Impact of Limited Range of Motion Exercise™ on physical function, exercise adherence, and perceptual outcomes in individuals with knee osteoarthritis

A White Paper Presented to

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September 2015

Introduction

Joint pain and inflammation impact 30% of Americans and account for half of the chronic conditions in individuals over 65 years of age (A. D. Woolf and Pfleger 2003; A. Woolf 2000). As part of a coordinated treatment approach, resistance exercise helps to manage joint pain, improve physical function, and promote health and longevity (Messier et al. 2004; Rall et al. 1996; Fransen, McConnell, and Bell 2002; Barry et al. 2014). How resistance exercise is performed, however, is a concern when dealing with the pain that accompanies joint disorders.

Current recommendations specify that resistance exercise be executed using a full range of motion (ROM) to ensure uniform development of physical performance (Garber et al. 2011). In an individual suffering from joint pain, however, the benefits of full ROM exercise may become a secondary concern if pain limits exercise adherence, performance, and adaptation. The use of limited, pain-free ROM resistance exercise may therefore serve as a safe and effective training alternative that promotes exercise adherence in populations with joint pain.

Previous investigations have established that limited ROM resistance exercise can promote performance improvements throughout the full ROM. Limited ROM was as effective as full ROM exercise for increasing strength in a 12-week training investigation of lumbar extension (Graves et al. 1992). When performed at the training speed of 2.09 rad/sec, strength during isokinetic knee extensions significantly increased across the ROM despite the use of a limited ROM (McNair and Stanley 1996).

Limited ROM exercise has shown other benefits as well. In a study of men and women with chronic low-back pain, it was as effective for improving strength and perceived pain and disability during full ROM lumbar extension (Steele et al. 2013). In a 6-week isokinetic training study of 55 women, limited ROM increased motor unit recruitment, isometric force, rate of force development, and work output even in ranges of motion not trained (Y. Barak, Ayalon, and Dvir 2006; Y. Barak, Ayalon, and Dvir 2004; V. Barak, Ayalon, and Dvir 2008). The finding that limited ROM produced comparable improvements for full ROM performance has been seen elsewhere (Massey et al. 2004; Clark et al. 2011), although one 12-week investigation suggested that full ROM may result in slightly higher gains in strength and muscle thickness (Pinto et al. 2012). As a whole, however, these data suggest that limited ROM resistance exercise provides performance benefits that extend to the full ROM, supporting its efficacy as a training approach when full ROM is contraindicated.

While performance benefits may transfer from limited ROM exercise to the full ROM, it is not clear whether a limited ROM approach is optimal for real-world applications. In particular, it is important to establish whether limited ROM exercise results in improved outcomes, including functional ability, pain, exercise adherence, cognitive function, and body composition in individuals with existing joint pain. Thus, the purpose of this investigation is to determine whether the use of a proprietary *Limited Range of Motion Exercise™* (LROME) training methodology translates to improved measures of physical function and quality of life in individuals with knee pain.

Specific Hypotheses

Previous investigations in this area, while valuable, were often limited in scope in terms of their relationship to LROME™ . The studies explained that, for example, force production was developed to the same extent using partial versus full ROM in a single exercise; while this fact is useful in a scientific manuscript, it is not as accessible to a broader audience and provides little data for marketing LROME™ . Isokinetic performance is not something that the average person relates to; these types of measures do not tell the larger population whether or not an approach like LROME™ will make them feel better, help them to get through their day-to-day tasks, or improve their quality of life.

The proper execution of a training investigation is both cost- and labor-intensive. Subject recruitment, personnel management, scheduling, attrition concerns, and the time required to train subjects for any length of time requires the concerted effort of the research team and study sponsors. This often results in very short-term, small sized training studies (10 subjects for around 6 weeks) with few variables to avoid costs. The issue, however, is that these investigations are frequently dismissed; they are unlikely to produce meaningful results that will make an impact on the scientific world – even if a series of small studies are performed to examine different experimental questions.

Another approach is to limit outcome variables in an attempt to save on costs. Once a training framework is in place, however, and there is little extra cost or energy required to add more testing variables (in other words, with a subject already training and being tested for strength, it takes little added effort to ask them to perform a vertical jump beforehand or step into the BodPod while at the lab). Given the existing investments of time, energy, and funds already allotted to a project, then, it is advisable to upgrade from a series of small, shorter-term investigations to a single, well-executed, larger investigation that explores multiple variables and produces the best return on the investment. Thus the model used by the principal investigator (Dunn-Lewis, Kraemer, et al. 2011; Dunn-Lewis et al. 2012; Dunn-Lewis, Flanagan, et al. 2011), including her previous work with UnderArmour, Advocare, the Dairy Council, the military, and other major corporations, is the same as the best in this field: to examine, within reason, a wide array of variables in a single investigation. Carefully chosen variables will resonate with both the scientific community and the average person (and can also be used by a sponsor for a variety of different marketing purposes if appropriate):

1. **Physical performance**:
    a. **Strength**: In agreement with previous work on isokinetic dynamometers, we anticipate that strength gains from free weights and machines will be comparable between the LROME™ and full ROM groups.

    b. **Power**: We anticipate that LROME™ will provide comparable improvements in vertical jump power to full ROM. If LROME™ promotes reduced pain and improved exercise performance, however, vertical jump power may be highest in LROME™ .

    c. **Range of motion**: We anticipate that LROME™ will provide comparable improvements in range of motion to full ROM.

2. **Functional ability**:
    a. **Balance**: We anticipate that LROME™ will provide comparable improvements in balance to full ROM.
    b. **Gait speed**: Gait speed is an important indicator of health, mortality, independence, and quality of life. We anticipate that LROME™ will improve gait speed over full ROM by increasing performance without inducing pain or inflammation.
    c. **Activities of daily living**: We anticipate that LROME™ will improve performance of activities of daily living as compared to other approaches by increasing performance without inducing pain or inflammation. This is an important, relatable marker of health and independence in the older population.

3. **Physical Activity**: If LROME™ provides a pain-free method of increasing physical function and performance, we anticipate that individuals training with LROME™ will experience increased voluntary physical activity in their day-to-day lives.

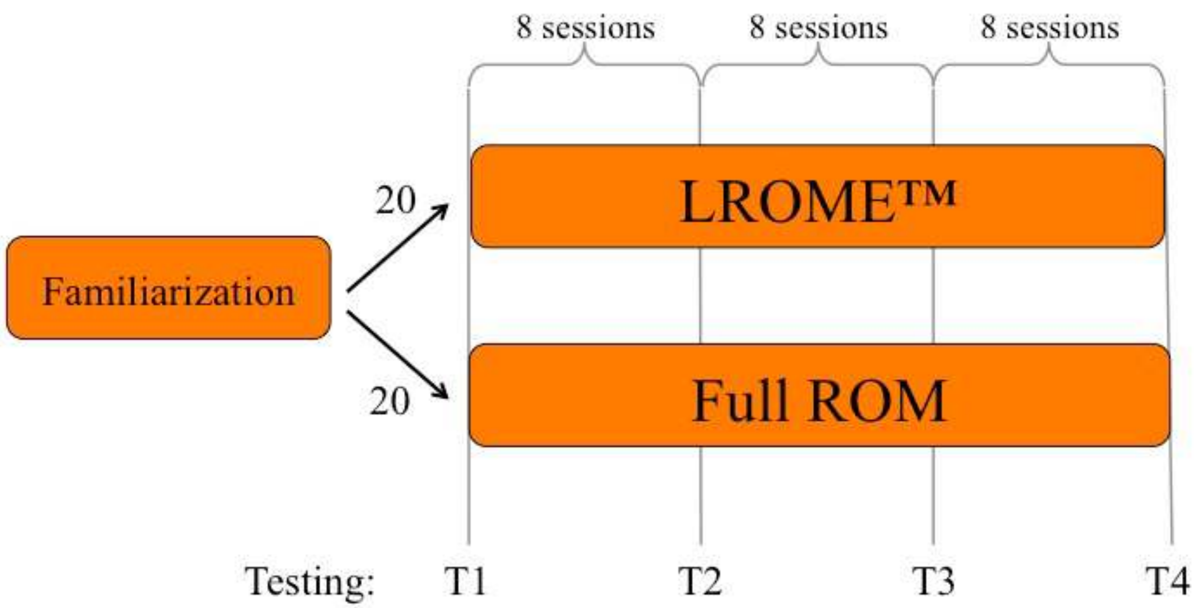
4. **Reaction Time and Cognitive Function**: In agreement with previous work, we anticipate that both training methods will increase reaction time.

5. **Exercise adherence**: We would hypothesize that the reduction in discomfort allowed by LROME™ will increase adherence over the full ROM group.

6. **Muscle quality and body composition**: We hypothesize that muscle quality will increase in both groups. The primary reason for the inclusion of overall body composition is for descriptive purposes (it is an expectation for high-quality academic journals). Due to the length of this investigation, we may not detect significant changes in body composition (fat and muscle mass). If changes are seen, however, it is likely that there will be an increase in muscle mass in the training groups.

Methods

To examine the experimental question, 40 individuals with osteoarthritis of the knee will be randomized to one of two groups: a *Limited Range of Motion Exercise*™ (LROME) group or a full range of motion (ROM) group. Prior to all testing and training, subjects will attend a comprehensive, self-paced familiarization session. The intervention itself will last for 24 sessions (approximately 12 weeks). Subjects will complete a testing battery (described below) at baseline, after 8 sessions, after 16 sessions, and after their final (24^{th}) training session.



Biographical Sketch of Courtenay Dunn-Lewis, Ph.D.

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B.A. Johns Hopkins University, Baltimore, MD 2006
Field of Study: Public Health
Advisor: James D. Goodyear, Ph.D.

M.A. University of Connecticut, Storrs, CT 2009
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Ph.D. University of Connecticut, Storrs, CT 2013
Field of Study: Kinesiology (Exercise Physiology)
Secondary Concentration: Statistics
Advisor: William J. Kraemer, Ph.D.

Dr. Dunn-Lewis completed her graduate work at the University of Connecticut, which is ranked as the #1 doctoral program by the National Academy of Kinesiology for its intense and productive research environment. As a master's student, she was admitted into the laboratory team regarded worldwide for its work with resistance exercise. Her initial coordination of small studies and components of larger training investigations led to her appointment as the Laboratory Team Leader in her first year as a doctoral student. In this role, she coordinated and supervised the development, execution, analysis, and publication of research at all levels for the next four years. Her experience spanned from basic biochemical analysis and the training and mentorship of master's students to the development of several successful grant proposals, including awards of over half a million dollars. She received the Department of Kinesiology's Outstanding Doctoral Student Award and the NEACSM David Camaione Doctoral Award.

As an undergraduate, Dr. Dunn-Lewis completed graduate coursework at the Bloomberg School of Public Health before graduating from the #1 ranked program for public health at Johns Hopkins University in 2006. During that period, she also worked at the Center for Tuberculosis Research at the Johns Hopkins Medical Institutions and as an Assistant Manager of Fitness Programs at the Johns Hopkins University Recreation Center. Following graduation, she also served as manager for several other fitness programs as well as performing research at Skidmore College's Department of Exercise Sciences in 2007.

Dr. Dunn-Lewis has direct experience at all levels with several large-scale, multi-million dollar resistance training investigation initiatives, from basic subject training to logistical coordination, analysis, publication, and public presentation. Both collaborative projects and her first-author publications have included direct work with physical activity in older populations. She is a past Editorial Associate at the Journal for Strength and Conditioning Research, a current reviewer, as well as a guest reviewer for several peer-reviewed journals. She has presented her work at conferences nationwide and has over 30 peer-reviewed publications on PubMed.

Selected Peer-Reviewed Publications:

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