Lower extremity joint contact force symmetry across activities with varied task demands following ACL reconstruction

Weis E[1], Meardon S[2], Willson J[2] [1] Department of Kinesiology; [2] Department of Physical Therapy

Introduction

- ACL rupture is a common sports injury that often involves surgical reconstruction (ACLR) and increases the likelihood of knee and hip osteoarthritis[1]
- Altered knee joint loading following ACLR may expedite premature OA onset and progression
- Compensatory adaptations at the hip and ankle may exist in the presence of altered knee joint loading
- Lower extremity joint kinetic asymmetry during more mechanically demanding tasks than walking has not been reported

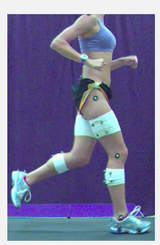
Purpose

Test if greater hip, knee, or ankle joint contact force asymmetry exists during running compared to walking among people following ACL reconstruction

Participants and Methods

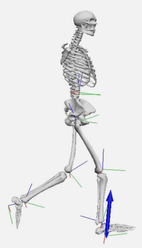
- 30 (19 female) recreationally active individuals 2-7 years post-unilateral ACLR
- 30 control participants matched on weight, activity level, sex

Bilateral motion capture



Self-selected walking (1.2 m/s) and running (2.7 m/s) pace

Inverse dynamics



Joint kinematics
Joint moments

Validated musculoskeletal model, static optimization

Hip, knee, and ankle joint contact forces

- Limb symmetry index (LSI) calculated for hip, knee, and ankle peak force and force impulse:

$$LSI = (involved/uninvolved)*100$$

- LSI evaluated between groups across walking and running tasks using separate 2-factor (group x task) ANOVA (α=.05)

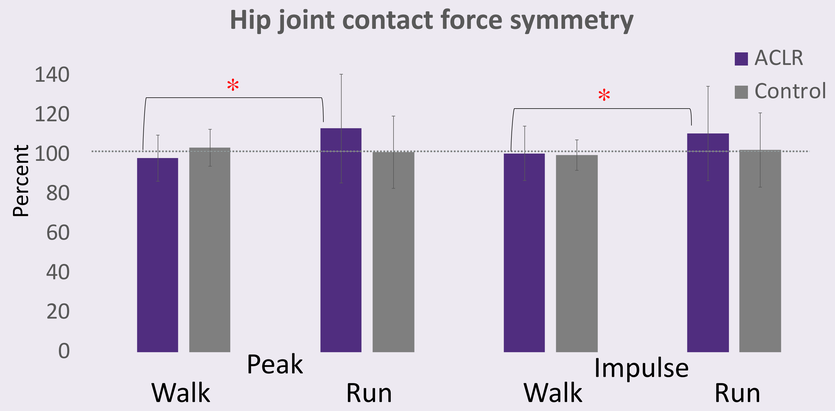


Figure 1. Hip joint contact force symmetry index during walking and running in people with and without unilateral ACLR. Error bars represent 1 SD. * Increased asymmetry during running in ACLR group only (interaction, p = .002)

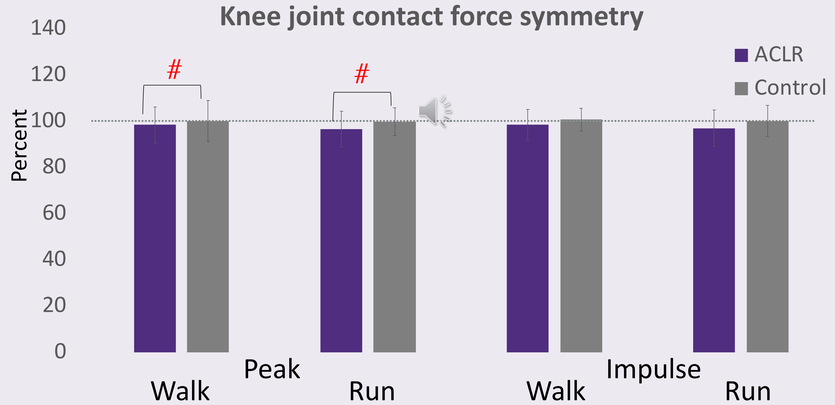


Figure 2. Knee joint contact force symmetry index during walking and running in people with and without unilateral ACLR. Error bars represent 1 SD. # Increased asymmetry during walking and running in ACLR group (main effect, p = .002)

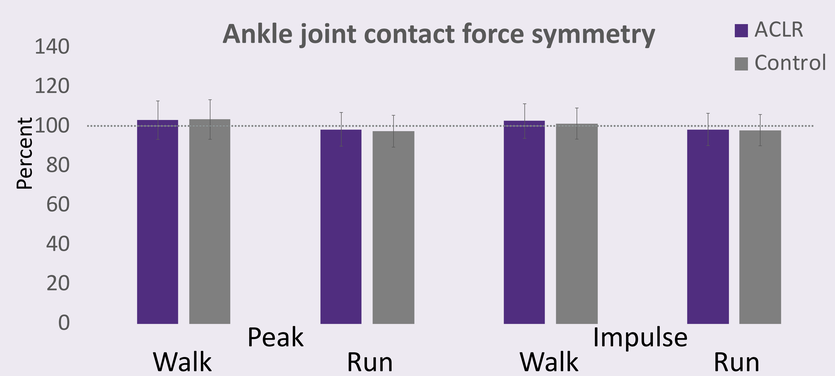


Figure 3. Ankle joint contact force symmetry index during walking and running in people with and without unilateral ACLR. Error bars represent 1 SD.

Discussion

Greater hip joint contact force asymmetry during running than walking for people following ACLR

- May represent a compensatory proximal redistribution of TFJ loads, when task demands are high
  - Greater sagittal plane hip moment during running at 3 years after ACLR compared to healthy control previously reported [2]
  - Decreased hip moments in short term after ACLR and among those with knee OA during walking [3,4,5]
- Increased hip contact force may increase risk of ipsilateral hip pathology

Knee joint contact force asymmetry observed during both tasks

- 2-3% asymmetry did not increase with increasing task demand
  - LSI magnitude consistent with previous studies[6]
- ACLR rehabilitation efforts traditionally focused on restoration of knee joint contact force symmetry
  - Greater attention to hip asymmetry possibly warranted

Ankle joint contact force asymmetry not observed

- Compensations for altered knee joint loading on average occur proximally rather than distally

Clinical Relevance

Consideration of both hip and knee mechanics appear necessary to restore a symmetrical lower extremity kinetic profile following ACLR, particularly during activities with greater task demands

References

1. Richmond et al. (2013). J Orthop Sports Phys Ther. 43:8. 515-B19
2. Kuenze et al. (2014). Med Sci Sports Exerc. 1067- 1076.
3. Roewer et al. (2011). J Biomech. 44. 1948-1953.
4. Wellsandt et al. (2017). J Biomech. 50. 63-69.
5. DiStaci et al. (2015). J Orthop Sports Phys Ther. 45:3. 207- 214.
6. Saxby et. al. (2016). Med Sci Sports Exerc. 2195- 2206.