

Analysis of the effects of physical therapy on knee osteoarthritis

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Abstract. Among all degenerative joint diseases, Knee Osteoarthritis (KOA) has the highest incidence rate. However, common surgical and pharmaceutical treatments come with side effects. In comparison to surgery and medication, physical therapy is more cost-effective and safer. The purpose of this article is to conduct a systematic review of domestic and international studies on the effectiveness of physical therapy for patients. The results show that physical therapy plays a crucial role in KOA, including manual therapy, physical factor therapy, exercise therapy. Manual therapy aids in improving joint function and alleviating pain, physical factor therapy can be used to manage pain, exercise therapy enhances muscle strength and stability. Personalized treatment plans typically combine various methods to meet the needs of patients. Comprehensive physical therapy approaches offer hope for KOA patients, improving their quality of life and alleviating pain. However, there is relatively limited research on physical therapy, and the elucidation of mechanisms is not yet sufficiently clear and in-depth, which could become a focal point for future studies.

Keywords: Knee osteoarthritis, physical therapy, manual therapy, exercise therapy.

1. Introduction

Osteoarthritis, which is also called degenerative joint disease, degenerative arthritis, hypertrophic arthritis, or arthrosis, is a common joint disorder. Among all forms of degenerative joint diseases, Knee Osteoarthritis (KOA) is the most prevalent. In China, the prevalence of KOA is 18%, with a rate of 11% in males and 19% in females. Among individuals aged 55 and above, 60% exhibit X-ray evidence of KOA, and in those aged 65 and above, the prevalence of KOA rises dramatically to 85% [1]. Currently, the exact etiology of this condition remains not entirely clear.

Regarding the treatment of KOA, there are currently various intervention measures. Surgical treatment can significantly and rapidly improve the symptoms of patients, but it has certain limitations and involves substantial costs. Drug therapy can to some extent alleviate pain and improve symptoms, but it comes with potential medication side effects. With the continuous advancement of research, physical therapy has gradually gained attention and have been applied in clinical practice. Compared to drug therapy, physical therapy is safer and better tailored to meet the needs of patients. It helps improve joint stability, enhance muscle strength, alleviate pain, and enhance daily function. Therefore, assessing

its effectiveness is crucial in choosing the best treatment method. Currently, ongoing research in clinical practice is focusing on physical therapy for KOA. However, there are relatively few comprehensive reviews available, and there is a lack of systematic understanding of the mechanisms and treatments. Therefore, this article aims to reveal the effectiveness of physical therapy in KOA patients, including the actual effects of different intervention methods (manual therapy, physical factor therapy, exercise therapy) on aspects such as pain relief, muscle strength enhancement, and joint function improvement. This will be helpful in the physical therapy for KOA.

2. Manual therapy

Manual therapy techniques include MWM (Joint Mobilization Treatment), PJM (Patellar Mobilization Treatment), Mulligan Technique, etc. In the treatment of Knee Osteoarthritis (KOA), MWM can enhance joint function and stability and alleviate corresponding pain for patients with restricted joint mobility and decreased function. PJM has a significant therapeutic effect on symptoms related to patellar instability, such as patellar instability and pain. Its advantage lies in directly adjusting and improving the position of the patella to alleviate symptoms. A study conducted by Li Linlin et al. From January 2015 to January 2016, 90 patients with KOA were randomly divided into two groups. The control group received treatment with glucosamine hydrochloride capsules, while the treatment group underwent patellar medialization in addition to the treatment received by the control group. Comparisons were made between the efficacy of the two groups at 1 month and 3 months after treatment. After one month of treatment, the results showed that the cure rate of the treatment group was 37.78%, the improvement rate was 46.67%, the non-healing rate was 15.56%, and the total effective rate was 84.44%. At 3 months after treatment, the cure rate was 62.22%, the improvement rate was 33.33%, the unhealed rate was 4.44%, and the total effective rate reached 95.56%. The control group's cure rate after one month was 17.78%, the improvement rate was 51.11%, the non-healing rate was 31.11%, and the total effective rate was 68.89%. At 3 months after treatment, the cure rate was 28.89%, the improvement rate was 48.89%, the unhealed rate was 22.22%, and the total effective rate was 77.78%. The treatment group's efficacy at 1 month after treatment was significantly different. Similarly, when compared with the control group during the same period of treatment, there was also a significant difference in efficacy ($P < 0.05$) [2]. Combining these techniques with exercise therapy seems to provide faster symptom improvement for KOA patients, both in the short term and long term [3]. Currently, there is no clear consensus on the underlying mechanism of patellar maltracking leading to knee osteoarthritis. The main viewpoints cover four etiological mechanisms: ① Abnormal static stability around the patella; ② Abnormal dynamic stability around the patella; ③ Poor development of the trochlear groove; ④ Decreased proprioception in the knee joint itself [4].

In addition, there is another technique called the Mulligan technique, which aims to improve joint function and alleviate pain in patients by jointly correcting joint position and enhancing joint movement. Compared to MWM and PJM, the Mulligan technique is more suitable for elderly knee osteoarthritis patients and can help promote the recovery of knee joint function. This makes it worthy of widespread clinical promotion and application. A study conducted by Duan Gang et al. randomly divided 92 elderly patients with knee osteoarthritis admitted between September 2019 and September 2020 into two groups. The control group received conventional treatment, while the experimental group received conventional treatment combined with the Mulligan technique. The results of the study showed that in the control group, the WOMAC osteoarthritis index score decreased from 83.2 before treatment to 70.6 after treatment, the Lysholm knee joint function score increased from 38.4 to 50.6, and knee joint range of motion increased slightly from 114.2 ± 10.5 to 116.1. These changes were statistically significant ($P=0.000$, 0.000 , and 0.037 , respectively). In the experimental group, the WOMAC osteoarthritis index score decreased from 84.1 before treatment to 60.3 after treatment, the Lysholm knee joint function score significantly increased from 37.6 to 65.6, and knee joint range of motion also improved, increasing from 114.1 to 120.8. These changes were also statistically significant (P all < 0.05) [5]. However, it's worth noting that the need for long-term physical therapy should be determined based on individual circumstances. Some patients may achieve significant results in the short term, while others may require

ongoing physical therapy to maintain good results. This indicates that Mulligan technique treatment may be an effective adjunctive means for the rehabilitation of knee osteoarthritis, helping patients improve joint function and alleviate pain.

In summary, MWM, PJM, and Mulligan techniques are effective physical therapy methods for treating knee osteoarthritis (KOA). MWM is suitable for patients with restricted joint mobility and decreased function, as it can enhance joint function and stability while reducing pain. PJM, on the other hand, is particularly effective for symptoms related to patellar instability and can directly improve the position of the patella. Mulligan technique is especially suitable for elderly patients and helps promote the recovery of knee joint function. It is worth promoting and applying in clinical practice.

3. Physical factor therapy

In order to achieve preventive, therapeutic, and restorative goals, physical factor therapy entails applying a variety of natural and artificial physical factors to the human body. These factors work on physiological regulatory mechanisms such as the neurological system, bodily fluids, and endocrine system. These therapies include shockwave therapy, electrotherapy, traction therapy, among others. Currently, there are numerous methods for treating osteoarthritis (KOA), and physical factor therapy stands out due to its advantages of being non-invasive, cost-effective, easy to administer, and safe, which has garnered widespread attention in both clinical practice and basic research [6].

In recent years, extracorporeal shockwave therapy (ESWT) has seen significant advancements in understanding its mechanisms of action in the treatment of humans and animals. ESWT has been found to influence the expression of cytokines, alleviate inflammation, improve microcirculation, promote the resolution of inflammation, and protect joint cartilage [7]. It offers several therapeutic benefits in the context of KOA:

Pain Relief: ESWT can influence the expression of pain receptors, such as calcitonin gene-related peptide (CGRP), reducing pain sensitivity. It also reduces peripheral nerve sensitivity and decreases the release of pain-inducing factors like substance P (SP), thereby inhibiting pain signal transmission.

Improvement in Local Microcirculation: ESWT can dilate blood vessels and enhance microcirculation, facilitating the rehabilitation of KOA. It achieves this by improving local microcirculation through the conduction of mechanical waves and mechanical pressure, promoting blood circulation and oxygen supply.

Cartilage Protection: ESWT can suppress the expression of pro-inflammatory cytokines, reducing the degradation of joint cartilage, while also stimulating the regeneration of cartilage cells and the synthesis of extracellular matrix, thus helping protect joint cartilage.

ESWT can regulate cytokine levels by decreasing the expression of pro-inflammatory cytokines like IL-1, IL-6, and TNF- α and boosting the expression of anti-inflammatory cytokines like TGF- β and IL-10, which helps to reduce inflammation linked to KOA [8].

Li Mingzhen et al. found that Extracorporeal Shockwave Therapy (ESWT) treatment can significantly reduce the expression of pain receptors, decrease pain sensitivity, stimulate vascular neogenesis, improve blood circulation and metabolism, promote the proliferation and differentiation of cartilage cells, inhibit cartilage cell apoptosis, thereby playing a protective role in cartilage, improving joint mobility, delaying the progression of osteoarthritis, and facilitating the repair of cartilage and subchondral bone injuries [9]. ESWT also demonstrates advantages when compared to other therapies, such as its effectiveness in cartilage protection and prevention of subchondral bone sclerosis. A study conducted by Lee et al., A group of 20 patients with knee osteoarthritis (KOA) was split into two groups: one received ESWT, and the other, conservative physical therapy (CPTG) [10]. The use of a heat pack for 20 minutes, interferential electrical therapy for 15 minutes, and ultrasound therapy for 5 minutes were all parts of the normal conservative physical therapy that was given to both groups. Additional extracorporeal shockwave therapy was administered to the ESWT group. Sessions took place three times a week for the entire four weeks of the treatment. The Visual Analog Scale (VAS) was used to measure the patients' pain levels, and the Knee Injury and Osteoarthritis Outcome Score (K-WOMAC) was used to assess their functional status. Both groups exhibited significant decreases in their respective scores,

with the ESWT group showing a more pronounced reduction. Specifically, VAS scores decreased from 7.9 before treatment to 2.9 after treatment, and K-WOMAC scores decreased from 37.4 to 9.3 in the ESWT group, while the CPTG group showed only a modest decrease from 6.8 to 5.5 in VAS scores and from 30.9 to 25.4 in K-WOMAC scores. The inter-group comparison after treatment revealed a significant difference favoring the ESWT group. In another study conducted by Xi Feifeng et al., 30 patients were divided into a trigger point injection group and an ESWT group, both receiving a 5-week treatment regimen with sessions once a week [11]. The findings demonstrated that one week following therapy, both people's VAS pain scores significantly decreased. However, the trigger point injection group showed an increase in pain scores over the course of 6 weeks, 3 months, and 6 months after treatment, whereas the ESWT group continually showed a significant decline. The VAS pain scores in the trigger point injection group versus the ESWT group were as follows (pre-treatment: 50.5 vs. 51.0; at 6 weeks: 19.1 vs. 17.2; at 6 weeks: 47.5 vs. 15.2; at 3 months: 49.6 vs. 14.5; at 6 months: 50.2 vs. 30.2).

Research indicates that ESWT holds significant potential advantages in treating KOA. ESWT exerts multifaceted effects on the therapeutic mechanisms for KOA patients, including analgesic effects, improvement of local microcirculation, protection of joint cartilage, and regulation of cytokine levels. These collaborative effects contribute to alleviating patients' pain symptoms, enhancing joint function, delaying the progression of osteoarthritis, and promoting the repair of cartilage and subchondral bone injuries. Compared to other treatment methods, ESWT demonstrates distinct advantages in cartilage protection and preventing subchondral bone sclerosis. However, there are still aspects that require further refinement and investigation: longer-term follow-up studies are needed to assess the long-term efficacy of ESWT treatment; further exploration of the optimal dosage, frequency, and duration of ESWT treatment is warranted to ensure the best treatment outcomes. Additionally, the sample size used in the study may be insufficient to represent the entire population of KOA patients, necessitating a larger sample size to enhance the persuasiveness of the data.

4. Exercise therapy

Exercise therapy refers to a treatment approach that utilizes targeted exercise and physical activities to improve the physical and mental health of individuals. This includes aquatic exercise therapy, aerobic exercise, traditional Chinese exercise, etc.

4.1. Aquatic exercise therapy

Aquatic exercise therapy offers strong therapeutic effects and is a successful conservative treatment for knee osteoarthritis (KOA). A meta-analysis that searched databases ultimately included 13 studies with a total of 883 patients. It was found that the aquatic exercise group had superior improvement compared to the non-aquatic exercise group [12]. Specifically, WOMAC pain scores and VAS scores were significantly different in the group receiving aquatic physical therapy compared to the group not receiving it (SMD = -1.09, 95% CI -1.97, -0.21, $p=0.02$) and (SMD = -0.55, 95% CI -0.98, -0.12, $p=0.01$), respectively. Additionally, aquatic exercise therapy effectively improved WOMAC physical function scores (SMD = -0.57, 95% CI = -1.14, -0.01, $p=0.05$). Moreover, aquatic physical therapy greatly reduced the time-up-and-go Test (TUGT) (MD = -0.89, 95% CI -1.25, -0.53, $p<0.05$). These results suggest that aquatic exercise therapy has significant improvements for pain and physical function in KOA patients. However, there were no significant improvements in other indicators such as quality of life (QOL), flexibility, and body composition, which may be related to the intervention time being too short. It was found that swimming intervention in elderly KOA mice (18-month-old male mice with natural aging, established elderly knee osteoarthritis model swimming intervention) had a tendency for a decrease in peripheral blood cells compared to the elderly group (18-month-old mice with natural aging), but there was no significant difference. Lymphocyte counts significantly decreased ($p<0.05$). It was concluded that swimming exercise can reduce inflammatory cells in the blood and alleviate inflammatory reactions, thereby protecting joint cartilage [13]. Additionally, it increases knee joint activity while avoiding excessive joint load.

4.2. Traditional Chinese health exercise

Traditional Chinese health exercise (such as Tai Chi, Yi Jin Jing, Baduanjin, and Wuqinxi) also has significant therapeutic effects. A meta-analysis that summarized relevant studies from database construction to March 2020 ultimately included 28 studies with a total of 1800 KOA patients, mainly involving four traditional exercises (Tai Chi, Yi Jin Jing, Baduanjin, and Wuqinxi). According to the findings, when compared to the control group, the total effect size of traditional Chinese health exercise intervention on WOMAC pain scores was [SMD = -0.50, 95% CI: -0.67 to -0.33, $p < 0.001$], the total effect size of WOMAC stiffness scores was [SMD = -0.59, 95% CI: -0.82 to -0.37, $p < 0.001$], and the total effect size of WOMAC physical function scores was [SMD = -0.71, 95% CI: -0.89 to -0.53, $p < 0.001$], all of which had significant statistical differences, indicating that traditional Chinese health exercise had significant therapeutic effects [14]. Another study found that Tai Chi can enhance the muscle strength of quadriceps femoris and gastrocnemius and improve lower limb muscle strength of knee joints, thereby improving clinical symptoms and achieving significant relief of conditions [15]. However, some studies have shown that after a 12-week practice, the benefits of Tai Chi for pain alleviation and improved joint function did not last, which indicates that exercise therapy may require long-term adherence to exercise for it to be effective [16]. Moreover, the mechanism of exercise therapy for treating KOA still needs further research at present.

5. Conclusion

Middle-aged and elderly individuals commonly suffer from a degenerative joint disease known as KOA, causing severe pain and limitations in movement. As a non-drug treatment method, physical therapy performs a significant function in the management of KOA. This review synthesizes the research and evidence from current literature on physical therapy for KOA to explore the clinical effects of different physical treatment methods in patients with KOA. The research shows that physical therapy plays a crucial role in KOA, including manual therapy, physical factor therapy, and exercise therapy. Manual therapy can help improve joint function and reduce pain, physical factor therapy can be used for pain management, and exercise therapy enhances muscle strength and stability. Personalized treatment plans typically combine different methods to meet the needs of patients. Integrated physical therapy methods provide hope for KOA patients to improve their quality of life and relieve pain. However, physical therapy may need to be prolonged to achieve good results, therefore, patients need to actively participate in and adhere to treatment plans to obtain long-term benefits. Additionally, currently, there is a lack of research on physical therapy, with some studies having small sample sizes and incomplete mechanisms elucidated. In the future, it is possible to expand the sample size, regions, and conduct more multi-center, multi-sample evidence-based research with long-term follow-up and effect evaluation to further improve the treatment effects and quality of life of KOA patients, bringing better health benefits to patients.

Authors Contribution

All the authors contributed equally and their names were listed in alphabetical order.

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