Bilateral Weight Distribution Asymmetry in the Functional Movement Screen Deep Squat

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ABSTRACT
The functional movement screen (FMS) deep squat (DS) is used to identify movement deficiencies and potentially predictor injury. While evidence does not support the predictive validity of FMS scores, useful information can still be obtained. Weight shifts are often observed in the FMS DS, but current literature lacks information about asymmetrical weight distribution. PURPOSE: To determine the amount of weight distribution asymmetry in physically active young adults during the FMS DS. METHODS: Nineteen physically active participants (11 F, 8 M; 20.8 ± 1.0 yo) were recruited and granted informed consent. Participants performed three trials of the FMS DS with feet flat (FF) followed by three trials with elevated heels (EH) elevated on a 2.56 board. Trials were completed on two embedded force plates (1200Hz). Vertical ground reaction force (vGRF) data were used to determine asymmetry in bilateral weight distribution. Six reflective markers placed bilaterally on the greater trochanter, lateral femoral epicondyle, and lateral malleolus were tracked with a 10-camera motion analysis system (120Hz). A MATLAB script processed the 3D and computed knee flexion angle and vGRF asymmetry at squat initiation and full squat. Paired samples t-tests with a significance level of 0.05 were used. RESULTS: A significant increase (p<0.01) in knee flexion occurred in the EH squat condition (Left 105.8±24.5°, Right 108.8±25.0°) compared to FF (Left 100.8±22.8°, Right 101.0±23.1°). On average, participants experienced >5% asymmetry (0% being perfectly symmetric) for the starting position and full squat position during both FF and EH. There were no significant differences in weight distribution symmetry in the starting position (p=0.31) between squat conditions. The EH condition did not significantly change weight distribution symmetry (p=0.69) in the full squat position. Within squat condition, there was no significant differences between weight distribution symmetry from the starting position to the full squat position (FF: p=0.76, EH: p=0.43). CONCLUSION: Bilateral weight distribution asymmetry was present in the FMS DS both with flat and elevated heels in physically active participants. Coaches and trainers should consider implementing training programs to optimize biomechanical function during the FMS DS.

METHODS
• Three-dimensional motion capture system (Qualysys Oqus 100; Goteborg, SWE; 120 Hz)
• Accuracy of 3D location < 0.25 mm
• 6 reflective markers (dias=12.5mm) (Figure 1)
  • Placed bilaterally on greater trochanter, lateral femoral epicondyle, and lateral malleolus
• Two embedded force plates (AMTI Optima; Watertown, MA) sampled at 1200Hz
• FMS DS Protocol
  • Feet shoulder width apart, dowel overhead
  • Descend as deep as possible, hold for a count of one, return to starting position
  • 3 trials FF, 3 trials EH (Figure 3)

DATA PROCESSING
• Custom MATLAB (MathWorks, Inc. R2016b; Natick, MA) script lowpass filtered both marker trajectory and force data with a cutoff frequency of 30 Hz
• Vertical ground reaction force (vGRF) used to measure force exerted on the ground by each limb
• Maximum knee flexion was used to identify full squat
• vGRF values at squat initiation and full squat were compared between right and left sides to compute asymmetry score
• ANOVA and paired samples t-tests were used to test for significance

RESULTS
• 38 participants with no current musculoskeletal injuries
  • Physically active for 30 minutes, 3 days per week for at least 3 months
  • 20 female, 18 male
  • 20.8 ± 1.4 yo, 1.71 ± 0.17 m, 68.3 ± 13.9 kg

DISCUSSION
• No significant changes in weight distribution asymmetry occurred between the start and full squat positions
  • Individuals with injuries may present more asymmetry during the squat compared to quiet standing
• Healthy, physically active people could experience anywhere from less than one percent to about 11 percent asymmetry in weight distribution
• About one quarter of the physically active population presents weight distribution asymmetry greater than five percent
  • Clinical implications – Weight shift during FMS DS should be considered in addition to score.
  • Individuals with more than 11 percent asymmetry may be at an increased risk for injury.

FUTURE WORK
Need to further establish threshold for asymmetry
• Evaluate weight distribution of athletes prior to competitive season and follow over time to quantify relationship between asymmetry and injury risk
• Examine individuals with significant weight distribution asymmetry to determine underlying cause
  • Biomechanical factors
  • Strength imbalances
  • Flexibility limitations
  • Neurological factors

REFERENCES

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