INFLUENCE OF PREVENTION AND PHYSIOTHERAPEUTIC INTERVENTIONS TO REDUCE FUNCTIONAL LIMITATIONS IN PATIENTS WITH KNEE OSTEOARTHRITIS

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Abstract: Knee osteoarthritis (KOA) is a degenerative chronic disease that leads to prolonged pain and permanent damage. Changes in the surrounding muscles of the knee joint may progress together or develop prior to damage in the subchondral bone and articular cartilage. The aim of this review is to review physiotherapeutic interventions that may have a positive effect on muscle function and can improve functional activity in patients with osteoarthritis of the knee. Materials and methods: For the purposes of this publication, an overview of available scientific articles which deal with the application of various physiotherapeutic interventions that may be potentially effective in preventing weakness and affecting muscle function and functional activity in patients with knee osteoarthritis has been reviewed. Results were sought in Pub Med, defining: knee osteoarthritis, functional activity, muscle weakness, prevention, therapeutic exercises, aerobic exercises, resistance ground-based exercises, aquatic exercises, neuromuscular exercises, balance training proprioceptive training, exercises to reduce body weight, tai chi and other traditional exercises. Results: The overview of the available literature found evidence of a positive effect of exercise and therapeutic exercise in patients with knee osteoarthritis, both to prevent the onset and the progression of the disease and to reduce the intensity of the clinical symptoms. Depending on the type of intervention, various mechanisms have been identified that can reduce pain, reduce muscle weakness, improve proprioception, postural balance, and increase functional activity. Conclusion: The use of therapeutic exercises in treatment and rehabilitation of patients with knee osteoarthritis is highly recommended therapy. Therapeutic exercises, depending on their variety, can lead to improved therapeutic outcomes and reduced functional impairment. The application of different type strategies for prevention is an important part of the therapeutic process. When developing strategies for the management of the knee osteoarthritis it is necessary to consider the individual characteristics of the patient and the accompanying comorbidity. There is a need to continue research on the use of therapeutic exercises in order to better understand the mechanism by which they can lead to optimization of functional activity and reduction of adverse effects in patients with knee osteoarthritis.
Keywords: Knee osteoarthritis, Muscle weakness, Prevention, Terapeutic exercises, Knee rehabilitation

1. INTRODUCTION

Knee osteoarthritis (KOA) is a degenerative chronic disease which leads to prolonged pain and permanent damage. (Madry et al. (2016); Zeng et al. (2021)) The disease is common in patients over 50 age. (Abassy et al. (2020) It affects more often women (Loeser (2010); Hsu & Siwiec (2021); Ferreira et al. (2019)) The disease is associated with joints structure damage, degeneration and loss of cartilage, clinically presented by functional deficiency (Huang et al. (2017)) leading to reduction in the ability to carry out daily activities, increased economic costs and increased economic burden on society. (Mesa-Castrillon et al. (2021); Zeng et al. (2021)) The main symptoms are pain (Neogi (2013)), morning stiffness, reduced range of motion, crepitations, joint instability, edema, muscle weakness and psycho-emotional stress associated with pain. (Hunter & Bierma-Zeinstra (2019); Hunter et al. (2008))

Often the radiologically changes cannot explain the presence of pain. (Roos et al. (2011)) Changes in the muscles of the knee joint (KJ) may progress together or may occur before the subchondral bone and articular cartilage damage. Muscle weakness is a symptom that is widespread in KOA and is considered a better predictor than pain and joint narrowing (Roos & Arden (2016)), which impairs the dynamic stability of KJ. (Leumann et al. (2019); Roos & Arden (2016)) Influencing muscle function and especially KJ extensors could be a successful strategy in managing KOA. (Chehab et al. (2014); Astephen Wilson & Kobsar (2021)) Increasing functional activity through the therapeutic exercises are recommended according to the current guidelines for management of KOA. Therapeutic exercises that recommended are aerobic exercises, resistance exercises, muscle strength exercises, aquatic exercises, neuromuscular exercises, balance training and proprioceptive training, weight loss, tai chi, and other traditional exercises. (Kolasinski et al. (2020); Bannuru et al. (2019), Zeng et al. (2021); (Lai et al. (2021))

2. MATERIALS AND METHODS

For the purposes of this publication, an overview of available scientific articles dedicated to the application of various physiotherapeutic interventions that may be potentially effective in preventing weakness and affecting muscle function and functional activity in patients with knee osteoarthritis has been reviewed. Results were sought in Pub Med, defining: knee osteoarthritis, functional activity, muscle weakness, prevention, therapeutic exercises, aerobic exercises, resistance ground-based exercises, aquatic exercises, neuromuscular exercises, balance training proprioceptive training, exercises to reduce body weight, tai chi and other traditional exercises.

3. RESULTS

The overview of the available literature found evidence of a positive effect of exercise and therapeutic exercise in patients with knee osteoarthritis, both to prevent the onset and the progression of the disease and to reduce the intensity of the clinical symptoms. Depending on the type of intervention, various mechanisms have been identified that can reduce pain, reduce muscle weakness, improve proprioception, postural balance, and increase functional activity.

4. DISCUSSIONS

OA is considered to a chronic disease of the whole organism, which develops slowly and is susceptible to prevention and treatment in the early stages. Some factors, such as obesity, joint injuries, and impaired muscle function, are modifiable risk factors and can managed through primary and secondary prevention. Strategies must be individually targeted and acceptable to the patient. (Roos & Arden (2016)) Preventing the KOA requires lifestyle changes. (Gress et al. (2020), Charlesworth et al. (2019), Sprouse et al. (2020)) They are effective and safe and should be recommended due to the low risk of injury. (Charlesworth et al. (2019))

The non-pharmacological agents for treatment of OA include: Patient education, weight loss, social support, occupational therapy, exercise, orthotics, Laser therapy, magnetic field, ultrasound, transcutaneous electrical nerve stimulation (TENS), Deep Oscillation® therapy, acupuncture, intake of nutritional supplements, herbal medicines, vitamins and minerals. (Tanna S, 2004)

The goals of Physical and Rehabilitation Medicine in OA treatment are: prevention, reduction of pain and stiffness, recovery and maintenance of range of motion, muscle strength and elasticity, restoration of affected joint function; prevention of the consequences of immobilization; training in aids usage; gaining independence and social adaptation; and preservation of the general activity of the patient.

Educating patients in self-care programs are recommended. According to guidelines for treatment of degenerative joint diseases, it is important for patients to be well informed about their own disease and to have an adequate and active attitude towards their own health. (Ilieva et al. (2013)) OA-induced pain is accompanied by anxiety and attempts to avoid pain, leading to immobility, loss of muscle mass and strength, deterioration of general condition. (Ilieva et al. (2013)). It is recommended to conduct primary, secondary, and tertiary prevention. (Roos & Arden (2016), Christensen et al. (2007))

Primary prevention aims to prevent the onset of the disease. It includes: *Weight control*. Obesity is considered a risk factor for OA. Maintaining or reducing body weight can reduce the risk of OA. (Roos & Arden (2016)) Control of obesity leads to potential reduction of the risk of KO (Hunter & Bierma-Zeinstra (2019)) The risk of occurrence of OA in overwight people is three times higher compared to people with normal wight and obesity prevention can reduce the risk by 8-60% in countries with a higher incidence of overweight. *Prevention of sports injuries*: Prevention of joint damage, such as preparation for exercise /warm-up before training/ and appropriate equipment usage, neuromuscular and proprioceptive training programs aimed at improving sensorimotor control and functional stability of joints. (Roos & Arden (2016)) *Prevention of occupational injuries*: Avoiding repetitive uniform loading of joints and their injury during work can help prevent OA. (Schram et al. (2020))

Secondary prevention. Includes early diagnosis and timely treatment. However, this is difficult in OA because there are no effective biomarkers to determine disease progression. Patients who have KJ trauma and anterior cruciate ligament (ACL) injury have a higher risk of developing OA, impaired physical function, overweight, or obesity after 3-10 years compared to healthy controls (Whittaker et al. (2015)), and those who underwent arthroscopic meniscectomy have a sevenfold increased risk of developing OA. (Englund, Roos & Lohmander (2003); (Roos & Arden (2016)). The application of neuromuscular training for 15-20 minutes before training, 2-3 times per week, prevent 50% of ACL injuries.

Tertiary prevention focuses on reducing the consequences of the disease. The goal is to reduce and delay the occurrence of complications and damage. The strategy aims to reduce pain and disability and to improve the quality of life. Iti ncludes: self-management (weight control, physical activity, education); Cognitive behavioral interventions; Rehabilitation and medical surgical treatment. (The Center for Disease Control, 2004)

Muscle function is crucial for maintaining joint mobility, stability, and function. Muscles give dynamic stability to the joints. (Roos et al. (2011)) Muscle weakness is one of the earliest and most common symptoms of KOA (Astephen Wilson & Kobsar (2021); Zeni & Higginson (2009)) and is considered as more significant predictor of joint space narrowing and pain. (Roos EM (2011); Palmieri et al. (2010)). Occurrence and progression of KOA is related to changes that occur in joint and extraarticular structures: muscles, tendons involving the sensory system. (Roos et al. (2011)). The diagnosis and severity of KOA are often based on radiographic data alone. Most of the patients with radiographic signs of OA do not show clinical symptoms. Up to 50% of the patients with radiographic KOA who have osteophytes and narrowed joint space do not experience pain. Osteophyte probably increases the contact area and helps to stabilize the joint, thus reducing instability and pain. Stabilization of joints by forming osteophytes may explain the asymptomatic radiographically proved KOA. Up to 50% of the patients with pain in the knee suggestive of OA, do not have radiographic signs of OA. (Roos & Arden (2016)) The application of magnetic resonance imaging can detect bone marrow lesions, synovitis, and meniscal abnormalities, but the clinical significance of these lesions is unknown. It is likely that neither X-ray data for KOA nor MRI lesions of the meniscus can be effective markers of symptomatic KOA. (Roos & Arden (2016)) Joint structures (bones, ligaments, cartilage), muscles that perform movement and the nerve structures that control it are considered to be the main functional unit of the neuromuscular system. Age-related changes in the neuromuscular system affect motor function in adults over 60 and especially over 80 years. Reduced muscle strength, slower contractile speed, increased fatigue, reduced joint stability, which can vary in different individuals, is observed (Hunter, Pereira & Keenan (2016)). The extent to which muscle weakness and atrophy are caused by KJ degeneration or muscle weakness precedes it (Roos et al. (2011)) is discussed. Quadriceps femoris muscle weakness is currently thought to be a predictor of OA more often in women (Segal et al. (2010)), and that the role of afferent sensory dysfunction is important for the progression of KOA. Muscle function is more related to joint pain than narrowing of the joint space and is easier to change, making it a realistic therapeutic goal. (Roos et al. (2011); Øiestad et al (2015)) Physical activity can change the properties and function of the motor unit in adults, although the effects on the variability of motor characteristics are largely unknown. (Hunter et al. (2016))

There is considerable evidence for the effectiveness of therapeutic exercises in KOA. A summary of large number of systematic studies, evaluate the effect of exercise and identify improvements in function, and overall assessment. (Ilieva et al. (2013)) Therapeutic exercises are likely to prevent degenerative changes in cartilage, to reduce inflammatory activity and changes in the subchondral and metaphyseal areas of bone. There is growing evidence that exercises can affect pain, stiffness, muscle weakness and joint dysfunction. Therapeutic options include exercises to increase muscle strength, aerobic exercises, neuromuscular exercises, balance exercises, proprioception, aquatic exercises and some traditional exercises. (Zeng et al. (2021))

Exercises to increase muscle strength: isometric, isotonic, isokinetic, concentric/eccentric, and dynamic. A common goal in OA therapy is to increase muscle strength of m. Quadriceps femoris (Adedoyin et al. (2005)), reducing malnutrition due to hypokinesia and preventing the progression of degenerative processes. It is assumed that the stronger m. Quadriceps femoris may prevent KJ and thus slow the progression of KOA (Sharma et al. (2003)). Increasing muscle strength may have a positive effect on pain and function of the affected KJ (Adedoyin et al. (2005); Li et al. (2016); DeVita et al. (2018); Messier et al. (2021); Sharma L (2021)). A review of the Cochrane database Fransen et al. 2015 supports the role of therapeutic exercises in KOA to reduce pain and to improve its function, although there is not enough information to make recommendations for specific types of exercise or dosage.

Brosseau L. et al. (2017) Ottawa panel Part 2 reported that the application of exercises to increase muscle strength in combination with exercises for coordination, balance, and functional exercises, significantly reduce pain and improve physical function and quality of life. In KOA, this type of exercise can increase joint stability, due to the ability of muscles to generate more strength by increasing their strength and endurance. (Bathia et al. (2013)) The aim is to increase the strength of the muscles of the lower limbs, while reducing the load on the KJ and the direct stress in the KJ when walking. (Segal et al. (2010)) Isokinetic exercises lead to improve dynamic muscle strengthening and can reduce pain. (Coudeyre et al. (2016)) Eight-week program including concentric-eccentric exercises to increase muscle strength of m. quadriceps (50 min three times per week) (Lin D, et al. 2009), reduces pain in KJ (WOMAC Pain) and improves physical function (WOMAC Function). Another study reported that a 6-week isokinetic exercise program could reduce TNF-α, IL-6, and C-reactive protein levels in patients with KOA, as well as to reduce pain, to improve muscle strength, and to increase functional capacity (Samut et al., (2015)). A randomized controlled clinical study (Akyol et al. (2010)) found that isokinetic exercise can increase muscle strength, walking distance, and improve quality of life in patients with KOA.

Isometric exercise may increase hyaluronic acid levels and joint fluid viscosity in patients with KOA. (Miyaguchi et al. (2003)) They can improve proprioception and recovery of muscle strength, with no difference in the training effect in different sexes. (Zeng et al (2021))

Several studies have shown that *resistance exercises* can significantly reduce the sensation of pain. (Galdino et al, 2014). Induced endogenous hypoalgesia as a result of therapeutic exercise is thought to be due to the release of endogenous opioids and growth factors (Koltyn (2002)), as well as the activation of cerebrospinal nociceptive inhibitory mechanisms controlled by the brain. (Ray & Carter (2007); Millan (2002)) The improvement can also be explained with the biomechanical changes in the joint and increased stability. (King et al. (2008)) The application of exercises to increase muscle strength (with/without other types of exercises), depending on their characteristics (type of resistance; type of muscle contraction, intensity, and duration) can significantly reduce pain, improve physical function and quality of life in KOA. Combining them with other therapeutic agents, such as patellar taping or manual therapy, is subject to further study. It is necessary to develop a combination therapy including behavioral strategy and exercises to increase muscle strength, which has a longer-lasting effect. (Brosseau L. et al. (2017)

Aerobic exercises: Walking, cycling, stepping from a sitting position, have a positive effect on pain, joint sensitivity, functional status, and capacity. (Brosseau L. et al. (2017)) Aerobic exercise and exercises to increase muscle strength are recommended to reduce pain and to improve function in OA. (Bischoff & Roos, (2003) Although the effectiveness of exercise in reducing pain may be similar to that of NSAIDs, therapeutic exercises are safer and lead to improved function. (Fransen et al. (2015)) Brosseau L. et al. 2017 reported that the implementation of a short-term program (12 weeks) with aerobic exercises with or without exercises to increase muscle strength may be effective in reducing pain without the use of pharmacological agents, improving physical function and quality of life in KOA. Aerobic exercises can improve adipose tissue metabolism, prevent muscle atrophy, accelerate the recovery of damaged cartilage, increase the body's immunity, and relieve pain. Different intensities of aerobic exercise have different therapeutic effects. Low-intensity aerobic exercise is better for patients with severe KOA, and high-intensity aerobic exercise is more appropriate for patients with mild KOA. (Zeng et al. (2021))

Patients with KOA often have poor general fitness (Li LC, et al. (2004); Dunlop et al. (2011)). Regular aerobic exercise (150 min. per week) is strongly recommended for patients with chronic diseases (ACSM 2013) in order to improve lung and functional capacity, which are important for daily activities. Aerobic programs with positive recommendations include different types of walking, running and cycling (veloergometer). (Salacinski et al. (2012))

Aquatic exercise: A number of randomized controlled studies have shown conflicting results regarding the benefits of aquatic exercise compared to conventional exercise. (Waller et al. (2014); Lim et al. (2010); Bartels et al. (2007) Khruakhorn & Chiwarakranon (2021)) However, they show faster effect in reducing knee stiffness in short-term water therapy exercise compared to routine rehabilitation training. (Munukka et al. (2020); Zeng et al. (2021))

Proprioceptive training: In a systematic review Smith at al. 2012 found that proprioceptive exercises outperformed muscle strength exercises in terms of functional outcomes. Proprioceptive training can slow KOA progression, reduce pain, improve joint and muscle condition, increase functional activity in early KOA (John Prabhakar et al., 2020), improve locomotion, and reduce the risk of falling in final stage of KOA. (Aljehani et al. (2021)

Manual mobilization: A systematic review by Jansen et al. (2011) recommened combining therapeutic exercises with manual mobilization in KOA, which may lead to better pain reduction compared to strength training alone.

Traditional Exercise: Brosseau et al. (2017) reported that the application of Hatha Yoga leads to a significant reduction in pain and improvement of physical function. An eight-week Hatha Yoga program (60 minutes once a week, plus 30 minutes of homework four times a week) is effective in reducing pain and improving physical function in older women with KOA (WOMAC Scale of Pain and Function). (Cheung C et al, 2014)

Tai Chi Qigong (Lee H. and al, 2009) showed a significant improvement in quality of life, pain relief and physical function. An eight-week program (60 minutes of exercise twice a week) to improve quality of life (SF-36) to relieve pain and improve physical function (WOMAC) is recommended. Sun style Tai Chi significantly reduces pain and improves physical function. A 20-week Sun style Tai Chi program (20 to 40 min. three times a week) is recommended to relieve WOMAC pain (Tsai et al. 2013) and improve WOMAC function. (Cheung and al. 2014) Tai Chi may be an appropriate physical training strategy to improve postural control and locomotion in older people with KOA. (You et al. (2021)) This type of traditional exercise can have a beneficial effect on pain, mood, and social interactions. (Zeng et al. (2021)) The exercises lead to reduction in stress, depression, and anxiety, as well as to increase in the self-esteem of people with chronic OA pain (Wang and al, (2014)), which can be due to the fact that these activities take place in a group environment.

5. CONCLUSIONS

The use of therapeutic exercises in treatment and rehabilitation of patients with knee osteoarthritis is highly recommended therapy. Therapeutic exercises, depending on their variety, can lead to improved therapeutic

outcomes and reduced functional impairment. The application of different type strategies for prevention is an important part of the therapeutic process. When developing strategies for the management of the knee osteoarthritis it is necessary to consider the individual characteristics of the patient and the accompanying comorbidity. There is a need to continue research on the use of therapeutic exercises in order to better understand the mechanism by which they can lead to optimization of functional activity and reduction of adverse effects in patients with knee osteoarthritis.

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