Kinematic And Kinetic Differences During The Y Balance Test™ In ACL Reconstructed Individuals

Meredith Decker-Hamm, MS, LAT, ATC, Logan Ruhde, BS, Cindy Trowbridge, PhD, LAT, ATC, Mark Ricard, PhD

Context and Objectives

The Y Balance Test™ (YBT) is a reliable[1] assessment of single-limb dynamic balance used with ACL reconstructed (ACLR) individuals throughout rehabilitation and at return to sport assessment. At these time points, reduced YBT reach distances and composite scores have been identified in ACLR limbs.[2] However, limited data exists for the associated kinematic and kinetic variables during YBT assessment, especially in ACLR individuals several years post reconstruction.

Purpose: To determine if ACLR individuals several years post reconstruction have any distance or composite score differences, as well as kinematic and kinetic differences, between their involved and uninvolved limbs during the YBT.

Methods

Subjects: Twelve recreationally active females (n=7) and males (n=5) (age=24.7±3.6yrs, mass=76.1±12.3kg, height=168.7±10.1cm) volunteered for this study. All subjects had a previous history of a unilateral ACLR with average time of 7±3.1 years post reconstruction.

Subjects	Involved (ACL) Leg	ACL Graft Type	Time Since ACLR (years)	Meniscus Involvement
1	L	Patellar tendon	8.8	Yes
2	L	Patellar tendon	10.2	No
3	L	Hamstring tendon	10.5	Yes
4	R	Patellar tendon	2	Yes
5	L	Hamstring tendon	8.5	Yes
6	R	Patellar tendon	10	No
7	R	Cadaver tendon	6.9	No
8	R	Hamstring tendon	10.1	No
9	R	Hamstring tendon	7	Yes
10	R	Patellar tendon	8.3	No
11	L	Patellar tendon	3	Yes
12	R	Patellar tendon	2.7	Yes

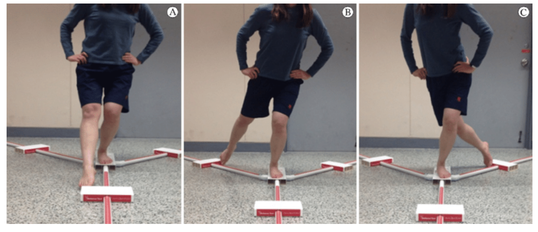

Figure 1: Y Balance Test™ Reach Directions: (A) Anterior, (B) Posteromedial, (C) Posterolateral
Image: https://goo.gl/images/A5sHnk

Methods Cont'd

Procedures: Subjects completed one testing session, in which they performed the YBT while being recorded using Vicon 3D motion analysis capture software and AMTI force plate. Subjects stood on the force plate, while they completed three trials in each direction on each leg. Each subject started on their right leg and reached in order of the anterior, posteromedial, and posterolateral directions, followed by the same sequence on the left leg. Before trials were collected, subjects were given 4 practice trials in each direction on each leg.[3]

Kinematic and kinetic variables were captured using Vicon motion analysis capture software and were analyzed using Visual 3D. Data analyzed at maximum reach distance (Y_{MRD}) for each reach direction were hip angle (H_{ANG}), hip moment (H_{MOM}), knee angle (K_{ANG}), knee moment (K_{MOM}), and minimum center of mass (mCOM).

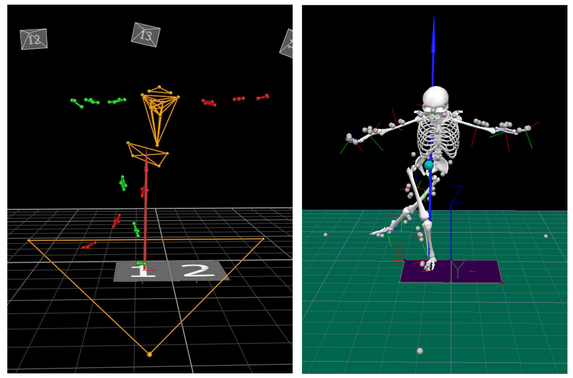

Figure 2 (Left): Vicon 3D motion analysis of a subject performing a posterolateral reach on the right leg; Figure 3 (Right): Visual 3D analysis of the posterolateral reach

Statistical Analysis: Mean±SD of Y_{MRD} and Y Balance composite scores (Y_{Comp}) were calculated for the YBT in the anterior, posteromedial, and posterolateral directions for involved and uninvolved limbs. Paired samples t-tests were performed to determine the mean differences between involved and uninvolved limbs. Alpha was set *apriori* at 0.05.

Results

YBT Reach Distances: Significant differences were found for Y_{MRD} in the PL direction between the involved (86.8±12.9cm) and uninvolved (90.9±10.7cm) limbs (p=0.01). No significant differences were found for Y_{MRD} in the ANT and PM reach directions. Y_{COMP} scores between the involved (90.9±7.2%) and uninvolved limbs (92.7±6.2%) were also significantly different (p=0.05).

Kinematic & Kinetic Variables: A significant difference (p=0.02) was found for H_{ANG} during the PL reach, with the involved limb demonstrating less hip flexion (81.1±17.7°) than the uninvolved limb (90.1±22.9°). No other significant differences were found for H_{ANG}, H_{MOM}, K_{ANG}, K_{MOM}, and mCOM in any of the YBT directions.

Results Cont'd

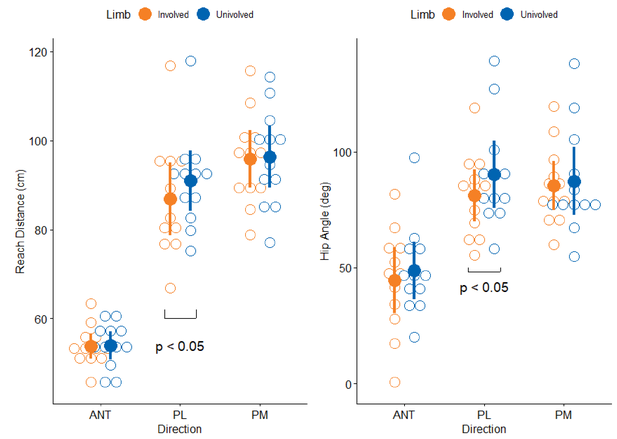

Figure 4: (Left) Maximum reach distance in the posterolateral direction between the involved (86.8±12.9cm) and uninvolved (90.9±10.7cm) limbs (p=0.01). Figure 4: (Right) Hip angle during the posterolateral reach, with the involved limb demonstrating less hip flexion (81.1±17.7°) than the uninvolved limb (90.1±22.9°) (p=0.02).

Conclusions

ACLR individuals demonstrated lower composite scores on their involved limb (90.9±7.2%) compared to their uninvolved limb (92.7±6.2%). Additionally, composite scores on both limbs were below the 94% threshold that has previously been associated with a greater injury risk.[4] Composite scores lower than 94% indicate a greater likelihood for lower extremity injury, especially in the involved limb. The posterolateral reach direction demonstrated significantly lower maximum reach distance and hip flexion angle in the involved limb. Most commonly, reach distance differences are found in the anterior reach direction;[4] however, this finding in the posterolateral direction may indicate that ACLR individuals several years post reconstruction may still have limitations in rotary stability on their involved limb. The lower reach distances and lower amount of hip flexion on the involved limb are likely related. ACLR individuals are changing the strategy in how they use their involved limb during a dynamic balance task which ultimately could lead to further joint injury.

References

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Department of Kinesiology
Biomechanics Laboratory

The University of Texas at Arlington