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Sensory Reweighting in ACL Reconstructed Patients: Analysis of a Single Leg Triple Jump Proprioceptive Task

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Context: The risk of anterior cruciate ligament (ACL) re-injury remains high when returning to sport despite advances in surgical reconstruction and rehabilitation. Sensorimotor deficits caused by neurological sensory reweighting for motor control after ACL injury may be an under-recognized factor contributing to re-injury risk. The objective of this study was to quantify sensory reweighting following ACL injury via a novel proprioceptive single leg triple jump task. **Methods:** This cohort study took place in a biomechanics research laboratory. Sixteen individuals who previously had an ACL reconstruction (8 males, 8 females; 25.5±1.37 years, 1.70±0.13 m, 75.6±19.2 kg) were recruited for this study, however, one participant was unable to complete the single leg triple jump under all conditions and was excluded from analyses. Therefore, fifteen individuals were used for analysis (7 males, 8 females). Inclusion criteria were: 18 to 39 years old, underwent an ACL tendon graft reconstruction, and currently physically active. Participants completed a Tegner activity survey indicating their current levels of activity (Tegner score: 6.0±1.5). The mean time interval after reconstruction was 23±18 months. Single leg triple jump capability was measured using a Vicon Motion Capture system (Oxford, UK). All subjects performed a single leg triple jump on each leg with eyes open and blindfolded to assess the relative visual contribution to the task. Participants were instructed to jump as high as possible on a single leg three times in a row and attempting to land in the same initial footprint (minimize excursion). Center of mass excursion was quantified from the start of the first jump till the final third jump landing. Paired samples t-tests were used to assess (1) the difference between sides for the change score of center of mass (CoM) excursion between full vision and blind vision for the sagittal plane, and (2) the difference between sides for the change score of CoM excursion between full vision and blind vision for the frontal plane. Alpha was set at 0.05 a priori. **Results:** The CoM frontal plane excursion change score from full vision to blind vision was significantly increased on the involved leg (left) (42.72 ± 42.40 cm; p=.027) relative to the uninvolved leg (right) (9.28 ± 24.72 cm). Participants did not show a difference in sagittal plane excursion on the involved leg (left) (.58 ± 18.90 cm; p=.463) in comparison to the uninvolved leg (right) (-2.82 ± 17.50 cm). **Conclusions:** These data suggest the single leg triple jump may be beneficial in identifying sensorimotor deficits and sensory reweighting post ACLR for frontal plane full body control. This finding emphasizes the importance of rehabilitating the sensorimotor system to address potential functional deficits from injury.

Kinematic and Kinetic Differences During the Y Balance Test™ in ACL Reconstructed Individuals

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Context: The Y Balance Test™ (YBT) is a reliable and valid assessment of dynamic balance used with ACL reconstructed individuals (ACLR) 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. However, limited data exists for the associated kinematic and kinetic variables during YBT assessment, especially in ACLR individuals. The purpose of this study was to determine if ACLR individuals several years post reconstruction demonstrate distance or composite score differences, as well as kinematic and kinetic differences between their involved and uninvolved limbs during the YBT. **Methods:** A cross-sectional study design was used, and data was collected in a university biomechanics laboratory. 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. All participants had a previous history of a unilateral ACLR with an average time of 7±3.1 years post reconstruction. Participants completed one testing session, in which they performed the YBT while being recorded using Vicon 3D motion analysis capture software and an AMTI force plate. Mean±SD of maximum reach distance (YMRD) and YBT composite scores (YCOMP) were calculated in the anterior (ANT), posteromedial (PM), and posterolateral (PL) directions for involved and uninvolved limbs. Kinematic and kinetic variables analyzed at YMRD for each reach direction were hip angle (HANG), hip moment (HMOM), knee angle (KANG), knee moment (KMOM), and minimum center of mass (mCOM). Paired samples t-tests were performed

to determine the mean differences between involved and uninvolved limbs. Alpha was set apriori at 0.05. **Results:** Significant differences were found for YMRD 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 YMRD in the ANT and PM reach directions. YCOMP scores between the involved (90.9±7.2%) and uninvolved limbs (92.7±6.2%) were also significantly different (p=0.05). A significant difference (p=0.02) was found for HANG during the PL reach, with the involved limb demonstrating less flexion (81.1±17.7°) than the uninvolved limb (90.1±22.9°). No other significant differences were found for HANG, HMOM, KANG, KMOM, and mCOM in any of the YBT directions. **Conclusions:** Differences between YCOMP scores and PL YMRD demonstrate dynamic balance asymmetries of the involved limb in ACLR individuals several years after reconstruction. The decreased YMRD and HANG during the PL reach of the involved limb suggests that altered dynamic stability exists during a task that requires rotary stability. The involved limb also demonstrated decreased YCOMP scores, however the values for both limbs were below the accepted 94% mark, which may indicate a predisposition for re-injury or contralateral injury. Dynamic balance training should be emphasized in ACLR individuals several years post reconstruction in an effort to reduce injury risk and limit limb asymmetries.

Can Lower Extremity Assessment Protocol Be More Efficient to Detect Deficits After Anterior Cruciate Ligament Reconstruction?

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Context: Lower Extremity Assessment Protocol (LEAP) is one of many different evaluating tools for deficits after the anterior cruciate ligament reconstruction (ACLR) and is consist of a set of 12 tests in strength, balance, landing posture, and functional task. Although this protocol has been used to provide comprehensive information for patient and clinicians, it is not clear whether this protocol includes redundant tests or not. We hypothesized that this protocol could be more efficient to assess deficit after the ACLR. The purposes of this study were 1) to examine a relationship between each battery of tests, and 2) to reduce many individual tests into a fewer number of dimensions. **Methods:** This study is a descriptive design in a laboratory setting. A total of 15 subjects [12 males & 3 females (Age:27.86 ± 4.1 yrs, Height:172.56 ± 4.81cm, Mass:75.51 ± 13.03kg, Tegner activity score:5.73 ± 1.16, IKDC:61.46 ± 13.62, Time from surgery:27.1 ± 14.03) who had a history of ACL reconstruction participated in this study. Each subject performed both isokinetic and isometric knee flexion/extension using CON-TREX® (Physiomed AG, Schnaittach, Germany), postural control on AccuSway (AMTI, Boston, MA), drop and jumping using landing error scoring system (LESS), and four functional hopping on both involved and non-involved legs. The dependent variables include Isokinetic extension 90 degree/sec, Isokinetic flexion 90 degree/sec, Isokinetic extension 180 degree/sec, Isokinetic flexion 180 degree/sec, Isometric quad for 30 sec, Isometric_hamstring for 30sec, single leg balance, functional singe hop, functional triple hop, functional cross-over, functional 6m hop, and LESS. We performed factor analysis over all 12 individual tests for grouping similar variables into dimensions. Then, regression analysis was used to confirm which dimension is useful to predict the IKDC. **Results:** Factor analysis with varimax rotation resulted 12 different tests of the LEAP were categorized into 3 factors: 1) strength, 2) functional, and 3) balance and LESS. Regression analysis showed only balance_LESS was found to be significant predictors of IKDC (b= .05, SE = .02, t (12) = 2.33, p = .04). Also, functional task was eliminated by multicollinearity (Variance Inflation Factor= 18807.31, p = .21). **Conclusions:** Our result suggests that clinicians may consider utilizing one of the most powerful measurements in balance with LESS to assess deficits after the ACLR. However, further research requires more participants in order to confirm its validity for a specific standard. In addition, the regression equation can be performed over 12 measurements with a large sample size to examine which measurements can be eliminated.