

Effectiveness of exercise for osteoarthritis of the knee: A review of the literature

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INTRODUCTION

Osteoarthritis (OA) of the knee is the most common type of arthritis and the major cause of chronic musculoskeletal pain and mobility disability in the elderly, and therefore represents a significant burden on healthcare provision. It is being encountered with increasing frequency as the population continues to age. Risk factors of OA of the knee include older age, female sex, obesity, osteoporosis, occupation, sports activities, previous trauma, muscle weakness or dysfunction, proprioceptive deficit and genetic factors^[1]. In primary OA of the knee, varus alignment increases the risk of medial OA progression and valgus alignment increases the risk of lateral OA progression^[2]. Optimal management of patients with OA of the knee requires a combination of non-pharmacological and pharmacological therapies^[3].

Conservative treatment is advocated in patients with mild to moderate OA of the knee. Because muscle weakness is associated with pain and physical dysfunction and influences the progression of the disease in patients with OA of the knee^[4-8], muscle strengthening is a key component in cases of OA. The objective of this paper is to discuss the effectiveness of exercise for OA of the knee based on a review of the literature, i.e. systematic reviews and meta-analyses searched with PubMed.

Abstract

Osteoarthritis (OA) of the knee is the most common type of arthritis and the major cause of chronic musculoskeletal pain and mobility disability in the elderly. The objective of this paper is to discuss the effectiveness of exercise for OA of the knee based on a review of the literature. We reviewed the relevant literature, i.e. systematic reviews and meta-analyses searched using PubMed. Muscle strengthening and aerobic exercises are effective in reducing pain and improving physical function in patients with mild to moderate OA of the knee.

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Key words: Osteoarthritis of the knee; Muscle strengthening exercise; Quadriceps; Hamstrings

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Table 1 Outcomes of systematic reviews and meta-analyses

Investigator	Type of study	Outcomes
van Baar <i>et al</i> ^[11] (1999)	Systematic review	Evidence of beneficial effects of exercise therapy in patients with OA of the hip or knee. Effect sizes indicated small-to-moderate beneficial effects of exercise therapy on pain, small beneficial effects on disability outcome measures and moderate-to-great beneficial effects, according to patients' global assessment of effect
Fransen <i>et al</i> ^[12] (2002)	Systematic review	Land-based therapeutic exercise was shown to reduce pain and improve physical function for people with OA of the knee. SMD (95% CI) was 0.46 (0.35, 0.57) for pain and 0.33 (0.23, 0.43) for self-reported physical function
Fransen <i>et al</i> ^[13] (2003)	Systematic review	Land-based therapeutic exercise was shown to reduce pain and improve physical function for people with OA of the knee. SMD (95% CI) was 0.39 (0.30, 0.47) for pain and 0.31 (0.23, 0.39) for self-reported physical function
Roddy <i>et al</i> ^[14] (2005)	Systematic review	Both aerobic walking and home-based quadriceps strengthening exercise reduced pain and disability from OA of the knee. Pooled effect sizes for pain were 0.52 for aerobic walking and 0.32 for quadriceps strengthening
Devos-Comby <i>et al</i> ^[15] (2006)	Meta-analysis	Exercise regimens led to improvement in physical health (by self-report and direct measures) and in overall impact of OA of the knee. Exercise had a moderate, but clinically important influence on patients' well-being
Vignon <i>et al</i> ^[16] (2006)	Systematic review	Exercises and other structured activities had a favorable effect on pain and function in sedentary knee OA patients. Static exercises were not favored over dynamic exercises, availability, preference and tolerance being the criteria for the choice of exercise
Bartels <i>et al</i> ^[17] (2007)	Cochrane review	Aquatic exercise had some beneficial short-term effects for patients with hip and/or knee OA: SMD (95% CI) was 0.26 (0.11, 0.42) for function and 0.32 (0.03, 0.61) for quality of life. A minor effect of a 3% absolute reduction and 6.6% relative reduction from baseline was found for pain
Pisters <i>et al</i> ^[18] (2007)	Systematic review	Strong evidence was found for no long-term effectiveness of exercise on pain and self-reported physical function, moderate evidence for long-term effectiveness on patient global assessment of effectiveness, and conflicting evidence for observed physical function in patients with OA of the hip and/or knee
Fransen <i>et al</i> ^[19,20] (2008, 2009)	Meta-analysis	Land-based therapeutic exercise had at least short-term benefit in terms of reduced knee pain and physical disability for people with OA of the knee: SMD (95% CI) was 0.40 (0.30, 0.50) for knee pain and 0.37 (0.25, 0.49) for physical function

OA: Osteoarthritis; SMD: Standardized mean difference.

NON-PHARMACOLOGICAL AND PHARMACOLOGICAL THERAPIES FOR OA OF THE KNEE

Recommendations cover the use of 12 non-pharmacological modalities: education and self-management, regular telephone contacts, referral to a physical therapist, aerobic, muscle strengthening and water-based exercises, weight reduction, walking aids, knee braces, footwear and insoles, thermal modalities, transcutaneous electrical nerve stimulation and acupuncture^[3]. Eight recommendations cover pharmacological modalities of treatment including acetaminophen, cyclooxygenase-2 non-selective and selective oral NSAIDs, topical NSAIDs and capsaicin, intra-articular injections of corticosteroids and hyaluronates, glucosamine and/or chondroitin sulphate for symptom relief; glucosamine sulphate, chondroitin sulphate and diacerein for possible structure-modifying effects; and opioid analgesics for the treatment of refractory pain^[3]. However, consensus recommendations are not always supported by the best available evidence^[9]. The recommendations have been revised regularly, following a systematic review of new evidence as this becomes available^[3,10].

EXERCISE FOR OA OF THE KNEE

Because pain, muscle weakness and physical dysfunction form a vicious circle in OA of the knee in which muscle weakness is associated with pain and physical dysfunction and influences the progression of the disease^[4-8], muscle strengthening exercise may be of primary importance in the prevention and treatment of OA of the knee.

Table 1 lists the outcomes of exercise on OA of the knee according to systematic reviews and meta-analyses of randomized controlled trials^[11-20]. Systematic reviews and meta-analyses of studies have established the beneficial effects of exercise in patients with mild to moderate OA of the knee, including muscle strengthening and aerobic exercises which have been reported to be effective in reducing pain and improving physical function^[11-20]. With regard to aerobic exercise, walking programs, aquatic exercise, jogging in water, yoga, and Tai Chi have been shown to be effective in improving the functional status, gait, pain, and aerobic capacity in people with OA of the knee^[13,21]. Both high and low intensity aerobic exercise appear to be equally effective in improving a patient's functional status, gait, pain and aerobic capacity for people with OA of the knee^[22].

Bennell *et al*^[7] reported that strengthening exercise appears to be superior to aerobic exercises in the short-term for specific impairment-related outcomes (e.g. pain), whereas aerobic exercise appears to be more effective for functional outcomes in the long-term in patients with OA. In contrast, Brosseau *et al*^[22] has reported that aerobic exercise in general is more beneficial for the OA patient than no exercise at all, and is superior or equivalent to strengthening exercise. However, Roddy *et al*^[14] showed that both aerobic walking and home-based muscle strengthening exercises reduced pain and disability in cases of OA of the knee and that there were no significant differences in effects between the two types of exercises. Although it still remains controversial as to which type of exercise programs may be more effective for the treatment of OA of the knee, this line of evidence does indicate the short-term beneficial effects of both muscle

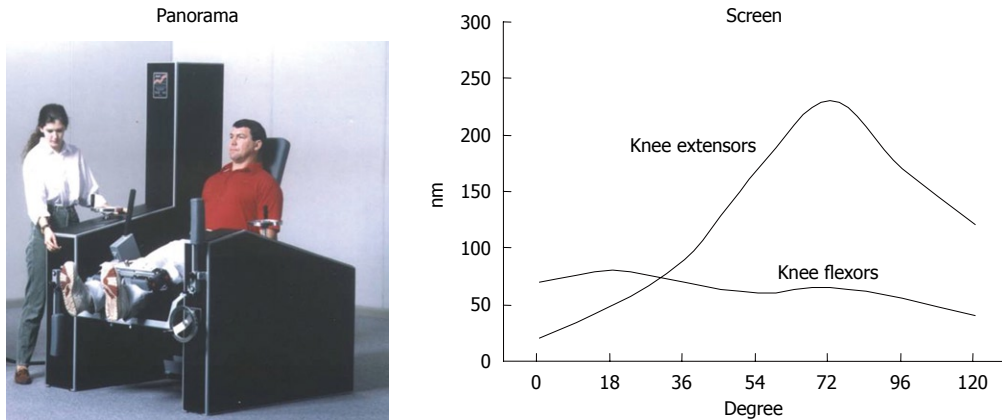


Figure 1 Medx knee machine (Back In Action, CA, USA). The strength of the knee extensor and flexor muscles was measured with a Medx knee machine. Each patient underwent isokinetic and isometric testing of the knee extensor and flexor muscles. Patients were positioned on the Medx knee machine chair with stabilization supports across the pelvis and distally over the thighs. Patients gripped the side of the chair and leaned back against the backrest which was inclined posteriorly to an angle of 90° above horizontal. The isometric torques of the both knee extensor and flexor muscles were measured with the both legs together at 6 points between 0° and 120° and then the maximum peak torque values of the knee extensor and flexor muscles were evaluated.

strengthening and aerobic exercises on the pain, muscle strength and physical function in patients with mild to moderate OA of the knee.

Although muscle strengthening exercise has been shown to improve pain and physical function in patients with OA of the knee^[13], it appears that facility-based supervised exercise is superior to independent home-based exercise for pain reduction^[12]. The use of the SOFMER (French Physical Medicine and Rehabilitation Society) methodology led to recommending a program of initial physical exercise supervised by a physiotherapist, then an unsupervised program at home with compliance^[23]. Thus, facility-based exercise is important to obtain the full beneficial effect of exercise.

DISCUSSION

A review of the literature has suggested that muscle strengthening and aerobic exercises are effective in reducing pain and improving physical function in patients with mild to moderate OA of the knee. Maximizing adherence is a key element dictating success of exercise therapy^[24]. This can be enhanced by the use of supervised exercise sessions (possibly in a class format) in the initial exercise period followed by home exercises^[24]. A combination of weekly facility-based supervised exercise and independent daily home-based exercise may be acceptable to patients. The effects of high-resistance strength training are not always greater than those of low-resistance strength training in patients with OA of the knee^[25]. Aerobic exercise may be well tolerated in patients with mild to moderate OA of the knee, whereas muscle strengthening exercise at a moderate intensity may be well tolerated in elderly patients with severe OA of the knee. Although there is still no evidence that the type of strengthening exercises (isometric, isotonic, isokinetic, concentric, eccentric and dynamic) have an important impact on the program outcome^[26], isometric and isotonic strengthening exercises may be practical. Hurley *et al.*^[27] suggest that integrated rehabilitation programs that

are acceptable, clinically effective, deliverable and affordable may be the best way of managing the large and increasing number of people suffering chronic knee pain.

Our practice-based observational study confirmed that the moderate exercise program, which consisted of a combination of weekly facility-based isotonic and daily home-based isometric muscle strengthening exercises, was effective for increasing the strength of the knee extensor and flexor muscles, evaluated quantitatively with a Medx machine (Figure 1), in patients with OA of the knee (Figure 2)^[28]. The diagnosis of OA of the knee was made based on the clinical symptoms, results of physical examination and X-ray findings of the knee^[29]. The effect was similar regardless of age, gender, body mass index, baseline muscle weakness and/or severity of OA. Therefore, muscle strengthening exercise should be emphasized for any patients with OA of the knee. Neither cardiopulmonary dysfunction nor severe knee pain and worsening of the symptoms of OA of the knee were reported after the exercises by the physical therapists, suggesting the safety of our exercise program. Because most of our patients were receiving monthly injections of hyaluronate sodium or corticosteroid and/or oral NSAIDs, the effect of the exercise program itself on the symptoms of OA of the knee, quality of life and progression of OA of the knee could not be assessed.

van Dijk *et al.*^[30] reported that greater muscle strength, better mental health, better self-efficacy, social support and more aerobic exercise were protective factors in cases of OA of the knee in the first 3 years. However, there is evidence of worsening of pain and functional status after 3 years in the natural course of OA of the knee^[30]. The long-term benefits of exercise for therapy and possible prevention of OA are not yet known because of the paucity of studies concerning long-term effects^[6,31]. There is a clinical impression that the beneficial effects of exercise on OA of the knee disappear over time^[31]. Our practice-based observational study revealed that the beneficial effects of exercise on the strength of the knee extensor

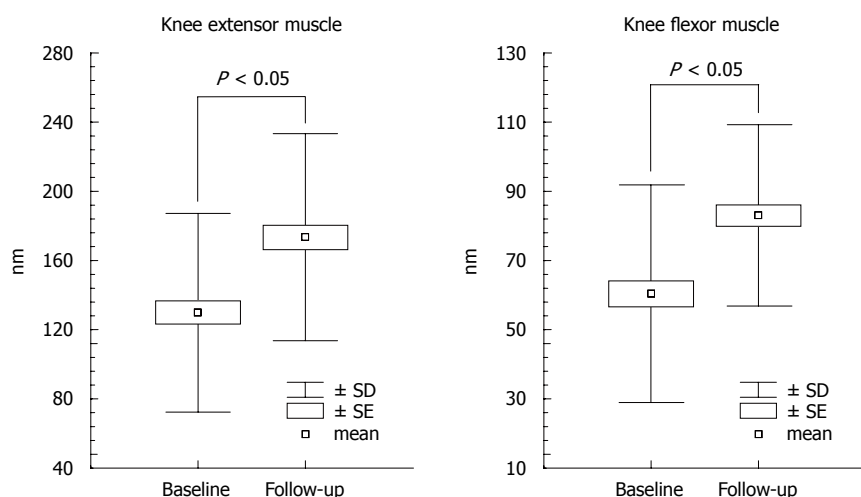


Figure 2 Effect of exercise on maximum peak torque of the knee extensor and flexor muscles^[28]. The muscle strength test was performed at baseline and then at between 6 and 12 mo (mean: 229 d) after the start of the exercise regimen. The MPT of the knee extensor and flexor muscles significantly increased by 42.5% and 60.4% respectively in all the patients.

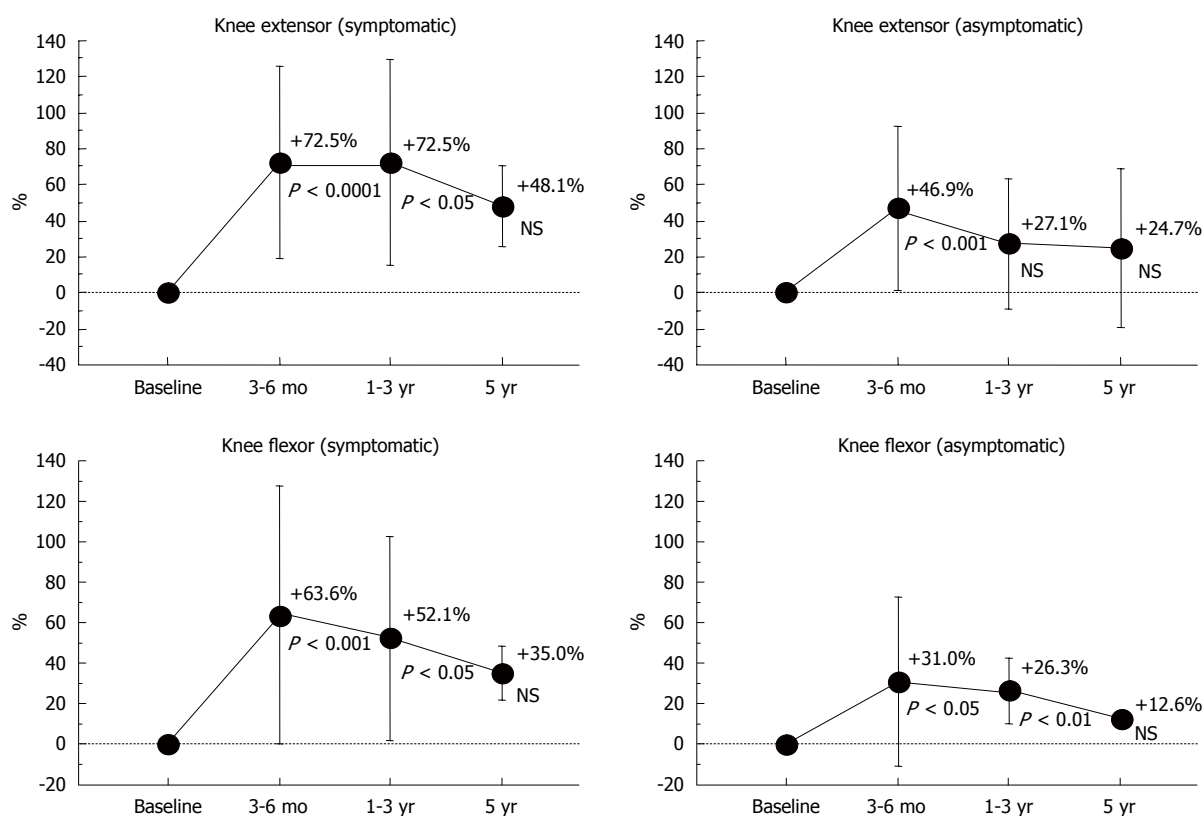


Figure 3 Longitudinal percent changes in the maximum peak torque values of the knee extensor and flexor muscles over 5 years^[32]. Data are expressed as mean \pm SD. Data comparison between baseline and time point was performed by unpaired *t*-test. All of the patients ($n = 26$) were able to complete the exercise program at 3-6 mo. Twenty-four (92.3%) and 17 (65.3%) patients were able to complete the exercise program at 1-3 years and 5 years respectively after the start of the exercise regimen. The beneficial effect of the exercises on the maximum peak torque values was observed in 3-6 mo after the start of the exercise regimen and maintained up to 1-3 years. The effect of the exercises was greater in the knee extensor muscle than in the knee flexor muscle. However, the beneficial effect of the exercises tended to be lost 5 years after the start of the exercise regimen. NS: Not significant.

and flexor muscles were recognized within 6 mo after the start of the exercise, maintained for up to 1-3 years, but tended to be lost at 5 years, which could be attributable to either inadequate intensity or frequency of exercise by the patients for maintenance of its efficacy or the influ-

ence of aging (Figure 3)^[32].

A recent report shows that patients with OA of the knee demonstrate significant weakness of the hip musculature compared with asymptomatic controls^[33]. Intervention studies show that targeting hip, rather than only knee

musculature, represents an effective biomechanically-based treatment option for medial knee OA^[34], and that hip strengthening reduces symptoms in patients with medial knee OA and varus malalignment^[35]. Therefore, not only the knee extensor and flexor muscles but also the hip muscles should be trained in order to maintain the effect of exercise on muscle strength in patients with OA of the knee.

In conclusion, based on the review of the literature, it has been shown that muscle strengthening and aerobic exercises are effective in reducing pain and improving physical function in patients with mild to moderate OA of the knee.

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