Our goal of the study was to determine if there are kinematic differences between the affected and unaffected side in the sagittal plane after DAA THA. We hypothesized the DAA group will have symmetrical kinematics between affected and unaffected sides during stair ascension and descension.

METHODS: Participants underwent a unilateral DAA THA at least one year prior to data collection for osteoarthritis. Exclusion criteria were contralateral hip disease, age over 75, BMI over 35, use of gait aids, other surgeries on the lower extremity, post-operative complications, and neuromuscular disease. A total of eleven participants (66 ± % 5 years old; 1.7 ± 0.1 m; 27 ± 5 BMI) completed the IRB-approved protocol following written informed consent. Data was collected at the MCW Center for Motion Analysis. Height, weight, pelvic width, leg lengths, knee widths, and ankle widths were measured for each participant. Reflective markers were placed on the sacrum, as well as bilaterally on the superior iliac spine, patella, lateral femoral epicondyle, lateral malleolus, calcaneus, and head of the second metatarsal in accordance with a modified Helen-Hayes marker set. Participants were asked to begin motion analysis by climbing stairs; three steps ascending and three steps descending. Data were collected from twelve infrared Vicon MX40 cameras using Vicon Nexus 2.11 software. Kinematics averages were calculated across trials throughout a single full stride cycle during stair ascension and descension. Data were assessed for symmetry as affected versus unaffected sides using a Welch's t-test with significance set at $p < 0.05$.

RESULTS: The affected side showed less ankle dorsiflexion during the load response portion of the gait cycle when ascending stairs and during midstance when descending stairs with a consistent trend of a plantarflexion shift throughout the cycle while ascending stairs and during stance descending stairs (Figure 1). The affected side showed significantly less knee flexion than the unaffected side for a short time during midstance, though it trended this way for more of the stance phase (Figure 1).

DISCUSSION: Our results did not fully support the original hypothesis. We found greater dynamic hip ROM following DAA along with altered ankle kinematics. The extensor shift in all leg joints suggests an altered biomechanical approach to stairs following the DAA approach to THA. Additional analyses will include assessing the synchronized EMG collected during the testing session to determine if there is a muscular activation alteration associated with the kinematic changes. Future work will consist of recruiting and analyzing patients that have undergone posterior THA to compare to our DAA results.

CLINICAL RELEVANCE: There has been limited research assessing the DAA using motion analysis, especially in the setting of climbing stairs. These results demonstrate a post-operative alteration to ambulating on stairs following a DAA to THA.

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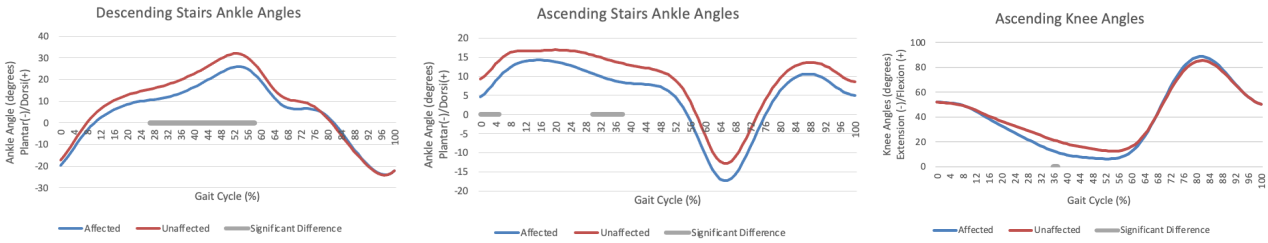

Figure 1: Average sagittal plane kinematics of the ankle while descending stairs (left) and ascending stairs (middle) as well as knee kinematics while ascending stairs (right) plotted for one full stride. Blue lines represent the side that underwent THA and red lines represent the contralateral side. Gray bars along the x-rays indicate times points of significant differences between sides.