Effects of localized muscle vibration on dynamic stability related to anterior cruciate ligament injury

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BACKGROUND

- Individuals with Anterior Cruciate Ligament Reconstruction (ACLR) are at a high risk for secondary ACL injury.
- The hamstrings muscles provide resistance against ACL loading (i.e. dynamic joint stability).
- Hamstring tendon (HT) graft use is a risk factor for knee instability and reduced knee flexion strength.
  - Translational, rotational, and valgus knee instability
- Dynamic Postural Stability Index (DPSI) and Time to Stabilization (TTS) are measures of dynamic postural control that are linked to secondary ACL injury risk and hamstrings function.
- Local muscle vibration (LMV) improves muscle function and quadriceps activation among healthy controls and increased peak torque in ACLR individuals.
- LMV may also improve dynamic postural control in manners consistent with a lower secondary ACL injury risk.

PURPOSE

Purpose: To evaluate the effects of LMV on DPSI and TTS during a single-leg (SL) landing task.

Hypothesis: LMV will result in decreased DPSI and TTS (i.e. improved dynamic postural control) in SL jump-landing tasks compared to a control intervention.

METHODS

Study Design

- This study consisted of two testing sessions during which participants received the control intervention in one session and LMV in the other.
- A counterbalancing scheme determined intervention order.
- DPSI and TTS were assessed prior to and following the intervention in each session.

Participants

- 8 healthy controls between age of 18 and 35 (21 ± 2) years with no history of ACL injury and no lower extremity injury in the past 6 months participated.

Dynamic Postural Stability

- Participants completed 3 SL landing trials for the dominant limb upon an embedded force plate from a 30 cm high box located half their height away and maintained balance for 10s upon landing (Figure 1).
- TTS was calculated in the medial-lateral (TTS_{ML}, Figure 2) and antero-posterior (TTS_{AP}) directions.
- DPSI was calculated as the mean deviation in the ground reaction force components (total/composite, ML, AP, and vertical) during the landing.

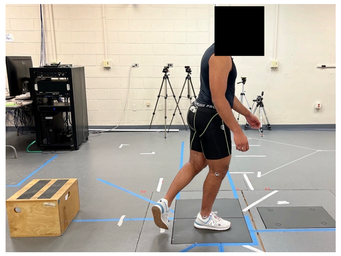

Figure 1. Single leg (SL) jump-landing

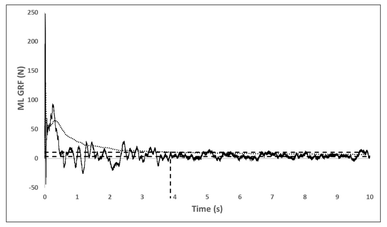

Figure 2.

Figure 2: Typical waveform for the medial/lateral (ML) ground reaction force (GRF) during single-leg landing. Solid line represents the raw GRF, while the dotted line represents the sequential average GRF. Time to stabilization (dashed vertical line) was identified as the instant at which the sequential average waveform was maintained within ±0.25 standard deviations of the raw waveform mean.

Local Muscle Vibration Intervention

- Participants stood in slight knee flexion while LMV (30Hz and 2*g*) was applied to the hamstrings (Figure 3).
- A two-minute rest period was given after the 60 seconds of LMV and this was repeated six times.

Control Intervention

- Participants were instructed to stand in slight knee flexion but received no vibration.

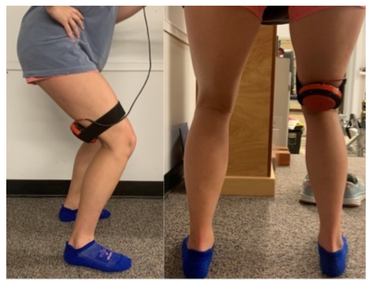

Figure 3. LMV applied to hamstrings

Statistics

- Change scores (post-pre) were calculated for each outcome (TTS_{ML}, TTS_{AP}, DPSI, ML-PSI, AP-PSI, V-PSI) and intervention (LMV, Control).
- One-way repeated-measures ANCOVA controlling for mean of pre-test scores was used to compare change scores between the interventions
- Statistical significance was set *a priori* at *P value* ≤ 0.05.

RESULTS

- No significant differences were identified between control and LMV interventions for any of the TTS or DPSI variables:
  - TTS_{ML} (p = 0.878)
  - TTS_{AP} (p = 0.207)
  - DPSI (p = 0.952)
  - ML-PSI (p = 0.119)
  - AP-PSI (p = 0.108)
  - V-PSI (p = 0.689)

DISCUSSION

- LMV did not influence DPSI or TTS during SL landing in healthy controls.
- However, this does not rule out the possible utility of LMV to improve hamstrings function and postural stability.
- LMV among controls had no improvement in knee extensor strength. (De Ruiter 2003)
- LMV improved static and semi-dynamic postural control in ACLR individuals. (Magbouli 21, Moezy 2008)
- This study solely examined the effects of an acute intervention of LMV among a small sample size of healthy controls.
- Future studies should examine the effect of longitudinal or repeated LMV treatments on dynamic stability as well as other variables affecting secondary injury risk among ACLR individuals.

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