The Mechanism of Injury’s Role in Jump Landing Mechanics After Anterior Cruciate Ligament Reconstruction

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Summary:
At the time of return to sport after anterior cruciate ligament reconstruction, jump landing mechanics, as indicated by Landing Error Scoring System score, does not seem to be impacted by the initial mechanism of injury.

Data:
Introduction: Many anterior cruciate ligament (ACL) injuries occur through a noncontact mechanism of injury where the patient is injured during deceleration, pivoting or jump landing. To regain stability in the knee and allow the athlete to return to sport the most common treatment is surgical reconstruction (ACL-R), however, there is a lengthy recovery process and a 15% secondary ACL injury rate. Poor jump landing mechanics are a common cause for noncontact ACL injury and are also a risk factor for secondary ACL injury. Therefore, addressing poor landing mechanics following injury indicating that post-surgical landing mechanics may appear to impact LESS scores when the patient is being cleared to return to play.

Methods: One-hundred and six patients (54M/52F, 21.4 ± 7.8yr, 171.8 ± 11.0cm, 74.4 ± 14.8kg, 9.1 ± 3.2mo post-ACL/R) participated in the observational study after a primary, isolated, and uncomplicated ACLR. Each patient self-reported their mechanism of injury as either contact or noncontact. The participant completed the Landing Error Scoring System (LESS) test which was recorded from a frontal and sagittal view then manually scored used Kinovea. A passing score for LESS was a score of four or below. A Chi-Square test was used to compare mechanism of injury and LESS pass/fail criteria. Independent samples t tests were used to compare LESS scores between groups. Tests were considered statistically significant if p = 0.05. Results: 45% (48/106) of participants failed the LESS test. Of those that failed, 69% (40/58) had sustained a noncontact injury and 31% (18/58) had a contact injury. There was no statistically significant difference in mechanism of injury between participants who passed the LESS test and those who failed (X² = 0.47, p = 0.49). There was no significant difference for total LESS score between the noncontact group (4.58 ± 2.07) versus the contact group (4.13 ± 2.08, p = 0.33). There was no significant difference for frontal LESS score between the noncontact group (2.80 ± 1.52) and the contact group (2.60 ± 1.55, p = 0.54), or for sagittal LESS score between the noncontact group (1.78 ± 1.41) and the contact group (1.53 ± 1.33, p = 0.41). Conclusion: Mechanism of initial ACL injury does not appear to impact LESS scores when the patient is being cleared to return to play. Therefore, patients with contact and noncontact injuries display similar landing mechanics following injury indicating that post-surgical landing mechanics may be unrelated to mechanism of ACL injury. There were patients that scored greater than a four for their overall LESS score, which has been associated with an increased risk for reinjury. The decision to allow a patient to return to play should occur after all risk factors, including jump landing mechanics, have been properly mitigated during rehabilitation.

Ceiling Effect of the Combined Norwegian and Danish Knee Ligament Registers Limits Anterior Cruciate Ligament Reconstruction Outcome Prediction

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Summary:
Machine learning analysis of nearly 63,000 patients in the Norwegian and Danish knee ligament registers enabled prediction of revision ACL reconstruction risk with moderate accuracy, however, accuracy was similar to a previously developed model based on 25,000 patients suggesting a ceiling effect of the current registers.

Data:
Background: Clinical tools based on machine learning analysis now exist for outcome prediction following primary anterior cruciate ligament reconstruction (ACL-R). Relying partly on data volume, a general principle is that more data may lead to improved model accuracy. The purpose of this study was to apply machine learning to a combined dataset comprised of the Norwegian (NKLR) and Danish (DKLR) knee ligament registers with the aim of producing an algorithm that can predict subsequent revision surgery with improved accuracy relative to a previously published model developed using only the NKLR. The hypothesis was that the additional patient data would result in an algorithm that is more accurate.

Methods: Machine learning analysis was performed on the combined DKLR and NKLR. The primary outcome was the probability of revision ACL reconstruction within 1, 2, and 5 years. Data were split randomly into training sets (75%) and test sets (25%). Four machine learning models intended for this type of data were tested: Cox Lasso, survival random forest, and gradient boosted regression (GBM), and super learner. Model performance was evaluated by calculating concordance and calibration using methods adapted for censored data. Concordance measures the proportion of pairs of observations in which predicted ranking of survival probabilities corresponds to actual ranking. Calibration is a measure of the accuracy of predicted probabilities that compares expected to actual outcomes. Results: After data cleaning, the combined registry population consisted of 62,955 patients. Revision surgery occurred in 5.1% of patients during an average follow-up time of 7.6 ± 4.5 years. The three nonparametric models – survival random forest, GBM, and super learner – had concordance in the moderate range (0.67, 95% CI 0.64-0.70) at all follow-up times. All three were also well calibrated, except for the random survival forest at 5 years (p = 0.001). The Cox lasso performed more poorly. Multiply imputed data did not show notable differences from the complete case analysis. Conclusion: Machine learning analysis of the combined registers enabled the prediction of subsequent revision surgery risk after primary ACLR with moderate accuracy. The most important finding of this study, however, was that this analysis of nearly 63,000 patients yielded similar prediction accuracy as a previous study of approximately 25,000 patients. This suggests a so-called ceiling effect of the registries has been reached and that simply adding more patients to the database is unlikely to appreciably improve prediction accuracy. This information can be used to inform further evolution of the knee ligament registries regarding data collection. The present study suggests that for an improvement in our ability to predict outcome based on knee ligament registry data, an evolution in the variables collected would be required. This represents a significant challenge as the balance between optimal variable collection and surgeon compliance is a delicate one - data collection must be streamlined to avoid survey fatigue and the addition of variables to the registry must be carefully considered, weighing the added value against the additional onus on the surgeons which may affect compliance.

Level of Evidence: III
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Summary: Clinicians should be aware of both modifiable and non-modifiable risk factors for not achieving a MIC after ACL-R and thus, should adjust treatment and establish realistic expectations for the patient.

Data: Objectives: To determine factors associated with not achieving a minimal important change (MIC) in the Knee Injury and Osteoarthritis Outcome Score (KOOS) Function, Sports, and Recreational Activities (Sport/Rec), and Knee-Related Quality of Life (QoL) subscales 1 year after anterior cruciate ligament reconstruction (ACL-R). Methods: This study utilized data from the Swedish National Knee Ligament Registry. Multivariable logistic regression models were used to identify factors associated with not achieving a MIC. The KOOS subscales Sport/Rec and QoL were dichotomized (not achieving/achieving MIC; the MICs for the Sport/Rec and QoL subscales were 12.1 and 18.3 respectively) and combined into one single variable (Sport & QoL). Results: Of 16,131 included patients 44% did not achieve the MIC for the combined Sport/Rec and QoL subscales 1 year after ACL-R. Older patients (OR 0.91, 0.88-0.94; p<0.0001), males (OR 0.93, 0.87-0.99; p=0.034) and patients receiving hamstring tendon autograft ACL-R (OR 0.70, 0.60-0.81; p<0.0001) had decreased odds of not achieving the MIC 1 year after ACL-R compared to younger patients, females and patients receiving patellar tendon autograft. Furthermore, patients with cartilage injuries (OR 1.17, 1.09-1.27; p<0.0001) and higher pre-operative KOOS Sport/Rec and QoL scores (OR 1.34, 1.31-1.36; p<0.0001) had increased odds of not achieving the MIC. Conclusion: Females, younger patients, and patients with higher pre-operative Sport/Rec and QoL KOOS scores, and cartilage injuries, are less likely to benefit from ACL-R and subsequently, have a lower probability for improved Sport/Rec and QoL scores after ACL-R. Furthermore, graft choice may also affect the risk of not achieving the MIC.

Category: Knee - ACL Post-Surgery

Return to Sports Bridge Program Improves Outcomes, Decreases Ipsilateral Knee Re-injury and Contralateral Knee Injury Rates Post-ACL Reconstruction: 2022 Update

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Summary: Supplementing primary ACL reconstruction and standard physical therapy with a return to sports bridge program prior to release to unrestricted sports performance was effective at improving patient outcomes and decreasing ipsilateral knee re-injury and contralateral knee injury rates.

Data: Purpose To present the results of a return to sports bridge program designed to reduce knee injuries following ACL reconstruction and physical therapy. Methods Two hundred and twelve (male = 111, female = 101) patients participated in an 8-week duration whole body neuromuscular control, progressive resistance strength and agility training program. Post-progression testing included functional movement form, dynamic knee stability, lower extremity power, agility, and sports skill assessments. Participants completed the Knee Outcome Survey–Sports Activity Scale (KOS-SAS) before and after program initiation. Subjects were re-estimated their pre-participation scores following program completion. Results Global KOS-SAS scores at program entry were 75.8 ± 14. Post-program global rating and calculated KOS-SAS scores were 91.0 ± 9.8 and 90.9 ± 9.7, respectively (p < 0.0001). Pre-participation KOS-SAS score re-estimates at program completion were 54.8 ± 23 (global) and 58.2 ± 20 (calculated). The approximately 30% lower pre-program global KOS-SAS score re-estimate (46.7 ± 32 vs. 75.8 ± 14), and 20% calculated KOS-SAS score re-estimate (56.2 ± 27 vs. 75.0 ± 15)(p = 0.04) observed at program completion suggests that subjects had inaccurately high sports readiness perceptions at program entry. Perceived overall sports activity knee function ratings improved from 2.9 ± 0.6 (abnormal) at program entry to 1.2 ± 0.5 (normal) at completion (p < 0.001). Most subjects returned back to sports or at above their pre-injury performance skill/performance level (84%, 179/212). By 7.7 ± 4.0 years (range = 2-15 years) post-surgery, 14 subjects had sustained an ipsilateral knee re-injury or contralateral knee injury (6.6%). The 2.8% non-contact contralateral and 1.9% non-contact ipsilateral knee injury rates observed were significantly lower than those cited in previous reports. Conclusion Supplemetning primary ACL reconstruction and standard physical therapy with a return to sports bridge program prior to release to unrestricted sports performance was effective at improving patient outcomes and decreasing ipsilateral knee re-injury and contralateral knee injury rates.

Category: Knee - ACL Post-Surgery

Early Use of Blood Flow Restriction Training with Low-Intensity Exercises following Anterior Cruciate Ligament Reconstruction Improves Quadriceps Strength and Post-Operative Pain: A Randomized Controlled Trial

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Summary: Compared to a traditional rehabilitation program, early use of blood flow restriction training coupled with low intensity exercises improves knee extension strength, range of motion, and pain in the acute post-operative phase (weeks 0-12) following ACL reconstruction.

Data: Background: Blood flow restriction therapy (BFRT) has been proposed as a way to enhance rehabilitation following anterior cruciate ligament reconstruction (ACL-R). However, a paucity of data exists to support the use of BFRT in clinical practice. The purpose of this study is to determine if early application of BFRT, used with low-load (LL) therapy exercises, increases quadriceps strength, and functional outcomes following ACLR compared to a traditional rehabilitation protocol without BFRT. Methods: Forty-five patients undergoing ACLR were randomized to receive either: (1) a traditional rehabilitation program (n=23), or (2) a modified program using BFRT with LL (20-50% of 1-repetition maximum) exercises (n=22). Two patients crossed over from the control to BFRT groups at postoperative weeks 2 and 4, respectively. An as-treated analysis was performed for biweekly measurements in the early postoperative period of range of motion (ROM), thigh circumference, and terminal knee extension (TKE) strength. Circumference and TKE strength were analyzed as a percentage of the contra-lateral side. VAS and IKDC scores were assessed preoperatively and during the first 12 weeks postoperatively. Results: Compared to the control group, the BFRT patients demonstrated significantly greater TKE strength at week 8 (72.9% vs. 79.4%, p = 0.043) and week 12 (73.0% vs. 85.5%, p = 0.030), as well as greater overall change in TKE strength from week 3 to 12 (9.2% vs 24.2%, p = 0.011). The BFRT group reported significantly lower VAS values at week 12 (1.2 vs. 0.3, p = 0.013) and significantly higher IKDC scores at week 12 (52.9 vs 61.8, p = 0.027). The BFRT group also reported significantly greater flexion than control for week 4 (91.8 vs 102.0, p = 0.025), week 6 (112.7 vs 121.1, p = 0.036), and week 12 (130.5 vs 137.2, p = 0.028). Conclusions: In comparison to a traditional rehabilitation protocol following ACLR, BFRT used in conjunction with LL exercises during the early postoperative period was associated with significantly lower VAS scores as well as significantly greater quadriceps strength and knee flexion. These results suggest that BFRT may help resist muscle atrophy and/or promote muscle hypertrophy during rehabilitation after ACLR, though future studies are needed to assess long-term outcomes.

Category: Knee - ACL Post-Surgery

Short Forms of the Knee injury and Osteoarthritis Outcome Score (KOOS) Following Anterior Cruciate Ligament Reconstruction: Are They of Use and Which Short Form to Choose?

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