4-1-2020

Knee Osteoarthritis and the Efficacy of Different Forms of Exercise: Is One Form Better Than Another?

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Capstone Project

Submitted to the Faculty of the

Department of Physician Assistant Education

of University of the Pacific

in partial fulfilment of the requirements

for the degree of

MASTER OF PHYSICIAN ASSISTANT STUDIES

April, 2020

Background

Osteoarthritis affects 20% of the global population, making it the most common musculoskeletal problem in the world. Knee osteoarthritis (OA) increases in prevalence with age and affects women more than men, although both are affected.[1] Eighty percent of persons with knee OA experience pain and 25% struggle to perform activities of daily living. These decreases in function and mobility can affect the overall quality of life for these individuals. Several studies have examined different forms of exercise in knee OA patients (resistance training, aerobic exercise, dynamic training, mind-body exercise, and retro and forward walking) as a means of improving pain, function, performance, quality of life, muscle strength, mobility, functional capacity, and aerobic fitness. Weight-bearing exercise shows promising results for improving the or the pain and dysfunction caused by knee OA.[1]

Knee osteoarthritis occurs gradually as the articular cartilage covering the femoral condyles and tibial plateau becomes worn. Several factors can contribute to the degradation of the articular cartilage, including age, weight, repetitive movements, injury or trauma, and family history. Since this disease can be very painful and can greatly hinder a patient's quality of life, treatment that decreases pain and improves function is desirable. Depending on the severity, different treatment options can be offered to help with the pain and dysfunction. Therapeutic options may be combined or used separately, and consist of pharmacologic (internal, local, and external), bracing, surgical, and physical modalities. Patients may take over-the-counter analgesics, such as acetaminophen and ibuprofen. However, long-term use of these medications increases the risk of their side effects and certain comorbidities prevent their use. In addition, their benefits are short-term pain relief only. Ibuprofen, a nonsteroidal anti-inflammatory (NSAID), can reduce inflammation as well as pain, but only if given in doses of adequate strength and duration to achieve anti-inflammatory blood levels. In an effort to minimize adverse effects from systemic medications, intra-articular (IA) administration of drugs is an alternative when a

few isolated joints are affected. Intra-articular corticosteroid (CS) injections (mixed with lidocaine for temporary analgesia) decrease pain, while the steroid decreases inflammation. However, IA CS can only be injected 3-4 times a year because the steroids can cause deterioration of the healthy soft tissues in the knee. Furthermore, as the frequency of steroid injections increase, the length of the patient's relief may decrease. Intra-articular injections with hyaluronic acid (HA) purportedly lubricates the knee and thus, is similar to synovial fluid in function. Although the improvements from HA injections may last longer than corticosteroids, the effects are still short-term. Moreover, IA injections are expensive, especially if insurance does not cover them. Platelet rich plasma (PRP) IA injections also seem to be beneficial but are unlikely to be covered by insurance. This injection is a concentration of platelets from the patient's own blood that includes healing factors, such as growth factors. PRP IA injections may provide the longest relief of the three intra-articular options but is still a temporary solution. For those who do not want to take medications or have injections, support and unloading knee braces are options. Bracing can be used as a stand-alone therapy or an adjunct to drug therapies. Among surgical treatments, total knee arthroplasty (TKA) is often the last option available when the patient decides that they are ready, but risks and complications can occur as with any surgery, especially in patients with heart conditions or other comorbidities that make them poor candidates for surgery. Total knee arthroplasty prostheses are improving all the time, but these materials do eventually wear out. Therefore, postponing TKA for as long as possible is preferred in order to prevent the need for a second knee surgery in the future. The limitations of these therapies highlight the need for studies exploring economically-friendly, nonpharmacologic, noninvasive options for either adjunctive or alternative treatment, thus forestalling the need for TKA. According to Jorge et al., quadricep muscle weakness and lack of hip control are common findings in patients with knee OA and according to Jan et al., weight-bearing exercise has been shown to improve muscle strength and neuromuscular control of the lower extremities in young athletes.[1, 2] Therefore, increasing the strength of the quadriceps and hip abductor

and adductor muscles with weight-bearing exercise is purported to have a positive effect on these patients.[1, 2] Examining available evidence about the effectiveness of exercise is worthwhile in order to ascertain its usefulness for treating symptoms and dysfunction of knee OA, thus improving patients' qualities of life and delaying TKAs.

Discussion

In a network meta-analysis by Goh et al., 103 trials were analyzed that followed a total of 9,134 participants from four to twelve weeks.[3] Aerobic exercise was found to be the most beneficial for pain and performance.[3] Mind-body exercise had equal improvement in pain and the best improvement in function. Aerobic exercises included swimming and jogging, while mind-body exercises included tai chi and yoga. Strengthening exercises (lifting dumbbells and squats), flexibility exercises (hamstring and gastrocnemius stretches), and neuro-motor skill exercises (wobble board and walking on foam) were effective, although less than aerobic and mind-body exercises for improving pain, performance, and function.[3] Mixed exercise was the least effective, but was still better than the usual care in which the control group continued their routine standard of care recommended by their primary care providers. However, the lack of response to mixed exercise might have been due to the flawed implementation of the program, such as insufficient intensity of the individual exercise components or poor adherence due to the complexity of the program.[3]

In an RCT by Kabiri et al., 78 participants were split up into three resistance training groups combined with either treadmill, cycle ergometry, or arm ergometer as their form of aerobic exercise.[4] Mixed exercise that included aerobic exercise with resistance training led to reduced pain and improved function after eight weeks, as assessed by the Visual Analog Scale (VAS) pain scale, Knee Injury and Osteoarthritis Outcome Score (KOOS), and timed up-and-go test (TUG). This program was supervised, improving patient compliance, whereas the exercise regimens in the network meta-analysis were not supervised, which may explain the lack of improvement in the mixed exercise group from that study.

In another RCT by Jan et al., weight-bearing exercise (WBE) and non-weight-bearing exercise (NWBE) were compared for their effects on functional capacity, muscle strength, and position sense in patients with knee OA.[2] One hundred and six participants who met the American College of Rheumatology (ACR) criteria for knee OA were randomly placed in either the WBE group, the NWBE group, or the control group which includes usual primary care. The WBE group and the NWBE group participated in eight-week programs, each with three sessions per week of their respective exercises. All participants had baseline data collected: The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) physical function assessment, walking speed over four different terrains, muscle torque, and the reposition error test. Within three days of the completion of the eight-week program, data were collected again from all participants. This RCT focused on strengthening the quadriceps, as these muscles are shown to be closely related to knee function. Both the WBE and NWBE groups compared with the control group (no exercise) showed significant improvements in function, walking speed, muscle strength, and position sense. Even though both the WBE and NWBE groups showed improvements in function, no significant difference between the two was found. However, the WBE group compared with NWBE had statistically significant improvements in walking speed, muscle strength, and position sense. Both WBE and NWBE and extension exercises improved function and strength over an eight-week period. NWBE alone provided adequate improvements so that some patients were satisfied and able to complete their activities of daily living (ADLs). However, the weight-bearing exercise also improved position sense, which helped with complex walking tasks, such as figure of 8 route and spongy surface walking.[2]

Jorge et al. performed a single-blind, randomized controlled trial on women with knee OA per ACR criteria to assess the effect of a progressive resistance exercise (PRE) program on pain, function, strength, and quality of life.[1] Sixty participants were randomly placed into either the experimental (PRE

program) or the control group. Data were collected using a horizontal visual analog scale for pain, the WOMAC physical function assessment for function, the six-minute walk test for walking distance, the one-repetition maximum (IRM) for strength, and the Brazilian version of the 36-Item Short Form Health Survey for quality of life. Evaluations by a blinded evaluator were done before the experiment at baseline, at 45 days and at 90 days. Since hip muscle weakness is a common occurrence in subjects with knee OA, Jorge et al. focused on resistance exercises in the PRE program that strengthened the hip abductor and adductor muscles. Statistically significant improvements were seen in pain, function, strength, and quality of life in these women with knee OA at both the 45-day and the 90-day assessments.[1]

Gomiero et al. saw a need for an alternative exercise because resistance training was not for every patient, so they compared it to sensory-motor training (SMT).[5] VAS, TUG, isometric strength, Tinetti balance scale and WOMAC questionnaire were used to determine effectiveness. In addition, the Short Form (36) Health Survey subscales on physical aspects, vitality, emotional aspects, and mental health was used to better assess quality of life. The resistance training included weights and isometric exercises. The SMT used a program emphasizing agility, coordination, and balance which included things like walking in different directions, crossing steps, walking on different surfaces, and using balance boards and trampolines. Both resistance training for the lower limbs and sensory-motor training led to similar reduction of perceived pain, increased mobility, functional capacity, isometric strength, and quality of life.[5] In view of these findings, the patient could decide with their provider which of the two therapies is preferable.

However, some patients prefer walking over more involved exercise. An RCT with 68 participants by Alghadir et al. found that the retro-walking (walking backwards) program resulted in greater reductions in pain, functional disability and improvements in quadriceps muscle strength and performance compared with the forward-walking and control groups.[6] Other patients may prefer

isometric exercises that strengthen the quadriceps, such as isometric quadriceps exercises, isometric hip adduction, and straight leg raises.[7] Anwer et al. examined 42 participants in an RCT and found that this six-week program increased quadriceps muscle strength and decreased pain and functional disability in the isometric exercise group over the control group (which did not perform any exercise) as measured by the Numerical Rating Scale (NRS), the WOMAC index, and a strength gauge device.[7]

For some patients, exercise alone may not be enough. A systematic review by Jansen et al. found that exercise therapy plus manual mobilization showed a moderate decrease in pain compared to strength training or exercise therapy alone.[8] Therefore, manual mobilization is an adjunctive treatment that providers can consider for a patient who is not benefiting from any of the different types of exercise. In a pilot RCT by Tackas et al., 40 people participated in a ten-week dynamic balance training program.[9] The program significantly improved pain, physical function, and fear of movement.[9] However, no change in dynamic balance itself was evident according to the Community Balance and Mobility Scale (CB&M), so further research is needed to investigate how exercise can improve objective measures of dynamic balance.

When it comes to supervised versus unsupervised, patients showed greater improvement when supervised according to Kuru et. al.[10] This RCT with 78 participants examined pain, muscle strength and balance, as well as hemodynamic parameters. Significant improvements in pain and muscle strength were noted in the supervised groups, suggesting that supervised exercise programs are beneficial for patients with knee osteoarthritis. However, no significant improvements in hemodynamic parameters (such as blood pressure and pulse rate) were noted, indicating the need for further investigation for improvement in the long-term.[10] Sixty-nine participants took part in a pilot RCT by Loew et al. that investigated the difference in outcome between a supervised community-based and unsupervised walking program based on the Ottawa Panel guidelines.[11] The findings revealed patients had increased adherence in the supervised walking program where they received guidance in improving their habits.

Patients respected the supervised program because it was structured and evidence-based. In addition, the level of commitment was significantly higher when the patients were placed in their preferred choice of program, either supervised or unsupervised. Patients feel empowered and motivated when they feel that they have a role in decisions about their health. Decreased stiffness, decreased waist circumference, increased static and dynamic balance, and lower level of anxiety were observed in the supervised group but not in the unsupervised group.[11]

Most studies showed that resistance training, aerobic exercise, dynamic training, mind-body exercise, retro and forward walking were effective for reducing pain and improving function in patients with knee OA.[1-13] Their evidence was strong by virtue of their RCT and meta-analysis designs. Some common limitations, however, were small sample sizes, lack of sample diversity, and short-term follow-up. A key limitation of the meta-analysis by Goh et al. was that the studies were fully reliant on author descriptions for the classification of exercises and control groups. Exercise programs and 'usual care' are not standardized and vary considerably between studies. Furthermore, even when the focus of exercise is strength improvement, it is typical to also find some elements of flexibility and/or aerobic exercise included in the program.[3] Regnaux et al. admitted that the quality of evidence was poor and that adverse events in the studies were poorly monitored.[12] Therefore, study protocols with more standardized programs could be developed for further research. Increased sample size and diversity would increase generalizability to a larger segment of the population. Nonetheless, all the available evidence supported benefit of resistance training, aerobic exercise, dynamic training, mind-body exercise, retro and forward walking in knee OA care. Further research is needed, however, to determine the long-term effects of these therapies. In fact, Oiestad et al. created an RCT protocol to advance investigations on the effectiveness of a 14-week strength and aerobic exercise program for improving quality of life, cartilage quality, and cost-effectiveness.[13] Furthermore, with the exercise protocol that

Jorge et al. designed, additional studies could increase in the duration of follow-up.[1] Lastly, exercises targeting different muscle groups could be examined to assess their effects on knee osteoarthritis.

Conclusion

Evidence from several studies affirms that resistance training, aerobic exercise, dynamic training, mind-body exercise, sensory-motor training, retro and forward walking improve pain, function, muscle strength, and overall quality of life in patients with knee OA. When pain is decreased, and function and mobility are increased, activities of daily living become easier and quality of life improves.[1.] These findings support the recommendation of these nonpharmacological and noninvasive treatments, specifically exercise, for the management of knee OA. The benefits of exercise have multiple explanations: exercise decreases weight, which decreases the overall load on the knee; it mobilizes and lubricates the knee joint, decreasing stiffness; and it strengthens the muscles of the lower extremity overall. These factors contribute to improvement in patients' symptoms. Moreover, weight loss may be an unintended benefit. Lastly, these exercises provide a means of delaying TKA in patients with severe knee OA. Nonetheless, patients differ in their treatment preferences and effective therapy often relies on patient compliance, thus highlighting the importance of offering a variety of treatment options for managing knee OA. Some patients may thrive on supervised exercise, such as in physical therapy or occupational therapy, whereas others may not. As seen with Loew et al. patients exhibited a greater improvement in their symptoms with supervised exercise rather than with at-home care.[11] Physical therapy and occupational therapy are both highly utilized in patients with knee osteoarthritis. Since several forms of exercise can improve the symptoms of osteoarthritis, the provider and the patient should have an honest conversation about which form of exercise causes the least pain and motivates the patient the most. This approach would allow the patient to choose a therapy that they prefer and thus, could enhance compliance. Although the studies observed patients for limited durations, the movement should be continued for life, which is another reason that patients should be involved in

therapy choices. Overall, clinicians can advise patients with confidence supported by the evidence that various forms as exercise are beneficial in the care of knee OA. Studies of longer durations, larger sample sizes, and with different muscle group focuses could confirm this approach.

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