Isokinetic Strength Recovery of Quadriceps and Hamstrings at Specific Angles in ACL Reconstruction Patients

Huijuan Shi [1], Hongshi Huang [2], Hanjun Li [1], Yuanyuan Yu [2], Shuang Ren [2], Hui Liu [1], Yingfang Ao [2]
[1] Biomechanics Laboratory, College of Human Movement Science, Beijing Sport University, Beijing, China.
[2] Department of Sports Medicine, Peking University Third Hospital, Beijing, China.
Email: liuhuibupe@163.com; aoyingfang@163.com

Summary

This study investigated angle-specific quadriceps and hamstring strength recovery in 23 unilateral ACL reconstruction (ACLR) patients at 6 and 12 months post-surgery, compared to 25 controls. Isokinetic strength was assessed at 60°/s (20°–90° flexion) and analyzed using statistical parametric mapping.

Introduction

Persistent quadriceps and hamstring strength deficits after ACLR increase reinjury risk. This study characterized angle-specific strength recovery in ACLR patients at 6 and 12 months post-surgery.

Methods

Twenty-three participants with surgical treated primary unilateral ACL rupture (ACLR group) and 25 age-, weight-, and height-matched healthy controls (Control group) participated in this study. In the ACLR group, the concentric knee extensor and flexor muscle strength were assessed on both the reconstructed and contralateral legs at 6 and 12 months after ACLR.

Knee extensor and flexor muscle strength were measured using an isokinetic dynamometer (CON-TREX MJ; Germany) at a sample rate of 256 Hz. The testing sequence began with the assessment of the contralateral leg, followed by reciprocal knee extension and flexion, and then proceeded to the reconstructed leg. Similarly, in the Control group, isokinetic muscle strength tests were conducted for both legs. The strength assessment protocol was as follows: five maximal concentric tests for knee extensor muscle at 60°/s and five maximal concentric tests for knee flexor muscle at 60°/s alternately. The limb symmetry index (LSI) for extensor and flexor strength was calculated point-to-point based on angle-specific data. Statistical parametric mapping were used to analyze angle-specific strength and LSI.

Results and Discussion

At 6 months post-ACLR, the reconstructed leg exhibited significant knee extension deficits and flexion deficits compared to the contralateral ($P < 0.013$) and control legs ($P < 0.013$). By 12 months, extension strength improved at larger flexion angles (60°–90°) and flexion strength at 20°–79° ($P < 0.050$), yet knee extension strength deficits persisted at lower flexion angles (reconstructed vs. controls: extension 25°–63°, $P < 0.013$).

LSI for extension remained lower than controls at 6 (20°–59°) and 12 months (24°–57°, $P < 0.017$), indicating unresolved asymmetry despite bilateral strength gains.

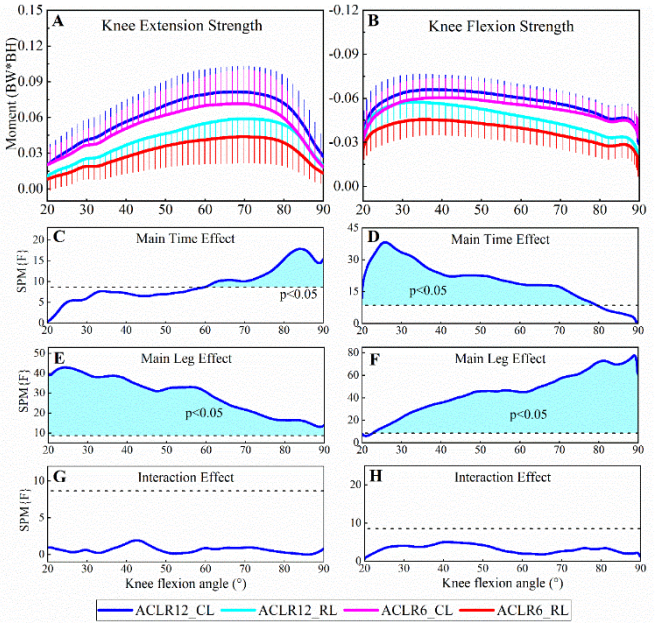

Figure 1: Knee extension and flexion strength in ACLR patients 6 months and 12 months postoperatively.

These findings suggest that traditional peak torque assessments may overlook deficits in critical ranges (e.g., <60° flexion), where ACL loading peaks during functional tasks. Targeted rehabilitation should prioritize low-flexion strength restoration to mitigate reinjury risk.

From 6 to 12 months postoperatively, knee extension strength increased bilaterally. However, limb symmetry index did not improve over time and remained lower than that of control legs. These results suggest that LSI alone cannot fully characterize strength status and it may overestimate or underestimate true function[1]. Careful investigation is necessary to identify specific deficits and address them through targeted rehabilitation.

Conclusions

Strength deficits at lower flexion angles (<60°) persist up to 12 months post-ACLR, emphasizing the importance of angle-specific training in rehabilitation protocols.

References

[1] Wellsandt E et al (2017). *Can Overestimate Knee Function After Anterior Cruciate Ligament Injury*. J Orthop Sports Phys Ther. **5**:334-338