Lower Limb Joint Work in Runners With and Without a Heightened Risk Post-traumatic Knee Osteoarthritis

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Summary

Altered running biomechanics post-knee surgery such as reduced peak knee flexion angle at the surgical knee joint have been linked to a heightened risk of developing post-traumatic knee osteoarthritis. We set out to investigate the lower limb joint work during running and identify whether runners shift their knee load to other lower limb joints post-surgery. Results indicated that runners displayed less work done by the surgical knee joint with a shift of load to the ankle, hip and uninjured limb; which seems to be detrimental to their future knee health. Further research is needed to uncover the underlying factors resulting in these running alterations and their link to future post-traumatic knee osteoarthritis.

Introduction

The popularity of running has grown in recent decades, likely due to its recognized health benefits, ease of access, and low cost. Although traumatic knee injuries are uncommon in runners, many individuals choose running as a perceived safer alternative to pivoting sports following knee surgery. However, changes in running biomechanics after surgery; particularly reduced loading at the knee joint (underloading); may contribute to the development of post-traumatic knee osteoarthritis [1]. It remains uncertain whether these load changes are redistributed to other lower limb joints, such as the hip or ankle.

We aimed to compare the total positive and negative work performed by the lower limb during the stance phase of running between individuals with and without a history of knee surgery (at heightened risk of post-traumatic osteoarthritis). Additionally, we explored the distribution of positive and negative work across the hip, knee, and ankle relative to the total work done by the lower limb.

Methods

This study was part of a larger prospective cohort study (Trajectory of Knee Health in Runners - TRAIL) with the full protocol published recently [2]. 102 participants from the TRAIL cohort were included, 52 with a history of knee surgery (46% females) and 50 controls (52% females).

A 10-camera 3D motion capture system (VICON) and two embedded AMTI force plates were used to collect biomechanical overground running data across two pre-selected paces (3-3.5 m/s and 5-6 m/s). A participant-specific whole-body biomechanical model was developed in OpenSim 4.3 to calculate joint power (the product of joint angular velocity and moment), which was integrated over the stance phase to determine positive and negative work. Joint work values were compared between the control and surgical groups, as well as between the injured and uninjured limbs within the surgical group. Linear mixed-effects models, stratified by sex, were applied to both absolute work measures (in Joules) and relative work measures (percentage contribution to total lower limb work) to identify any significant differences.

Results and Discussion

The surgical group displayed lower work done at the knee joint at both running paces for both positive (3-3.5 m/s= -5.2 J, 95%CI= -8.1 to -2.3; 5-6 m/s= -9.9 J, 95%CI= -13.9 to -5.9) and negative (4.4 J, 95%CI= 2.4 to 6.4; 7.4 J, 95%CI= 4.9 to 9.9) work done. The total work done by the lower limb followed this same pattern where the injured limb 'underloaded' when compared to the control group limbs, and uninjured limb. When converted to percentage-based relative contributions, a shift of load away from the knee (-1.34% to -2.63%) and towards the ankle (1.06% to 2.51%) and hip (0.23%) joints was observed.

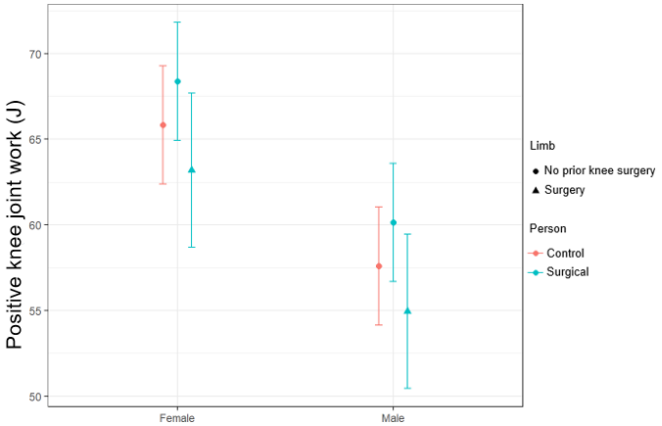

Figure 1: Differences in positive knee joint work for an average 70kg runner between sexes and surgical, non-surgical, and control limbs at the 3 to 3.5 m/s running pace.

Conclusions

Lower work done at the surgical knee joint was observed, as well as shifts of load to the hip, ankle, and uninjured limb. Our findings are essential to understanding the mechanisms behind the heightened risk of post-traumatic osteoarthritis following traumatic knee injury and to develop management strategies addressing it.

References

[1] Sritharan P, et al., *American Journal of Sports Medicine*. **48**:1711-1719, 2020.
[2] De Oliveira Silva D, et al., *BMJ Open*. **13**:e068040, 2023.