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Cross-sectional association between muscle strength and self-reported physical function in 195 hip osteoarthritis patients

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ABSTRACT

Introduction: This study aimed to evaluate associations between strength of selected hip and knee muscles and self-reported physical function, and their clinical relevance, in men and women with hip osteoarthritis (OA).

Methods: Cross-sectional data from 195 participants with symptomatic hip OA were used. Peak isometric torque of hip extensors, flexors, and abductors, and knee extensors were measured, along with physical function using the Western Ontario and McMaster Universities Osteoarthritis Index questionnaire. Separate linear regressions in men and women were used to determine the association between strength and physical function accounting for age, pain, and radiographic disease severity. Subsequently, magnitudes of strength associated with estimates of minimal clinically important improvement (MCII) in physical function were estimated according to severity of difficulty with physical function.

Results: For men, greater strength of the hip extensors, hip flexors and knee extensors were each associated with better physical function. For women, greater muscle strength of all tested muscles were each associated with better physical function. For men and women, increases in muscle strength between 17–32%, 133–223%, and 151–284% may be associated with estimates of MCII in physical function for those with mild, moderate, and severe physical dysfunction, respectively.

Conclusion: Greater isometric strength of specific hip and thigh muscle groups may be associated with better self-reported physical function in men and women. In people with mild physical dysfunction, an estimate of MCII in physical function may be associated with attainable increases in strength. However, in patients with more severe dysfunction, greater and perhaps unattainable strength increases may be associated with an estimate of MCII in physical function. Longitudinal studies are required to validate these observations.

Introduction

Hip osteoarthritis (OA) is a prevalent and costly chronic musculoskeletal condition [1,2]. After the knee, the hip is the most commonly affected lower-limb joint with 11% of older adults estimated to have hip OA [3]. Although pain is often considered the cardinal symptom of OA [4], physical function is also impaired in patients with hip OA [5] and is one of the drivers for costly joint replacement surgery [6]. Exercise, particularly strengthening, is among the core conservative treatments recommended by clinical guidelines [7–9] and can provide modest improvements in physical function for patients with hip OA [10]. However, a better understanding of the association between muscle strength and physical function in these patients may guide treatments, such that greater than modest clinical improvements can be achieved.

There is evidence of lower-limb muscle weakness in people with hip OA [11]. Although muscle weakness has been associated with objective measures of physical impairments [12], little is known about the relationship between muscle strength and self-reported physical function in people with hip OA. This is important given that self-reported measures, such as the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) questionnaire [13], measure different constructs of physical functioning to performance-based measures [14] and are often used as

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end-points in OA clinical trials evaluating the efficacy of interventions [15–17]. Moreover, previous research has demonstrated that a minimal clinically important improvement (MCII) in physical function is dependent on the severity of difficulty with physical function in people with hip OA [13]. Thus, providing context for change in strength associated with a clinically relevant change in physical function according to severity of physical function can facilitate future longitudinal research.

Therefore, the aim of this study was to test the hypothesis that greater strength of the major hip and thigh muscles would be associated with better self-reported physical function, assessed using the WOMAC, in men and women. If significant associations were found, we also aimed to explore the magnitude of strength gains associated with an estimate of MCII in physical function according to varying levels of initial physical dysfunction.

Methods

Study design

This was a cross-sectional study evaluating the relationship between muscle strength of selected hip and thigh muscle groups and self-reported physical function assessed using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) [18]. The study conforms to the STROBE statement for reporting cross-sectional studies [19].

Participants

Data from two studies [12,15] including 195 participants with symptomatic and radiographic hip OA [$n = 93$ from a cross-sectional study and $n = 102$ from a randomised controlled trial (RCT) study utilizing baseline data] were used. Participants were recruited via community advertisements in Melbourne, Australia from November 2006 to May 2008 for the cross-sectional study and from May 2010 to April 2012 for the RCT.

The two studies shared two inclusion criterion: (i) hip OA fulfilling America College of Rheumatology classification criteria of pain and radiographic changes [20] assessed on standing x-ray used standardised protocols and femoral or acetabular osteophytes and joint space narrowing greater than or equal to Grade 2 on a standing x-ray; and (ii) hip or groin pain on most days of the past month. The studies shared these exclusion criteria as follows: (i) presence of neurologic, cardiac, or other medical conditions that would compromise lower-limb function; (ii) back pain or other joint pain; (iii) lower extremity joint replacement; (iv) systemic arthritic conditions such as rheumatoid arthritis; (v) other previous pathology such as fracture; (vi) inability to walk unaided; and (vii) inadequate ability to understand English.

The cross-sectional study had additional exclusion criterion including secondary hip OA due to trauma, inflammatory, or metabolic rheumatic diseases. The RCT had these additional inclusion criteria: (i) 50 years or older; (ii) average pain intensity in the past week of 40 or higher on a 100 mm visual analogue scale (VAS); (iii) at least moderate difficulty with daily activities. The RCT also had the following exclusion criteria: (i) hip joint surgery within past 6 months, (ii) planned lower-limb surgery; (iii) physiotherapy, chiropractic treatment, or prescribed exercises for hip, lumbar spine, or both in the past 6 months; (iv) walking continuously for more than 30 min daily and regular structured exercise more than once weekly; (v) uncontrolled hypertension, or morbid obesity (body mass index $> 40\ \mathrm{kg/m^2}$); (vi) unable to comply with study protocol; (vii) current or past (within 3 months) oral or intra-articular corticosteroid use; and (viii) inability to comply with study protocol.

The most symptomatic hip was deemed the study hip in cases of bilaterally eligible cases. Ethical approval was obtained for the two studies from the University of Melbourne Human Ethics Committee and all participants provided their written informed consent.

Dependent variable (outcome)

Physical function was assessed using the WOMAC 17-item physical function subscale with hip-related questions on a scale from 0 ("none") to 4 ("extreme"). The total score was normalized to a 0–100 score, where higher scores indicate extreme difficulty [18]. Physical function on the WOMAC is recommended for OA clinical trials [21].

Independent variables (predictors)

Muscle strength was measured as maximal isometric muscle torque (Nm/kg) and normalized to body mass (kg) because a large proportion (75%) of the items on the WOMAC physical function subscale relate to weight-bearing activities [18]. The average of two maximal efforts was used to measure peak hip muscle torque (Nm); the peak of three trials was used for peak knee extensor torque. Differences in peak torque quantification (average versus peak) between hip and knee muscle strength assessments relate to differences in techniques (hand-held dynamometry versus isokinetic dynamometer). We have demonstrated excellent reliability for all strength measurement techniques used in this study [22,31].

Peak isometric hip muscle strength

Peak isometric muscle strength was assessed on the study hip only. Before each hip muscle strength test, participants performed a submaximal and a maximal contraction warm-up effort for familiarization. Participants performed two maximal trials for approximately 3 s. Each participant received standardised, strong verbal encouragement to "push/pull" as hard as you can, respectively. Techniques used to assess muscle strength in this study have been previously described in detail along with excellent test–retest reliability in patients with hip OA (intraclass correlation coefficient 0.84–0.97; standard error of measurement 3–12 Nm) [22]. Therefore, we provide a brief description below.

For hip extensor strength, participants were secured in a supine position with the study hip in 20° of hip flexion, aligned perpendicularly to a force transducer (FGV—10 force gauge; Shimpo Instruments, New York, USA) and digital inclinometer suspended from the ceiling. The lever arm was recorded as the distance from the most prominent aspect of the greater trochanter to the point of transducer attachment 5 cm proximal to the lateral malleolus. The transducer force was zeroed with the limb relaxed, to remove the gravitational weight of the limb from the recorded force. Hip abduction strength was measured with the Lafayette hand-held dynamometer (Lafayette Instrument Co, Lafayette, IN) in a stabilized, gravity-eliminated supine position, with both hips in neutral abduction–adduction. The lever arm was recorded as the distance from the most prominent aspect of the greater trochanter to the point of transducer attachment within 5 cm proximal to the femoral condyle.

For hip flexion strength, participants were securely seated in an upright position with the hip and knee in 90° of flexion. Strength was assessed using a hand-held dynamometer placed 5 cm proximal to the superior aspect of the patella on the anterior thigh. The lever arm was recorded as the distance from the most prominent aspect of the greater trochanter to the point of transducer attachment 5 cm proximal to the femoral condyle. Correction for the gravitational weight of the flexed limb was deemed not possible for hip flexion strength in this position.