Paper #37

IN-VIVO MEASUREMENTS OF ISCHIOFEMORAL DISTANCE IN RECREATIONALLY ACTIVE SUBJECTS DURING DYNAMIC ACTIVITIES: A HIGH-SPEED DUAL-FLUOROSCOPY STUDY

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Summary: Ischiofemoral distance was measured in-vivo in an asymptomatic population using dual-fluoroscopy during standing and dynamic activities. Compared to the standing trial, minimum ischiofemoral distance was significantly reduced during all dynamic activities, with the least distance during the external rotation pivot (10.3±3.6 mm). Ischiofemoral distance was smaller in females than males.

Ischiofemoral impingement is a recently recognized cause of extra-articular hip pain, believed to occur during hip extension, adduction, and external rotation. Ischiofemoral impingement is a dynamic process, yet guidelines to diagnose this condition are based on the distance between the lesser trochanter and ischium as measured by static, supine magnetic resonance imaging (MRI) scans (where >17 mm in female subjects was considered normal) [1]. One MRI study incorporated dynamic motion, but only investigated external rotation without weight-bearing [2]. In this study, we established baseline measurements of ischiofemoral distance in asymptomatic

controls during dynamic activities of daily living by coupling patient-specific computed tomography (CT) generated 3D models with dual-fluoroscopy to visualize in-vivo hip motion.

Eleven young, asymptomatic, recreationally active adults (6 males, aged 23±2 years, BMI of 21.1±1.9 kg/m2) were recruited. CT images were acquired and 3D reconstructions of the pelvis and femur were generated. Dual-fluoroscopy images were acquired at 100 Hz during a static standing trial, an external pivot, level treadmill walking and inclined (5 degrees) treadmill walking at a self-selected speed (1.29±0.11 m/s) [3]. Projections calculated from the 3D bone reconstructions were aligned with dual-fluoroscopy images to generate animations of bones moving in-vivo (previously validated to an error ∼ 0.6 mm) [4]. Bone-to-bone distance between the lesser trochanter and ischium was determined for each video frame [5]. Ischiofemoral distances were evaluated for normality using Shapiro's test. The minimum and range of ischiofemoral distance were compared across activities and gender using a paired and two sample Student's T-test, respectively, with Finner's correction for multiplicity.

Minimum ischiofemoral distance occurred during the pivot for 10/11 subjects and incline walking for 1/11 subjects. Minimum ischiofemoral distance (mean±SD) during the standing trial was 25.9±6.3 mm. Minimum distance was reduced during all dynamic activities when compared to standing ($p < 0.001$ for all). During pivoting, minimum distance was 10.3±3.6 mm; during level and inclined walking, the minimum distance was 15.1±6.8 and 15.2±7.4 mm, respectively. Minimum ischiofemoral distance was significantly smaller in females than males during all activities (20.9±2.8 vs. 30.1±5.1 standing; $p = 0.006$), (8.8±2.3 vs. 20.4±3.9 level walking $p < 0.001$), (8.5±4.1 vs. 20.8±3.6 incline walking; $p < 0.001$), (7.9±2.2 vs. 12.3±3.4 mm for pivoting $p = 0.031$). The range of distances during level walking was significantly less than inclined walking (27.5±4.8 vs. 33.3±7.1 mm, respectively; $p = 0.022$). For the cohort, femoral anteversion was 22.2±7.0 degrees and neck shaft angle was 135.3±3.9 degrees and was not significantly different based on gender.

Our results provide baseline values of ischiofemoral distance. Findings confirmed that ischiofemoral distance is reduced in female subjects. Considerable variation in measurements observed across activities suggests that a diagnosis of ischiofemoral impingement based on static measurements may be misleading. In the future, we will examine in-vivo hip motion and ischiofemoral distance for symptomatic patients. These data should elucidate how pelvic and femoral anatomy contributes to ischiofemoral impingement, and could allow clinicians to educate patients as to which activities put the hip at risk of ischiofemoral impingement.

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