

Effectiveness of Exercise Therapy and its Variations in Lower Limb Osteoarthritis: A Literature Review

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ABSTRACT

Osteoarthritis is an irreversible, progressive, degenerative joint disorder of multifactorial etiology that commonly affects weight-bearing joints and leads to pain, loss of movement and functional limitation. Exercise therapy has been shown to be beneficial in osteoarthritis, in terms of decreased pain, improved motion and improved functional outcomes. This review aims to look at some of the common as well as newer modalities of exercise therapy for osteoarthritis (OA), such as strength, training, stretching, agility training, aquatic exercises, Tai Chi and combinations of these modalities.

Keywords: Osteoarthritis, Exercise therapy, Strength training, Agility training, Aquatic exercises, Tai Chi, Stretching, Hip, Knee.

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INTRODUCTION

Osteoarthritis (OA) is an irreversible degenerative disorder of the joints, characterized by the destruction of the articular cartilage and subchondral bone. It is the commonest form of arthritis with studies showing it to be the second most reported disorder in elderly patients.^{1,2} Predominantly occurring in weight bearing joints, the knee is perhaps the most commonly affected joint, resulting in pain and functional limitation. Though, its etiology is still unclear, previous joint injury, a high body mass index, some high impact sports activities and occupational activities stressing the knee are some of the factors that may predispose to an early occurrence,

with women being significantly more susceptible to the disorder.^{3,4} Biomechanical abnormalities like excessive valgus and varus alignment have also been implicated as risk factors for development of knee OA. While both the deformities predispose the knee for earlier OA, a varus deformity has shown to be a greater risk not only for the development, but also for the progression of the disease.⁵

Clinically a patient suffering from OA may present with joint pain, loss of motion, joint effusion with or without signs of inflammation, muscle weakness and an altered gait pattern. Occasionally physical limitations could be accompanied with some psychological distress.^{6,7}

The Kellgren and Lawrence grading system⁸ is a commonly used radiological classification to determine the severity of OA. Though, it is considered to be a reliable tool, many studies have argued over the correct definition and grading of OA through this system.⁹ Nonetheless X-ray and magnetic resonance imaging (MRI) play an important role in determining the severity of osteoarthritis in the knee.¹⁰

Whatever the grade of the disease, there is enough published data to show that exercise therapy has some beneficial effect. A study by Knoop et al¹¹ has revealed that effectiveness of exercise therapy is independent of the MRI evaluated severity of OA, and thus becomes an important tool in the armamentarium of medical personnel in managing this disorder.

Despite the fact that exercise therapy is an important aspect of conservative treatment of the disease, designing an exercise rehabilitation program for individual patients is often a challenge, as each patient may require a personally tailored program that best suits them. Recent studies have shed light on the fact that though a number of treatment guidelines exist in literature, their implementation in clinical practice is still less than optimal.¹²

REVIEW OF LITERATURE

In a systemic review on guidelines and recommendations for managing OA, Amanda et al stated that an optimal conservative treatment would include therapeutic exercises, assisted devices, patient education and weight loss. Exercise interventions employed ranged from low impact aerobic exercises, to endurance and strength training,

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quadriceps specific training and flexibility exercises.¹ A quantitative systemic review by Uthman et al also concluded that prescribing an effective strength and flexibility program in combination with aerobic exercises had significantly positive results on pain and functional limitations in patients with OA of knees.¹³

It is believed that stretching exercises may be beneficial in conjunction with strengthening exercises in patients with knee OA. A clinical trial conducted by Weng et al investigated the effects of combining stretching with strength training in patients suffering from mild to moderate OA. Their study comprised of four groups, two of which received stretching exercises in combination with isokinetic strengthening, one received isokinetic strengthening alone while the fourth acted as the control. The results demonstrated that the two combination groups had significantly better strength and range of motion gain than the other two. A comparison of these two groups further revealed that proprioceptive neuromuscular facilitation (PNF) stretching proved to be more effective than static stretching when combined with isokinetic strengthening.¹⁴

Agility training is an essential component of athletic training, consisting of exercise drills, which aim to improve balance, speed, strength and co-ordination. Fitzgerald et al conducted a randomized trial to determine whether an agility and perturbation program would benefit patients suffering from OA of the knee. The authors could not find any significant added benefit of agility training. Moreover, they noted that it could increase the risk of falls in certain patients and therefore patient selection in this group would be critical.¹⁵ Therefore, further research is needed in this area before it can be recommended as a routine.

Loss of proprioception, instability and kinesthesia are some of the concerns in patients with OA knees and has therefore led many authors to study the effects of proprioception training in improving balance and stability. Jan et al investigated the benefits of a weight bearing (WB) exercise program over a non-weight bearing (NWB) exercise program with respect to functional speed and position sense. Their results demonstrated a significant improvement in both groups in comparison to a control group that did not undergo any exercise. Additional evidence pointed that the WB group exhibited a better sense of position than the NWB group. Therefore the authors recommended adding WB exercises in rehabilitation interventions due to their added advantage with proprioception.¹⁶

Similarly, Duman et al¹⁷ conducted a trial looking at the benefits of kinesthesia and balance training to study the added efficacy. The authors devised a home based

intervention with three groups undertaking combinations of kinesthesia, balance, agility plus resistance training; only resistance training; only kinesthesia, balance and agility training. A fourth control group was given a placebo treatment protocol. All groups showed positive results on pain and functional outcome at the end of the treatment but neither of the experiment groups were significantly different among themselves. Interestingly the control group in the study showed significantly improved Western Ontario and McMaster University (WOMAC) scores and decreased perception of pain. Though the authors attributed this to a statistical anomaly, it does lead to speculation over the positive impact a placebo can have during treatment. The fact that this study was entirely home based, puts it at a high-risk of bias, as it is difficult to know how strictly the patients adhered to their program. Nonetheless, improvements were evident and no adverse effects were reported.

Steib et al¹⁸ have shown that exercise programs, which emphasized high-speed movements, prove to be more beneficial in functional improvement compared to traditional strength training. It has also been demonstrated that muscle power attributes to patients' functional ability and would play a role in proprioception.^{19,20} Consequently Sayers et al²¹ conducted a study that investigated the benefits of high-speed power training (HSPT) and slow speed strength training (SSST) when compared to a control group, which performed stretching and warm up exercises. The results demonstrated an improvement in function and pain across all three groups. Patients in HSPT and SSST groups demonstrated enhanced muscle strength while improved muscle power and muscle speed was achieved only in the HSPT group. Based on the argument by about of muscle power being an important contributor to better functioning^{19,20} it seems that HSPT would be a beneficial addition to exercise interventions for patients who suffer from functional disability.

The benefits of aquatic exercises have been investigated in many studies. A recent review by Barker et al²² claims that aquatic exercises may have moderate benefit in regard to improvement of pain and function, however their report is focused on musculoskeletal disorders as a whole. Bartels et al²³ also concluded that aquatic exercises have a moderate and short-term effect, but recommended their use in the initial phase of an exercise rehabilitation program. Another study comparing aquatic exercises with land based exercises failed to show any benefits. The results of these studies exhibited no clinical benefits of aquatic exercises; on the contrary land based exercises proved to be more advantageous in improving pain and function in the participants.²⁴ On the other hand, Wang et al²⁵ conducted a similar study, which showed positive

Table 1: Randomized trials of exercise and allied therapies in OA in the last 5 years

Sl. no.	Author	Total Pt	Joint	Intervention	Outcomes studied	Conclusion
1.	Abbot et al (2013) ³³	206	Knee and Hip	Manual therapy (MT) vs exercise therapy (ET) vs combined ET and MT vs no therapy`	WOMAC score, physical performance tests	Improved WOMAC and scores in MT and ET groups. Better physical performance in ET group. No added benefit from combination of the two therapies
2.	Bennel et al (2014) ³⁴	100	Knee	Neuromuscular exercise vs Quadriceps strengthening	Knee adduction moment, pain, WOMAC score	Improved clinical outcomes in both groups, no improvement in adduction moment
3.	Bezalel et al (2010) ³⁵	50	Knee	Education program + home based exercise program vs short wave diathermy	WOMAC score, sit to stand test, get up and go test	Both groups showed improvement at 4 weeks Sustained improvement noted at 8 weeks in exercise group only
4.	Bossen et al (2013) ³⁶	199	Knee and Hip	Web based physical activity (PA) intervention vs no intervention	Physical activity, function and self perceived effect	Significantly improved physical function and self perceived effect in intervention group. No difference in PA
5.	Brosseau et al (2012) ³⁷	222	Knee	Community based walking program (WP) vs WP + education vs education alone	Quality of life, adherence, confidence and clinical outcomes	Improvement in all three groups, no statistically significant difference between the groups
6.	Bruce-Brand et al (2012) ³⁸	41	Knee	Home based resistance training (RT) vs neuromuscular electrical stimulation (NMES) vs no therapy (controls)	Walk test, stair climb test and chair rise test	Similar and significant improvement in both NMES and RT groups over control group Better adherence in NMES group (91%) over RT group (83%)
7.	Duman et al ¹⁷	54	Knee	Proprioceptive exercises vs control	Proprioception, balance and WOMAC score	Significant improvement in balance and WOMAC score in exercise group. No improvement in proprioception over control
8.	Ebnezar et al (2012) ³⁹	250	Knee	Hatha Yoga therapy vs therapeutic exercise	Walking pain, knee disability, range of flexion, joint tenderness, crepitus	Significantly better outcomes in the Yoga therapy group over therapeutic exercise group
9.	Farr et al (2010) ⁴⁰	171	Knee	Resistance training (RT) vs self management (SM) vs RT + SM	Moderate and vigorous intensity physical activity	MVPA increased all groups at 3 months. Sustained increase in MVPA at 9 months was noted in RT group only
10.	Fernandes et al (2010) ⁴¹	109	Hip	Patient education (PE) vs PE + supervised exercise (SE)	WOMAC score, pain component	No significant pain reduction in either group at 16 months follow-up
11.	Fitzgerald et al (2011) ¹⁴	183	Knee	Agility and perturbation techniques + exercise therapy (ET) vs ET alone	Self-reported knee pain and function, knee instability, performance based measure of function and global rating of change	Improvements in self-reported function and global rating of change in both groups but not statistically different in either group. No reduction in knee pain or performance based function
12.	Foroughi et al (2011) ⁴²	54	Knee	Resistance training (RT) program vs Sham training program	Dynamic shank and knee adduction angles and knee adduction moment, muscle strength, gait speed	Better muscle strength in RT group. No improvement in knee adduction moment, shank and knee adduction angles
13.	French et al (2013) ⁴³	131	Hip	Exercise therapy (ET) vs ET + manual therapy (MT) vs no therapy (waitlisted controls)	WOMAC – physical function, physical function, pain, range of motion, quality of life, patient satisfaction	Better outcomes in ET and ET + MT groups than no therapy group. No difference in WOMAC-PF between ET and ET + MT groups. Higher patient satisfaction in ET + MT group

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14.	Hale et al (2012) ²⁶	39	Knee and Hip	Water based exercise therapy (WBET) vs time matched computer training (control)	Physiological profile assessment, step test, time up and go test, WOMAC score	No statistically significant difference for any outcome between the two groups
15.	Hiyama et al (2012) ⁴⁴	40	Knee	Walking program vs control group	Automaticity index and Japanese knee OA measure	Better outcomes in walking program group over control group
16.	Jan et al (2009) ¹⁶	106	Knee	Weight bearing exercise (WB) vs nonweight bearing exercise (NWB) vs no exercise (controls)	WOMAC function scale, walking speed, muscle torque, and knee reposition error	Improvement in all parameters in WB and NWB groups over control groups, except reposition error. Reposition error improved better in WB group
17.	Knoop et al (2013) ⁴⁵	159	Knee	Knee stabilization exercises + Muscle strengthening vs muscle strengthening alone	WOMAC, pain score, global perceived effect and knee stability	Improved outcomes in both groups. No additional value of knee stabilization
18.	Lim et al (2010) ⁴⁶	75	Knee	Aquatic exercise (AQE) vs land based exercise (LBE) vs control	Changes in body fat composition, pain, physical function, and quality of life	Significant improvement in pain, disability and quality of life in AQE group. Both AQE and LBE showed improvement in WOMAC scores over control group
19.	Oliveira et al (2012) ³¹	100	Knee	Exercise therapy (ET) vs Instruction (I) Group	WOMAC score, timed up and go test (TUG), lequesne index	Better scores in ET group as compared to I group
20.	Salacinski et al (2012) ⁴⁷	37	Knee	Stationary cycling vs no cycling	Preferred and maximum gait velocity, VAS score at rest after 6 minutes walk, muscle strength and WOMAC score	Improved score in the stationary cycling group
21.	Song et al (2010) ⁴⁸	82	Knee	Tai Chi vs control group	Muscle strength, bone mineral density, fear of falling	Improved outcomes in Tai Chi group
22.	Tsai et al (2013) ²⁹	55	Knee	Tai Chi vs control group	WOMAC pain, physical function and stiffness subscales, Get up and Go test, Sit-to-Stand test; and the mini-mental state examination	Significantly better outcomes in Tai Chi group with regards to pain and stiffness WOMAC scores. Other parameters showed borderline improvement in Tai Chi group

BMD: bone mineral density; ET: exercise therapy; MT: manual therapy; NWB: nonweight bearing exercises; RT: resistance training; VAS: visual analog scale; WB: weight bearing exercises; WOMAC: western ontario and Mc master university osteoarthritis index

results in outcome measures of pain and quality of life. Patients in both land exercises and aquatic exercises presented with improvement in severity of pain over time, but no significant difference was found between the two groups. Researchers have also analyzed the role of aquatic exercises in relation to improving balance in patients presenting with risk of falls, however the results have been inconclusive and aquatic exercises proved to be of little benefit.²⁶ An interesting trial by Kim et al²⁷ studied the effectiveness of aquarobics (aerobic exercises conducted in water) in OA and its benefits on patients. Aerobic exercises required agility and by conducting them in water helps reduce the load on the patients' joints. A 12-week program of aquarobics was prescribed to an experimental group. The authors noted significant decrease in pain in the experimental group in comparison to the control

group. In addition patients in the experimental group showed significant improvement along with significant decrease in body weight and level of depression when compared to the control group.

Tai Chi is an ancient Chinese martial art, which has sometimes been recommended for treating pain and improving function in patients suffering from OA.²⁸ In the past few years, researchers have shown interest in this format of training and have investigated its efficacy in treating OA. Tsai et al²⁹ conducted a 20-week study that required patients to undergo Tai Chi training as opposed to a control group. They observed that the Tai Chi group showed signs of improvement midway through the treatment; the authors also noted improvements in both groups at the conclusion of treatment. However, the Tai Chi group exhibited significant

improvements in pain and function, presenting with better WOMAC scores than the control group. Ni et al³⁰ demonstrated similar results in a study demonstrating the efficacy of Tai Chi on improving function in cases of Knee OA. However in both these studies the control groups did not undergo any form of physical exercises, and since studies have shown benefits of physical exercises in OA^{13,31} it is difficult to say whether Tai Chi is more effective than standard exercises. Nonetheless it is a safe and controlled form of training and can be incorporated in a rehabilitation program, as it has not shown any adverse effects.

Along with physical impairments, patients suffering from OA may also develop psychological issues such as depression. A study conducted by Hunt et al³² investigated the benefits of combining sessions of pain coping skills training (PCST) during exercise sessions of supervised physiotherapy. They found that combining PCST with resistance training patients were able to overcome functional and psychological barriers. Though this study is outside the scope of this review, it is worth mentioning, as it is very feasible for a physiotherapist to guide patients in PCST during an exercise session. Table 1 summarizes the findings from randomized controlled trials on exercise and allied therapies in OA conducted in the last 5 years.^{14-17,26,33-49}

CONCLUSION

Due to its progressive nature, osteoarthritis is a challenging disease to manage. A healthcare professional constantly needs to monitor the progress of the disease and alter the course of treatment accordingly. From the recently published literature it is evident that a variety of interventions based on exercise therapy and adjuncts can benefit OA patients. While strength and proprioceptive training^{17,18} are highly regarded components of exercise therapy for the management of OA, alternate methods of training such as Tai Chi^{28,29} aquatic exercises²⁷ and agility training¹⁵ have the potential to develop into beneficial additions or even alternatives to standard exercises. While certain authors suggest that a simple flexion-extension exercise program is sufficient to achieve positive results in treatment,¹⁶ there is stronger evidence to suggest that a combination of various forms of exercises is most beneficial, although it is still unclear which exercise combinations work best.^{13,31} Furthermore, most functional outcome parameters are seen to improve with these interventions except pain and knee adduction moment, that show little improvement at long-term follow-up. More high quality systemic reviews addressing exercise therapy interventions are needed for narrowing down

optimum interventions, and would make it easier for healthcare professionals to design the most effective intervention programs.

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