Aim:

Introduction: SUI is common in active women and prevalent in 50% of recreationally active women. Women with SUI have decreased motor control of their PFM in addition to different motor control of the hips in conjunction with PFM. It is unknown whether women with SUI have different hip biomechanics during gait. In Gait, hip muscles provide internal joint moment forces to counteract ground reaction forces during weight acceptance (WA), as well as provide balance and stability during midstance (MS) and terminal stance (TS). Hip impairments exist in women with SUI, yet little is known about different hip biomechanics in this group vs. non SUI women. This study looks at hip biomechanics in 3 planes during gait, between women with and without SUI and between limbs.

Women with SUI have been shown to have decreased hip ABD. (decreased Gluteus Medius and minimus) Strength and so may have decreased frontal plane biomechanics and increased hip Adduction angles in gait and single limb activities. Also, women with SUI often have decreased ER strength, which could change transverse plane biomechanics, (as measured by OI and other short hip external rotators). Sagittal plane biomechanics also need further investigation.

Hip pathologies have caused abnormal stance phases. Data from both limbs is important, as differences impact function. EMG is an important measure, to know when muscles are most or least active and to understand which muscles (agonist or antagonist) are affecting joint moments at any point.

Objective was to look at hip biomechanics during all phases of gait in women with SUI and to compare limbs with and non-SUI women.

Methods:

Descriptive study. This is part of a larger study (see other outline/article) and data was gathered in a motion analysis lab.

Subjects, were the same as previous study and this was the second phase of their session (1 hour with clinical data gathering for previous study preceding 3 hours of gait testing with this study).

Data Collection: 1 blinded researcher collected clinical data. Surface EMG electrodes, > or= 2 cm apart, were placed on Bilateral Glut Max, Glut Medius and Tensor Fascia Lata. Subjects were asked to empty their bladders 3x: prior to beginning of clinical data collection, prior to PFM exam and again prior to this gait analysis (not all did it the third time, so they didn’t standardize bladder fullness). Also didn’t standardize shoe type.

Further electrodes and reflective markers were placed on bilateral medial and lateral Hamstrings and Vastus Lateralis. A 16 channel wireless EMG was used for the 12 muscles. Each muscle was put through an MVIC (maximal voluntary isometric contraction) first, to enable electrode placement.

Reflective markers were also placed on the pelvis, lower extremities and shoes. Participants walked over a 5 m walkway at a measured speed and trials with good force plate contact were used.
Hip angles, (using camera), joint moments (net forces, ), and muscle activity (EMG data) were gathered. Statistical Analysis: Means and standard deviations were reported for min/max hip angles, moment impulses as well as EMG data for each limb over 3 phases of gait: WA (weight acceptance), MS (mid stance) and TS (terminal stance). Although an exploratory vs. hypothesis driven study, analysis of variance (ANOVA) stats were used for between-group comparisons (SUI vs. non-SUI) and paired t tests for between limb comparisons.

**Results:**

**Between SUI and Non-SUI groups:**

**Hip Joint Angles:** No differences between groups in Dom limbs. **SUI women ND limbs had greater Adduction during WA and greater IR hip angles during MS.** Also, relatively less hip ER hip angles during MS than non-SUI.

**Hip Moment Impulses:** SUI women Dominant limb hip moments were greater for Abduction/ER during WA, for ER during Midstance and for Abduction during terminal stance. SUI non-Dom limb hip moments were also (as with Dom) greater than non-SUI, in ABD/ER during WA and for ER during MS.

For TS, there were greater Flexion moments.

**Muscle Activity:** *Women with SUI had more muscle activity than non-SUI, but only in TS, using Glut Max and Tensor fascia lata more.*

**Between Limb Comparisons:**

**Hip Joint Angles:** Both groups had between-limb differences for the following: *The dominant limbs were more flexed and externally rotated than the non-dominant, during WA.*

The **Non-SUI group had no other between limb differences.** For the **SUI group only, the non-dom limb had greater IR than the Dom limb, during all three phases:** WA, MS and TS.

The SUI group Dom limb also had the lesser IR during MS and greater ER during TS. The Dom limb achieved ER but the non-dom limb stayed in IR, during gait. The SUI group Dom limb also had less extension angle during WA (more minimal flexion angle) and greater maximum flexion during MS than the non-dom.

**Hip Moment Impulses:** Greater Hip IR moments during WA and TS in Dom vs. non-dom limbs, in both groups. No other between-limb diff for SUI group. For non-SUI group, there were greater hip ER moments during midstance in the Dominant vs. non-dom limb.

**Muscle Activity:** both groups had greater Glut Max activity in TS in the Dom vs. non-dom limb.

**Discussion:** There was a unique pattern of motor control for women with vs. w/o SUI: *The SUI group vs. non, had notably increased IR in their non-dom limb for WA and MS. Also increased Adduction at WA. (Table 5).* Also women with SUI had more between limb differences than non-SUI.

SUI women (Table 2), with their greater hip IR during WA and MS were consistent with the previous study clinical findings of increased IR ROM in prone, all in the non-dom limb. Non-SUI women did not have unique between limb differences in kinematics. SUI women had greater moment impulses (internal net forces) than non SUI. **Greater moments in the non-dom. Limb, of Abd. And ER, didn’t prevent excess Adduction and IR.** There wasn’t greater muscle activity, to they concluded these moments were due to force vectors of the Add/IR position. These women (as in previous study report) had less strength of hip Abd. And seated ER.

Gait analysis only showed differences in hip joint angles in the non-dom limbs. Most novel finding: SUI group had significantly **higher Glut max activity in TS than non- SUI (~100% higher in Dom limb and ~75% higher in non-dom limb).**
They surmise possibly due to anatomic and functional relationship of Glut max to: 1) ITB, 2) LA and 3) OI. Glut max attaches from ilium, sacrum and coccyx to ITB and Gluteal Tuberosity of femur. About 25% of fibers attach to Glut Tub and help with ER. More muscle activity of Glut Max may be to compensate from stiffer ITBs in SUI group (as per Ober test in previous study).

Another study links Glut max co activation with PFM and shows MRI fascial connections from Glut Max to LA. These authors suggest possible compensatory Glut Max activity in SUI group, to prevent bladder neck descent with a weak PFM. Obturator internus is at highest activation during extension/ER of hip, as with terminal stance. (OI is anatomically related to PFM). They suggest that Glut Max activity in TS could be compensatory for impaired OI (in SUI group).

They also point out that the Dom limb in the SUI group, vs. non-dom limb, is more effective in controlling hip position. The Dom limb went through greater flexion but less IR, possibly due to greater neuromuscular control of Glut Max, and in the non-dom limb, the Tensor Fascia Lata may be causing the greater hip IR angles and opposing the efforts of Glut Max.

Limitations: Descriptive, small sample size, not powered enough to off-set error associated with multiple comparisons.

Electrodes in upper Glut Max could not confirm 1 researcher’s clinical observation of women with SUI having underactive lower Glut Max during WA in gait. They recommend more research with more challenging activities which could provoke SUI, along with different amounts of bladder fullness, to see what compensatory strategies work or don’t work.

They also recommend considering close-chain and weight bearing exercises in the transverse plane (ER/IR) and specific gait training to reduce IR in the non-dom limb.

Conclusion: Women with SUI have altered gait mechanics, esp. in transverse plane, especially hip IR. Greater hip ABD/ER forces don’t avoid increased Adduction and IR positions, which are possibly due to decreased strength and motor control.

Discussion questions:

1) Although this is only a descriptive study, will you consider looking (or do you already) at OI, Hip IR ROM in prone and TFL tightness (Ober) as in the previous study?

2) Are there other tests you might consider doing with SUI patient, such as looking at their gait or functional, weight bearing strength, to look for possible OI impairments limiting Gluteus Medius function, or at possibly increased hip IR throughout stance in non-dominant limb?

3) What else might you look for?

4) What sorts of exercises do you like to give for Gluteus Medius strengthening? What might be helpful for OI? What do you think about adding in some weight bearing exercises in the transverse plane? If so, what might they be? What do you think about the “Immediate Effects” study’s exercises, in this regard?