Time Post-Anterior Cruciate Ligament Reconstruction Does Not Associate With The Capacity To Modify Walking Biomechanics

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Background
Approximately half of individuals with an anterior cruciate ligament (ACL) injury and reconstruction (ACLR) develop radiographic post-traumatic osteoarthritis (PTOA) within two decades following injury.1 Increased PTOA risk following ACLR is linked to both decreased quadriceps strength and aberrant walking biomechanics.2 Further, these alterations in quadriceps strength and walking biomechanics change as time post-ACLR increases.3,4 Real-time gait biofeedback (RTGBF) which cues changes in vertical ground reaction force impact peaks (vGRF-IP) may be an effective way to elicit sustained gait improvements in ACLR individuals.5 However, it remains unknown if the amount of time post-ACLR would alter ACLR individuals’ capacity to modify gait biomechanics and match given targets during a RTGBF intervention.

Purpose
The purpose of this study was to determine the association between time post-ACLR and individuals’ capacity to adapt vGRF-IP in response to a RTGBF-based RTGBF intervention. Specifically, we sought to evaluate the association between time post-ACLR and the root mean squared error (RMSE, described below) of vGRF-IP when using RTGBF to cue an increase of vGRF-IP by 5%, 10%, and 15%.

Methods
Participants
- Thirty-five individuals 6 months - 5 years following primary unilateral ACLR (22 F, 21.4±4.0 years, 25.2±3.8 kg/m², 32.2±15.7 mo. post-ACLR)
- Real-time Gait Biofeedback Procedures for Walking Trials
- Participants' self-selected speed was determined.
- vGRF-IP was defined as the peak vGRF during the first half of stance phase (from initial contact (vGRF > 20 N) to toe-off (vGRF < 20 N)).
- vGRF data were collected on a dual-belt force measuring treadmill (Bertec, Columbus, OH).
- Individuals participated in a usual walking trial and three 250-step randomized walking trials with vGRF-IP based RTGBF intervention cueing increases in vGRF-IP of 5%, 10%, and 15%, respectively.
- Targets were calculated to be a 5%, 10%, or 15% force increase, respectively, of the average vGRF-IP during the usual walking trial.
- A screen directly in front of the treadmill displayed a horizontal line representing the target peak vGRF-IP as previously calculated for each experimental condition using a custom MATLAB code.

Results
- Concurrently, the MATLAB code both calculated and displayed right and left bar graphs representing the continuously changing average of the previous two peak vGRF-IPs for each limb.
- Participants were instructed to attempt match their vertical bars to the target bars.
- Statistical Analyses
  - Individuals’ capacity to meet the given cues was reported as root mean square error (RMSE), the square root of the sum of the squared residuals (target vGRF-IP – measured vGRF-IP of steps 230-240) divided by 10 for each trial.
- Three separate univariate linear regression analyses between time post-ACLR and RMSE for each RTGBF condition were conducted (time-post ACLR and RMSE for 5% Increase Trial, time-post ACLR and RMSE for 10% Increase Trial, time-post ACLR and RMSE for 15% Increase Trial).

Conclusion
- There were no significant associations between time post-ACLR and RMSE (5% RMSE: 0.048±0.023, 10% RMSE: 0.063±0.032, 15% RMSE: 0.071±0.038) for any of the 3 RTGBF trials (R² ranged between 0.003-0.023; all P values > 0.05).
- The capacity to adapt to biomechanics cued by RTGBF does not associate with time post-ACLR.
- These data suggest that RTGBF could be implemented between 6 months and 5 years post-ACLR with similar efficacy for eliciting immediate changes in gait biomechanics.

References