Introduction: Knee OA is a common cause of decline in function and is generally associated with joint malalignment and laxity, joint space narrowing, quadriceps weakness, as well as sclerosis and attrition of subchondral bone (1–4). Hyaluronic acid (HA), also known as hyaluronan contributes to the lubricating mechanisms of synovial fluid (5). Intra-articular (IA) injections of HA are indicated to palliate symptoms and improve function in patients with knee OA. Primary outcome measures in studies on the efficacy of this treatment are largely self reports of pain and function. Information on the effect of HA injection on kinematic variables or on performance during functional tasks and muscle performance is limited.

The purpose of the study was to investigate the effects of HA injections on knee function and sagittal plane kinematics in patients with knee OA. In addition to short term changes in outcome measures, the persistence of significant treatment effects were evaluated.

Materials and Methods: Thirty subjects with symptomatic knee OA and scheduled for 5, weekly, IA injections of HA were recruited. The group had a mean BMI of 30.1±2.5 kg/m2 and a mean age of 52.9±10.0 years. Each subject was tested for baseline data. Post-treatment testing sessions were conducted within 3 weeks of finishing the series of HA and again five months after treatment.

Kinematic data were collected at 120 Hz using an eight camera motion analysis system (VICON, Oxford Metrics). Joint centers were defined by a static calibration trial. Rigid shells with tracking markers were attached to bilateral thighs and shanks. Marker trials were further placed on the sacrum and on each foot to track movement. Subjects walked a 10 m walkway at self-selected pace. Ten walking trials were collected and averaged. Kinematics were calculated using rigid body analysis and Euler angles.

Knee function was assessed with a knee specific questionnaire (Knee Outcome Survey (KOS)) and a global rating of self perceived knee function, goniometric range of motion (ROM) measures, a six minute walk (6MW) and a timed stair climbing task (SCT). Quadriceps strength was evaluated isometrically at 90° with a KinCom dynamometer (Chattanooga Group, Inc., Chattanooga, TN). The output (Newtons (N)) was normalized to Body Mass Index (BMI) and expressed as a ratio of the force output of the involved vs. uninvolved side (Quadriceps Index (QI)).

Repeated measures analysis of variance (ANOVA), multivariate analysis, linear regression analysis and paired t-tests were used to analyze the data. Alpha was set at 0.05.

Results: Multivariate analysis of knee flexion angles was used at two stages of weight acceptance; initial contact (IC) and peak knee flexion (PKF) between involved (INV) and uninvolved (UNINV) knees across the three testing times. The analysis showed an interaction between stage of weight acceptance and side (F=18.716; p=0.001). There were significant interlimb differences in knee excursion during weight acceptance (flexion angle from IC to PKF) for the first (5.3°; p=0.005), second (5.2°; p=0.001) and third (5.2°; p=0.001) testing times; the affected knee demonstrating less movement. Excursions of the INV and UNINV knees did not change across testing times.

Multivariate analysis of goniometric total knee ROM between the INV and UNINV knee across testing times showed an interaction by side (F=29.996; p<0.001) but not for testing time. The INV knee’s ROM was on average 8° less than that of the UNINV at the first testing session (p=0.003), 5.2° less at the second (p<0.001) and 7.2° less at the third testing session (p=0.001). Knee ROM of either knee did not change across testing times.

Larger knee flexion ROM at baseline predicted greater improvement on KOS scores on the first post-treatment testing session (r²=.540; p=0.004). Larger knee flexion ROM at the first post-treatment predicted greater improvements on KOS scores at the later testing session (r²=.398; p=0.021).

Significant within-subjects effects of testing times on KOS scores were found (F=4.65; p=0.02) as well as on global rating scores (F=4.084; p=0.036), on 6MW distance (F=12.010; p=0.001) and QI (F=5.903; p=0.013).

Discussion: Subjects demonstrated significantly improved function after a series of intra-articular hyaluronan injections as evaluated with the KOS and functional testing. Despite improved self-reported knee function and performance on the 6MW test, however, kinematic interlimb differences were unchanged across testing times. Goniometric measures of total knee range of motion confirmed interlimb differences in available joint ROM. Although subjects demonstrated ample functional ROM, this was not utilized during weight acceptance. The truncated knee flexion may impede the shock absorbing mechanism of the knee and impact the progression of knee OA.

While improvements in self reported scores were not maintained at the 5 month evaluation, walking distance continued to improve over time. This indicates that function continued to improve despite concurrent greater symptoms.