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Does a weight-training exercise programme given to patients four or more years after total knee arthroplasty improve mobility: A randomized controlled trial

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ABSTRACT

Aim: To investigate the effects of the home exercise therapy performed after at least four years postoperatively on skeletal muscle strength and functionality in patients with total knee arthroplasty (TKA).
Methods: Sixty patients (age; 69.66 ± 7.53, weight; 81.56 ± 14.43 kg, 10 male, 50 female) followed up four or more years were randomly divided into two groups. An 8-week exercise program was designed for bilateral TKA patients. While the patients in one group were assigned to weighted exercise group, the patients in the other group were assigned to non-weighted exercise group. The primary outcome was the isometric muscle strength of quadriceps femoris (QF) and hamstring muscles assessed by Hand-Held Dynamometer. The secondary outcomes were the pain level, 30 s sit-to-stand test, 10 m walk test, range of motion, and the knee function score of the Hospital for Special Surgery. The assessments were performed before and after the treatment.
Results: After treatment, significant differences were found in all evaluation parameters (except rest pain and range of motion) in favour of the weighted group. QF muscle strength changes (kg); weighted group: 1.99 ± 1.70, non-weighted group: 0.51 ± 1.14 ($p = 0.000$), 30 s sit-to-stand test changes (repetitions); weighted group: 3.66 ± 2.23, non-weighted group: 1.70 ± 1.95 ($p = 0.000$), 10 m walk test changes (seconds); weighted group: −2.60 ± 1.30, non-weighted group: −0.83 ± 3.51 ($p = 0.000$).
Conclusion: Home exercise programs applied to TKA patients after at least four years postoperatively was effective in increasing muscle strength, decreasing severity of pain, and improving functional activities. The improvements were significantly greater in weighted compared with the non-weighted exercise group.

1. Introduction

Muscle weakness is of particular concern after total knee arthroplasty (TKA) and, as such, interventions to improve skeletal muscle strength in patients with TKA are highly recommended. (Ciolac & Greve, 2011; LaStayo et al., 2009; Liao, Liou, Huang, & Huang, 2013; Maffiuletti, Bizzini, Widler, & Munzinger, 2010; Meier et al., 2008; Minns Lowe, Barker, Holder, & Sackley, 2012; Petterson et al., 2009). In accordance, a great number of studies have investigated the efficacy of strength training in this population. (Ciolac & Greve, 2011; Frost, Lamb, & Robertson, 2002; Kramer, Speechley, Bourne, Rorabeck, & Vaz, 2003; LaStayo et al., 2009; Levine, McElroy, Stakich, & Cicco, 2013; Maffiuletti et al., 2010; Minns Lowe et al., 2012; Moffet et al., 2004; Petterson et al., 2009; Unver, Karatosun, & Bakirhan, 2005). Since the decrease in the quadriceps femoris (QF) muscle strength and limitations in functional activities are greater during the early postoperative period, thus far studies have mostly focus on this period (Frost et al., 2002; Huang, Chen, & Chou, 2012; Kramer et al., 2003; Levine et al., 2013; Liao et al., 2013; Maffiuletti et al., 2010; Minns Lowe et al., 2012; Moffet et al., 2004; Petterson et al., 2009; Unver et al., 2005). Few studies have investigated the effectiveness of rehabilitation programs after the first postoperative year in TKA

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patients (Ciolac & Greve, 2011; LaStayo et al., 2009). Considering the small sample size, variability in the amount of time since TKA surgery, minimal invasive surgical technique used, and the inclusion of both unilateral and bilateral TKA's, these studies were underpowered and their patients formed a heterogeneous cohort (Ciolac & Greve, 2011; LaStayo et al., 2009). The existing studies do not guide us on how to improve mobility in such situation.

Strengthening exercises are the most effective intervention for improving muscle strength and functionality and have been recommended in the guidelines for knee osteoarthritis management and in clinical reviews for TKA rehabilitation (Ciolac & Greve, 2011; Frost et al., 2002; Iwamoto, Sato, Takeda, & Matsumoto, 2011; Meier et al., 2008; Minns Lowe, Barker, Dewey, & Sackley, 2007). Although there is still no evidence that the type of strengthening exercises (isometric, isotonic, isokinetic, concentric, concentric-eccentric, and dynamic modalities) have an important impact on the program outcome (Carvalho, Bittar, Pinto, Ferreira, & Sitta, 2010; Ciolac & Greve, 2011; Frost et al., 2002; Iwamoto et al., 2011; Meier et al., 2008; Minns Lowe et al., 2007, 2012; Yilmaz, Polat, Karaca, Kucuksen, & Akkurt, 2013), progressive isometric and isotonic strengthening exercises with/without weights may be practical and they could be continued by older patients without difficulty at home (Carvalho et al., 2010; Frost et al., 2002; Huang et al., 2012; Iwamoto et al., 2011; Sashika, Matsuba, & Watanabe, 1996; Trudelle-Jackson & Smith, 2004; Yilmaz et al., 2013). According to literature, exercise programs including simple isometric and isotonic exercises without weights and range of motion exercises were also effective for increasing the skeletal muscle strength and functionality (Carvalho et al., 2010; Frost et al., 2002; Huang et al., 2012; Iwamoto et al., 2011; Petterson et al., 2009; Sashika et al., 1996; Trudelle-Jackson & Smith, 2004; Yilmaz et al., 2013). However, randomized controlled trials are warranted to investigate the effectiveness of strengthening exercises in individuals after a TKA.

Therefore, we performed a single-blind randomized controlled trial to assess the efficacy of two different rehabilitation programs (weighted vs. non-weighted exercises), on skeletal muscle strength and functional capacity in patients with primary bilateral TKA with a standard paramedian incision at least 4 years ago. We hypothesized that (I) both of the exercise groups would significantly improve on all outcome measures after 8-week exercise program, and (II) the weighted exercise group would have significantly more improvements on all outcome measures compared with the non-weighted exercise group.

2. Participants and methods

Sixty patients (mean age; 69.66 ± 7.53 years, 10 male, 50 female, mean height; 159.93 ± 7.22 cm, mean weight; 81.56 ± 14.43 kg, BMI; 32.00 ± 6.11 kg/cm^2) followed up four or more years after bilateral TKA were included the study. The patients registered on the orthopedic physiotherapy department patient list, who had undergone bilateral TKA at least 4 years ago in Dokuz Eylul University Hospital, were recruited though the telephone calls. All participants provided written informed consent prior to participation.

The preoperative diagnosis was knee osteoarthritis for all the patients. All operations were performed by the same surgeon (VK) using the paramedian approach. All knees were implanted with cemented and cruciate retaining TKA (Nexgen®, Zimmer, Warsaw, IN, USA).

The inclusion criteria: The patients who (a) had had TKA at least 4 years ago, (b) had not developed operation-related complications (revision/infection), (c) had a Hospital for Special Surgery (HSS) knee score below 85 and (d) underwent standard paramedian approach were included in the study.

The exclusion criteria: Patients who (a) had heart, liver, renal, gastrointestinal or endocrinological diseases, malignancy, rheumatoid arthritis, gout, or a previous fracture of the lower limbs, (b) were not able to perform exercises or tests due to medical or musculoskeletal problems, (c) had neurological or medical conditions causing locomotor disability were excluded from the study.

An experimental design with two groups was used. The study was designed as a single-blind randomized controlled trial. The patients were allocated into one of two groups using a Table of random numbers from a computer program and patients with numbers 1–30 were allocated to weighted exercise group ($N = 30$), and numbers 31–60 to non-weighted exercise group ($N = 30$). The patients were blind as to their intervention allocation.

This study was approved by the Ethics Committee of Dokuz Eylul University Hospital (protocol number: 239/2009) and was in accordance with the Declaration of Helsinki. This study was conducted at the Dokuz Eylul University, School of Physical Therapy and Rehabilitation, a public, not-for-profit institution.

2.1. Intervention

Subjects were allocated in a different set of exercises depending of group assignment.

Subjects in the weighted exercise group performed 12 basic isometric, active resisted range of motion, various resisted straight leg raising exercises, and static stretching exercises for the lower limbs (Carvalho et al., 2010; Frost et al., 2002; Huang et al., 2012; Iwamoto et al., 2011; Petterson et al., 2009; Sashika et al., 1996; Trudelle-Jackson & Smith, 2004; Yilmaz et al., 2013). These exercises consisted of QF sets, hamstring sets, ankle pumps, terminal knee extension with weight, straight leg raising with weight in supine, side-lying, and prone, hip and knee flexion-extension with weight in supine, knee flexion-extension with weight in prone, and in sitting, static stretching exercises for hamstrings and gastrosoleous muscles.

For weighted exercises, De Lateur's technique, a method with stable low weight, was used (Yilmaz et al., 2013). They started with the lowest weight (1 kg) and progressed up to a maximum of 2 kg. We choose De Lateur's technique, because it has been generally suggested that resistance exercise intensity should have a slower and decreased rate of progression in older adults than in younger adults, mainly in older adults with physical limitations (Ciolac & Greve, 2011; Yilmaz et al., 2013).

The exercise protocol for the non-weighted exercise group was similar to weighted exercise group. But all exercises were performed without weight.

Subjects in both groups were instructed to perform 10 repetitions of each exercise at home one time a day for 8 weeks. The first follow-up visit was scheduled within the first 2 weeks to ensure that subjects were performing the exercises correctly and to progress the exercises as needed. If patients were experiencing increased pain, the intensity of the exercise program was not changed. Otherwise, all exercises were progressed to 15 repetitions. A second follow-up visit was scheduled within the next 2 weeks after the first visit. During the second follow-up visit, exercises were again checked for proper form and progressed to 20 repetitions. After the second follow-up visit, subjects continued to exercise on their own at home for the remainder of the 8-week period.

The patients took no pain medication during the intervention.

All these interventions were supervised by the same physiotherapist (SB).