

Changes in Thigh Musculature and Torque Production following 2-weeks of Knee Immobilization in Young and Older Adults

Stephan Bodkin¹, Megan Pales Taylor,¹ Chad Skiles¹, Zachery Fennel¹, Hannah Zabriskie¹, Paul-Emile Bourrant², Elena Yee², Robert Castro², Micah Drummond^{1,2}

¹Dept. Physical Therapy and Athletic Training, University of Utah, Utah, USA

²Dept. Nutrition and Integrative Physiology, University of Utah, Utah, USA

Email: stephan.bodkin@utah.edu

Summary

Two-weeks of knee joint immobilization in healthy adults resulted in $5.6 \pm 3.7\%$ atrophy of thigh muscle cross sectional area (CSA) and $7.2 \pm 4.6\%$ atrophy of quadriceps CSA. Following a one-week recovery, only 2% of muscle CSA returned. Similarly, two weeks of immobilization resulted in $21 \pm 25\%$ declines in maximal knee extensor torque production.

Introduction

Skeletal muscle is the biomechanical driver to human motion. With age and disease, declines in skeletal muscle size and strength are observed that can lead to fall risk and declines in physical activity [1]. Immobilization models allow the opportunity to assess the impact of inactive joint musculature on torque production [2]. Therefore, the purpose of this study was to assess the change in thigh muscle cross sectional area and knee extensor and flexor torque production following 2-weeks of knee immobilization in young and old adults.

Methods

15 participants (11 Young Adults: 23.4 ± 3.1 years, 174.3 ± 9.0 cm, 77.2 ± 13.9 kg; 4 Older Adults: 70.0 ± 1.8 years, 176.3 ± 8.2 cm, 78.2 ± 7.8 kg) received a two-week knee immobilization intervention, where the knee was braced and unloaded with crutches. Participants completed isokinetic testing for peak knee extensor and flexor torque (Nm/kg) at $60^\circ/\text{sec}$, $120^\circ/\text{sec}$, and $180^\circ/\text{sec}$. Lower extremity Dixon Magnetic Resonance Imaging was collected to receive mid-thigh muscle and quadriceps cross sectional area (CSA) (mm^2/kg). Measures were assessed pre-immobilization, post-immobilization, and following 1-week recovery.

A 2x3 mixed design ANOVA was performed to assess changes in strength and muscle CSA between age-cohort (Young, Old) and Visit (Pre-Immobilization, Post-Immobilization, 1-week recovery). Change scores were calculated as percent differences between each visit. Pearson's r correlation coefficients were performed to assess the change in muscle mass to the change in strength between visits, stratified by age-cohort.

Results and Discussion

There were strong, positive relationships between Quadriceps and Thigh Muscle CSA to knee extensor and flexor and strength between all visits (all $p < .05$). However, no relationships were observed between the change in muscle CSA to the change in knee extensor torque over the immobilization period (all $p > .05$).

Knee Extensor Peak Torque: There was a significant main effect for Visit ($F_{2,18}=3.48$, $p=.05$) at $120^\circ/\text{sec}$. Across all participants, there was an average 20.6% decline in knee extensor strength post-immobilization.

Knee Flexor Peak Torque: There was a significant Age*Time interaction ($F_{2,18}=4.05$, $p=.035$) at $120^\circ/\text{sec}$. Young adults had a 12% reduction in knee flexor strength from between Pre-Immobilization to Post-Immobilization ($p=.02$) that was not observed in older adults.

Thigh Muscle CSA: There was a significant main effect for Visit ($F_{2,26}=8.99$, $p=.001$), with a $5.6 \pm 3.7\%$ reduction in Thigh Muscle mass between Pre- Immobilization to Post-Immobilization ($p=.003$).

Quad CSA: There was a significant main effect for Visit ($F_{2,26}=15.03$, $p < .001$) and Cohort ($F=4.32_{1,13}$, $p=.05$). There was a $7.2 \pm 4.6\%$ reduction in Quadriceps CSA between Pre-Immobilization to Post-Immobilization ($p=.003$) within all participants (Figure 1). Across visits, Older Adults had 26% lower Quadriceps CSA compared to Young adults ($p < .001$).

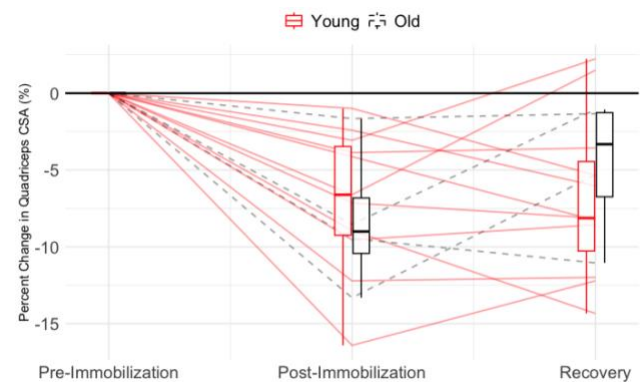


Figure 1: Change in Quadriceps muscle group CSA from pre-immobilization, post-immobilization, and the one-week recovery.

Conclusions

Two-week knee immobilization resulted in approximately a 7% decline in quadriceps CSA. This decline in strength was not associated with changes to knee extensor or flexor torque output during this period.

Acknowledgments

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References

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- [2] Bączkiewicz D et al. (2020) *J Clin Med.* **9**(2):451.