Acute Effect of Local Muscle Vibration on Hamstring Muscle Function in Healthy Controls

Emma Tyndall, Alex Nilius[1], Troy Blackburn[1]

The University of North Carolina at Chapel Hill[1]

MOTION SCIENCE INSTITUTE

UNC COLLEGE OF ARTS AND SCIENCES Exercise and Sport Science

Background

- Approx. 30% of young patients experience secondary anterior cruciate ligament (ACL) injury in the 5 years following initial reconstruction. (Grindem 2016)
- Secondary ACL injury is influenced by factors including strength imbalance and poor landing biomechanics. (Paterno 2010)
- Hamstring tendon autografts for ACL reconstruction (ACLR) are common but come with elevated risk of secondary injury and hamstring strength deficits. (Konrath 2016)
- Hamstrings protect against anterior tibial translation, which loads the ACL and thereby increases risk of injury. (Blackburn 2013)
- Whole-body vibration (WBV) and local muscle vibration (LMV) increase quadriceps function in healthy and ACLR individuals but their effects on the hamstrings muscles are unclear. (Fu 2013)

Purpose

- The purpose of the present analysis was to determine the acute effects of LMV on hamstring peak torque and rate of torque development during maximal voluntary isometric contraction following the application of LMV to the hamstrings in healthy controls.

Subjects & Study Design

- Subjects were 8 individuals with no history of ACLR (75% male; age 21±1.89 yr; avg mass 76.5±14.89 kg; avg height 1.78±0.12 m)

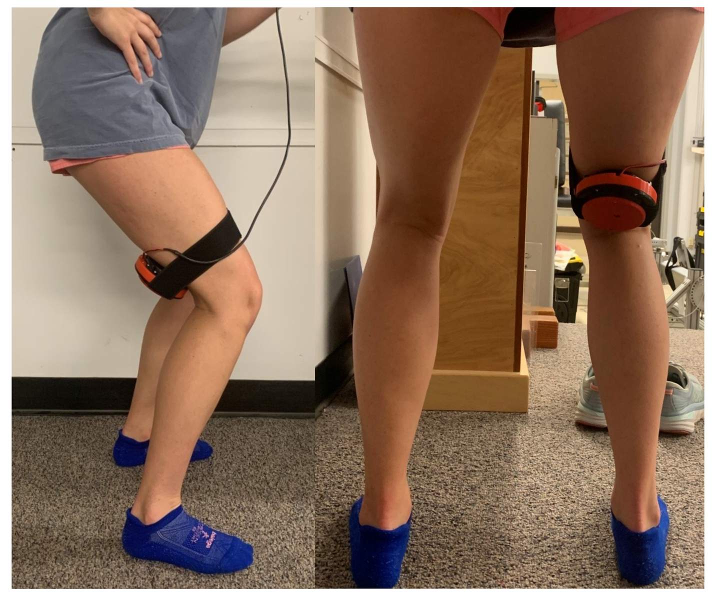
Subject Demographics	
Mean Age (yrs)	21.125
Male	n=6
Female	n=2
Mean Mass (kg)	76.5
Mean Height (m)	1.78

- Hamstring strength was assessed during 3 knee flexion maximal voluntary contractions (MVICs) before and after intervention.
  - Knee flexion peak torque (PT) and rate of torque development (RTD) were calculated from torque-time curve for each trial

Methods

Interventions

- 2 sessions conducted (LMV and control)
  - Single blinded study
  - Interventions carried out by research assistants
- Participants stood with slightly flexed knees while treatment was administered
  - 6 intervals of 60 seconds with 2-minute rest period between intervals



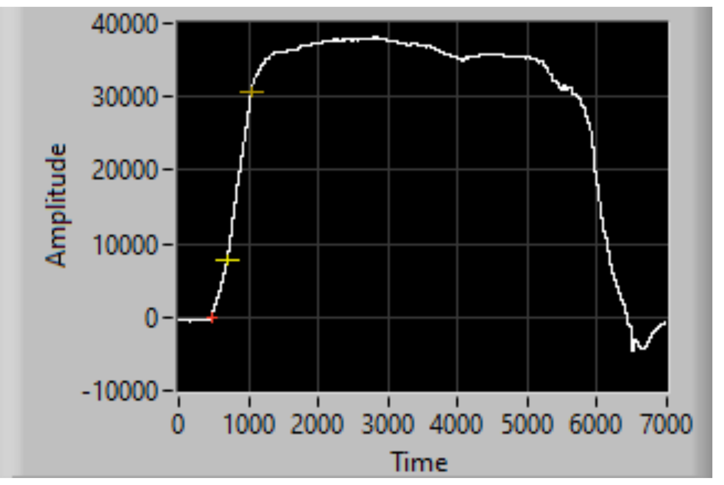
LMV was administered via a small vibrational device placed over the hamstrings. Participants held a slight squat as treatment was administered.

Strength Assessment

- Strength assessments were conducted using a HUMAC Norm isokinetic dynamometer
- Participants completed 3 warm up trials at 25%, 50%, and 75% of their perceived maximal effort
- Participants used 100% of perceived maximal effort for collected trials
  - Data sampled at 2.0kHz and low pass filtered at 50Hz (4th order Butterworth)

Data Processing

- Torque data were processed using a custom LabView program
  - RTD and PT were calculated
    - PT represents maximal voluntary torque value
    - RTD calculated as the slope of the torque-time curve between initiation of MVIC to 80% of PT
    - All measures normalized to body mass for statistical analysis

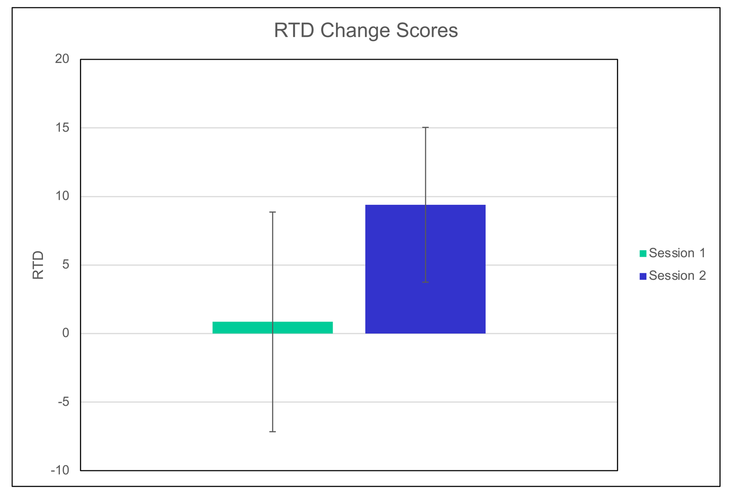


Torque v. time curves as calculated in LabView. Amplitude measured in Nmm, time measured in ms. Amplitude shown is prior to normalizing for bodyweight.

Statistical Analysis

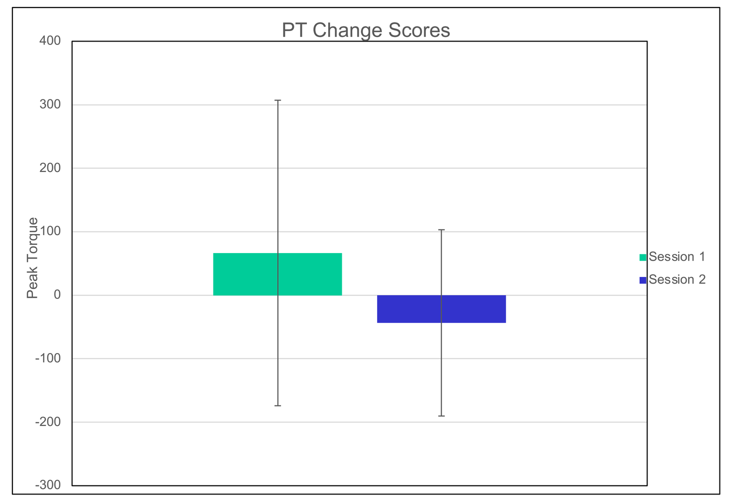
- Change scores (post-pre_ calculated for each outcome (PT, RTD) and intervention (LMV, Control)
- Changes scores compared between interventions using 1-way repeated measures ANCOVA controlling for average pre-test scores from both of 2 sessions

Results



Change score for RTD across all participants in session 1 compared to session 2

- No significant difference between LMV and Control for PT ($p = 0.967$) or RTD ($p = 0.551$)



Change score for PT across all participants in session 1 compared to session 2

Discussion

- LMV did not appear to have an affect on hamstring function in these healthy controls
  - Participants likely did not have underlying hamstring dysfunction to be improved by LMV (ceiling effect)
- Small sample size limited the scope of results
  - Larger sample sizes may see healthy controls with more hamstring muscle activation as a result of a more diverse sample

References

Blackburn, J Troy, et al. “Hamstrings Stiffness and Landing Biomechanics Linked to Anterior Cruciate Ligament Loading.” *Journal of Athletic Training*, U.S. National Library of Medicine, 2013, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3867087/.

Fu CLA, Yung SHP, Law KYB, et al. The Effect of Early Whole-Body Vibration Therapy on Neuromuscular Control After Anterior Cruciate Ligament Reconstruction: A Randomized Controlled Trial. *The American Journal of Sports Medicine*. 2013;41(4):804-814. doi:10.1177/0363546513476473

Grindem, Hege, et al. “Simple Decision Rules Can Reduce Reinjury Risk by 84% after ACL Reconstruction: The Delaware-Oslo ACL Cohort Study.” *British Journal of Sports Medicine*, BMJ Publishing Group Ltd and British Association of Sport and Exercise Medicine, 1 July 2016, https://bjsm.bmj.com/content/50/13/804.

Konrath JM, Vertullo CJ, Kennedy BA, Bush HS, Barrett RS, Lloyd DG. Morphologic Characteristics and Strength of the Hamstring Muscles Remain Altered at 2 Years After Use of a Hamstring Tendon Graft in Anterior Cruciate Ligament Reconstruction. Am J Sports Med. 2016 Oct;44(10):2589-2598. doi: 10.1177/0363546516651441. Epub 2016 Jul 18. PMID: 27432052.

Paterno MV, Schmitt LC, Ford KR, Rauh MJ, Myer GD, Huang B, Hewett TE. Biomechanical measures during landing and postural stability predict second anterior cruciate ligament injury after anterior cruciate ligament reconstruction and return to sport. Am J Sports Med. 2010 Oct;38(10):1968-78. doi: 10.1177/0363546510376053. Epub 2010 Aug 11. PMID: 20702858; PMCID: PMC4920967.

MOTION SCIENCE INSTITUTE

Our Mission is to Explore, Educate & Engage in MUSCULOSKELETAL INJURY PREVENTION