

## ORIGINAL RESEARCH

## RAPID KNEE-EXTENSIONS TO INCREASE QUADRICEPS MUSCLE ACTIVITY IN PATIENTS WITH TOTAL KNEE ARTHROPLASTY: A RANDOMIZED CROSS-OVER STUDY

Rasmus Skov Husted\*<sup>1,2,3</sup>Lousia Wilquin\*<sup>4</sup>Thomas Linding Jakobsen<sup>1,5,6</sup>Anders Holsgaard-Larsen<sup>7</sup>Thomas Bandholm<sup>1,2,3</sup>

## ABSTRACT

**Background:** Inhibition of the quadriceps muscle and reduced knee-extension strength is common shortly following total knee arthroplasty (weeks to months), due to reduced voluntary activation of the quadriceps muscle. In healthy subjects, strength training with heavy loads is known to increase agonist muscle activity, especially if the exercise is conducted using rapid muscle contractions.

**Purpose:** The purpose of this study was to examine if patients with total knee arthroplasty could perform rapid knee-extensions using a 10 RM load four to eight weeks after surgery, and the degree to which rapid knee-extensions were associated with greater voluntary quadriceps muscle activity during an experimental strength training session, compared to that elicited using slow knee-extensions.

**Study Design:** A randomized cross-over study.

**Methods:** Twenty-four patients (age 66.5) 4-8 weeks post total knee arthroplasty randomly performed one set of five rapid, and one set of five slow knee-extensions with the operated leg, using a load of their 10 repetition maximum, while surface electromyography recordings were obtained from the vastus medialis and lateralis of the quadriceps muscle.

**Results:** Data from 23 of the 24 included patients were analyzed. Muscle activity was significantly higher during rapid knee-extensions (120.2% [10<sup>th</sup>-90<sup>th</sup> percentile: 98.3-149.1]) compared to slow knee-extensions (106.0% [88.8-140.8]) for the vastus lateralis ( $p < 0.01$ ), but not for the vastus medialis (120.8% [90.4-134.0]) and (121.8% [93.0-133.0]) ( $p = 0.17$ ), respectively. Slow and rapid knee-extensions were performed at a median angular velocity of 19.7 degrees/sec (13.7-24.4) and 51.4 degrees/sec (28.9-63.1), respectively

**Conclusion:** Four to eight weeks after their total knee arthroplasty, the patients in the present study were able to conduct rapid knee-extensions according to the experimental protocol with an approximately doubled angular velocity compared to slow knee-extensions. This was associated with increased muscle activity in the vastus lateralis when compared to slow knee-extensions, but not in the vastus medialis. Whether this significant, although relatively small, difference in vastus lateralis muscle activity has any clinical relevance needs further study.

**Level of Evidence:** 3

**Keywords:** Exercise evaluation, knee-extension velocity, quadriceps muscle, rehabilitation, total knee arthroplasty

<sup>1</sup> Optimed, Clinical Research Centre, Copenhagen University Hospital, Hvidovre, Copenhagen, Denmark

<sup>2</sup> Department of Orthopedic Surgery, Copenhagen University Hospital, Hvidovre, Copenhagen, Denmark

<sup>3</sup> Physical Medicine & Rehabilitation Research – Copenhagen (PMR-C), Copenhagen University Hospital, Hvidovre, Copenhagen, Denmark

<sup>4</sup> Faculty of Health and Technology, Department of Physiotherapy and Occupational Therapy, Metropolitan University College Copenhagen, Denmark

<sup>5</sup> Health and Rehabilitation, Nørrebro, City of Copenhagen, Denmark

<sup>6</sup> Lundbeck Foundation Centre for Fast-Track Hip and Knee Arthroplasty, Copenhagen University Hospital, Hvidovre, Copenhagen, Denmark

<sup>7</sup> Orthopaedic Research Unit, Department of Orthopaedics and Traumatology, Odense University Hospital, Institute of Clinical Research, University of Southern Denmark, Odense, Denmark

## Funding statement

The study has received funding from Lundbeck Foundation Centre for Fast-Track Hip and Knee Arthroplasty and the Danish Foundation for Research in Physiotherapy, Denmark.

The funding bodies have not influenced the research process, i.e. protocol, design, data collection, off line analysis, composition of manuscript or considerations on publication.

\*These authors contributed equally (shared first authorship).

## Acknowledgements

Acknowledgements go to Elin Mikkelsen, MSc, for help with the experimental work. We acknowledge the support from the physical therapists and the management at the rehabilitation centers (Vanløse, Vesterbro/Kgs. Enghave/Valby, Brøndby and Hvidovre, Denmark).

## CORRESPONDING AUTHOR

Husted, Rasmus Skov  
Optimed, Clinical Research Centre  
Copenhagen University Hospital,  
Amager-Hvidovre, Kettegård Alle 30, 2650  
Hvidovre, Denmark  
E-mail: rasmus.skov.husted@regionh.dk