Factors Contributing to Pelvis Instability in Female Adolescent Athletes During Unilateral Repeated Partial Squat Activity

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Introduction

During one-legged stance tasks, the hip abductor complex of the stance limb provides pelvis stability.1 If the hip abductor complex is not working effectively then the opposite side of the pelvis will drop. Pelvis instability is measured as the amount of pelvic drop in the frontal plane. Hip abductor muscle strength and femoral neck offset have been positively correlated with pelvis stability.1,2 However, little is known about the relationship of other anatomical orientations and joint biomechanics and pelvis stability.

Pelvis drop has been linked to stance knee injury risk and low back pain.3,4 Unilateral partial squat tasks are often performed by sports medicine clinicians to assess athletes’ lower extremity (LE) neuromuscular control. Biomechanical analyses of single limb squat activities that challenge the hip abductor complex can offer assessment of pelvis stability and the contribution of the stance limb’s anatomy. This exploratory study focused on assessing pelvic drop among female athletes during a unilateral repeated partial squat activity.

Purpose

Purpose: 1) to investigate the influence of lower extremity physical characteristics and biomechanics on pelvic drop during the repeated unilateral partial squat (RUPS) activity and 2) to assess the effect of leg dominance on pelvic drop among female athletes during the RUPS activity.

Materials and Methods

Subjects:
➢ 42 female athletes total (27= softball pitchers, 15= gymnasts)
➢ Average age= 16.48 ± 2.54 years
➢ 34 high school and 8 college athletes

Test Protocol:
Bilateral Lower Extremity Physical Assessment:
➢ Quadriceps (Q angle) – in supine and passive hip rotation ROM – in prone
➢ Hip abduction – in side-lying and extension (prone) strength via dynamometer (Average of 3 trials for analysis)

Repeated Unilateral Partial Squat (RUPS) Activity (Figure 1),
➢ Subjects stood on one leg at edge of a 17.78 cm box.
➢ Hands on hips.
➢ Each athlete squatted with contralateral limb hanging freely, without contact with ground.
➢ 5 continuous repetitions.
➢ One practice trial and one data trial performed for each limb.

Data Collection: Vicon™ motion capture system (120 Hz) and force data from 3 force plates, Bertec Corp., (1200 Hz).
➢ 62 reflective markers created a 15 body segment model (Figure 2).
➢ Calculation of joint angles during RUPS performed in Visual 3D™software (C-Motion, LLC)

PELVIS INSTABILITY MEASURE: Greatest pelvis drop angle of contralateral side (Frontal plane) during RUPS. Intersection of the line through the anterior superior iliac spine ASIS at the lowest position during the RUPS with the mid point of the line through both ASIS during static standing (Figure 3).

Statistical analyses: Paired T-test, Spearman correlations and multiple regression model (SPSS V24).

Results

Relationship of lower extremity physical characteristics and biomechanics with Pelvis Drop (Pelvis Instability measure)

Pelvis Drop Angle:
➢ Did correlate with isometric hip abduction strength, r = -.241, p = .028 and did not correlate with isometric hip extension strength, r = -.116, p = .297
➢ Did not correlate with Q angle, r = .115, p = .299
➢ Did correlate with passive hip internal range of motion, r = .281, p = .012. However, did not correlate with passive hip external range of motion, r = .098, p = .388.
➢ Positively correlated with the frontal hip plane angle (hip abduction/adduction angle) at the time of greatest pelvis drop angle, r = .627, p<.001 (Figure 1).
➢ Did not correlate with the transverse hip plane angle (hip internal/external rotation), r = .165, p = .161, or the transverse ankle plane angle (ankle pronation/supination angle), r = -.122, p = .277, at the time of greatest pelvis drop angle.

The effect of leg dominance on Pelvis Drop (Pelvis Instability measure) and lower extremity physical characteristics

Pelvis Drop Angle:
➢ Did not differ between Dominant and Non-Dominant limbs, Dom: -3.40 ± 5.10°, ND: -3.46 ± 4.44°, p = .831

Lower Extremity Physical Characteristics:
➢ Only the isometric hip extension strength measures demonstrated statistically significant difference between Dominant and Non-Dominant limbs (Table 1).

Variables predicting Pelvis Drop
➢ 6 variable regression model that included both physical characteristics and biomechanical measures successfully predicted peak pelvic drop angle, R²(6,73) = 0.784, p < .0005, R² = 0.595 (Table 2).

Discussion & Conclusions

Pelvis instability is associated with reports of low back pain and stance knee injury (medial compartment and ACL strain). This study offers insight on some of the physical and biomechanical factors which contribute to pelvis instability during a task commonly used for assessing lower extremity neuromuscular control.

➢ The strongest combined predictor variables of pelvis instability during the RUPS activity were hip frontal plane angle (abduction/ adduction) at the time of greatest pelvic drop during the RUPS and hip abduction strength followed by subject’s weight (Aim 1).
➢ Pelvis instability (the greatest pelvic drop angle) during the RUPS did not correlate significantly with Q angle or hip extension strength (Aim 1).
➢ In our female athlete sample, pelvis instability measurement during the RUPS activity did not differ between Dominant and Non-Dominant limbs (Aim 2).

Significance: Our results suggest that female athletes could be screened for some of the physical characteristics that contribute to pelvis instability during the RUPS activity. Improved understanding of these contributing factors may guide sports medicine clinicians’ future physical assessments and recommendations for corrective strength and conditioning exercises to prevent injury.

References: