Research progress in the treatment of Knee Osteoarthritis

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Abstract. Osteoarthritis in the knee is a disease that is chronic and degenerative. It occurs more frequently between the elderly and the obese populations, and the prevalence rate of women is higher than that of men. With the accelerated aging of the population, the prevalence of knee osteoarthritis has also increased, which has brought greater pressure to the patients themselves and society. In recent years, although through the efforts of researchers, there have been a variety of treatment methods for knee osteoarthritis in the clinic, researchers have not yet found a complete cure for knee osteoarthritis. This paper introduces the research status of therapeutic modalities, exercise therapy and traditional therapy in the therapy of knee osteoarthritis by investigating previous research, aiming to promote the level of knee osteoarthritis therapy.

1. Introduction

Osteoarthritis is a common articular disease in a great number of countries, and the knee joint is the most commonly affected area of osteoarthritis. With the acceleration of global population aging, knee osteoarthritis is becoming a worrying communal fitness problem, which not only imposes a heavy social burden and economic pressures but also affects people's psychological and physical health and quality of life [1]. Knee osteoarthritis (KOA) is a common chronic disease of the musculoskeletal system characterized by degeneration, damage, and osteoporosis of the subchondral bone of the knee arthrosis. The clinical symptoms and signs of knee osteoarthritis mainly include knee pain, stiffness, swelling, joint deformation, muscle weakness, limited activity, abnormal gait, decreased function of standing and walking, and decreased quality of life, At the same time, it may also be accompanied by some psychological complications,such as depression and anxiety [2-4].

Knee osteoarthritis is more usual in older and obese populations, and the epidemicity of knee osteoarthritis in females (10.3 %) is higher than that in males (5.7 %). [5]. The incidence of knee osteoarthritis in adults in China can reach 15%, of which the incidence rate in people older than 40 years old is about 10%-17%, the occurrence rate in persons over the age of 60 years old can reach 50%, and the occurrence rate in persons older than 75 years old can even reach 80% [6]. Studies have also shown that KOA is the main cause of disability in the elderly.

Previous studies have shown that biomechanical interventions can lead to imbalances in the synthesis and degradation of chondrocytes, extracellular matrix, and subchondral bone, inducing KOA. During walking or standing, if the line of force is disturbed, it will cause an increase of knee varus torque, resulting in abnormal stress loads in the knee joint, resulting in problems such as decreased muscle strength, pain, and joint instability around the knee joint [4].

Although there have been more and more clinical studies of knee osteoarthritis in recent years, researchers have not yet found a complete cure for knee osteoarthritis. Currently, the treatment of knee osteoarthritis is primarily aimed at reducing pain and stiffness, improving function, correcting lines of force, retaining and improving mobility, and reducing disability rates; standardized treatments for knee osteoarthritis include joint injections, drug therapy, weight management, physical therapy, exercise therapy, assistive devices, and knee replacement surgery for end-stage disease [7]. Many guidelines abroad recommend exercise therapy as the preferred treatment for KOA [8].

Safe and effective treatments for knee osteoarthritis are particularly important. This paper mainly discusses the therapeutic effect of physical therapy, exercise therapy and traditional treatment in the therapy of KOA, aiming to promote the development of knee osteoarthritis treatment research.

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2. Therapeutic modalities for knee osteoarthritis

Pain and stiffness are common clinical manifestations of knee osteoarthritis, which directly interfere with patients' functional level and daily quality of life, and are also the main complaints of patients when seeking treatment. At present, modalities are one of the main treatments for knee osteoarthritis in clinical practice, and it is also one of the treatment programs that most patients are willing to accept. A variety of therapeutic modalities treatments are available, including infrared, ultrasound, pressure, diathermy, laser, massage, electrical stimulation, biofeedback, drug penetration, traction, joint loosening, taping, etc. This article focuses on the efficacy of electrotherapy, heat therapy, and massage therapy in physiotherapy in relieving pain and stiffness of knee osteoarthritis.

2.1 Electrotherapy

Studies have shown that electrotherapy can relieve pain in patients. Electrical stimulation induces sensory fibers to promote presynaptic suppression of pain. One study [9] randomly divided 60 patients with KOA into a control group and a modulated medium frequency radiotherapy group, there were 30 cases in each group. These two groups were the same in conventional rehabilitation treatment and clinical medication, in which the modulated intermediate frequency electrotherapy group was given modulated intermediate frequency electrical therapy. The outcomes reflected that the modulated IF radiotherapy group was better on the McGill pain scale than the other group, and the statistics were different ($P<0.05$). In a meta-analysis by Ding Xiang et al. [10], it was found that the high-frequency percutaneous neuromuscular electrical stimulation group indicated obvious distinctions compared with the control group, but the low-frequency percutaneous neuromuscular electrical stimulation group displayed no significant distinctions compared with the control group. Therefore, high-frequency percutaneous neuromuscular electrical stimulation has an obvious effect on relieving pain in KOA patients, while low-frequency percutaneous neuromuscular electrical stimulation is not obvious in relieving pain symptoms. In a systematic review and meta-analysis of KOA pain easing with electrical stimulation by C. Zeng et al. [11], interference electrotherapy appeared to be the most promising analgesic therapy for KOA.

2.2 Thermotherapy

Thermotherapy can speed up the metabolism of cells, but also relax tense muscles and reduce the mechanical pressure of nerves, thereby reducing pain. In the study of Kenji Takahashi et al. [12], 112 patients received anti-inflammatory drugs or intra-articular injection of hyaluronic acid for 3 months, but knee pain did not improve. More than a month after the last use of anti-inflammatory drugs and intra-articular injection of hyaluronic acid, 12 patients were treated with radiofrequency hyperthermia, as proved in Figure 1, the outcomes displayed that the patient's Lequesne index (LI) declined by 3.55 points from baseline, and the Japan Orthopaedic Association scale (JOA scale) has improved significantly. In a study of short-wave hyperthermia in the adjuvant treatment of knee arthritis [13],9 out of 10 patients with degenerative arthritis had improved symptoms of pain and stiffness, and short-wave hyperthermia was effective for other types of arthritis.

Figure 1. This patient was being treated for radiofrequency hyperthermia.

2.3 Massage therapy

Massage treatment is a safe and effective non-pharmacological intervention that accelerates blood flow, improves circulation, and promotes edema absorption to relieve knee pain, stiffness, and eliminate edema. At the same time, massage can also improve the flexibility of the knee joint, increase the tension of the muscles around the knee arthrosis, and thus improve the functional state of the knee joint [1]. In a randomized controlled study by Adam I. Perlman et al. [14], 68 patients with KOA who had been confirmed by radiography were divided into two groups, one taking standard Swedish massage and the other gaining usual care as a control group. The final results showed that the group adopting massage treatment had obvious enhancements in WOMAC scores, functional retention, pain reduction and stiffness, while there were statistically obvious distinctions between the intervention group and the usual care group. In a study by Adam Perlman et al. [15], patients were divided into massage, light-touch, and usual care groups, all of which were identical in medication use. The results indicated that in the short-term therapy, the WOMAC result of the massage group was greatly improved compared with the light touch group and the routine care group, and it was also significantly better than that of the light touch group and the nursing group in terms of pain release and function enhancement. However, from the perspective of long-term care, the distinction between the massage group, the light touch group, and the routine care group was not large and not statistically significant.

3. Exercise therapy for knee osteoarthritis

With the speed of population aging in China, the incidence of KOA is also increasing. As a non-surgical rehabilitation method, exercise therapy has become the preferred rehabilitation method for the treatment of KOA because of its good pain reduction effect, strong operability, and few side effects. [8] Exercise training can improve the muscle strength, joint range of motion (ROM), and function of the lower limbs, thereby increasing the flexibility and stability of the knee joint; exercise training can also accelerate the metabolism and blood circulation around the knee joint, thereby promoting the absorption of inflammatory factors and the process of injury repair. [4] There are also many types of exercise therapy, including aerobic training, muscle strength training, neuromuscular training, balance training, water exercise training, joint mobility training, etc. [8] This paper mainly discusses the effect of muscle strength training, aerobic training, and water exercise training in exercise therapy on decreasing knee osteoarthritis pain and increasing knee function of patients.

3.1 Muscle strength training

The decrease of muscle strength around the knee joint is a common clinical symptom of KOA patients. The decrease in muscle strength will affect the daily life activities of patients and bring many inconveniences to patients. There are many methods of muscle strength training, such as isokinetic training, isometric training, advanced resistance training, etc. In a systematic review and regression analysis by Cecilie Bartholdy et al. [16], strength training exercise interventions that kept the American College of Sports Medicine (ACSM) criteria provided better results in extensor strength but were less effective at relieving pain or disability control. A development in knee extension strength of at least 30% is likely to have a helpful influence on pain, and an increase of at least 40% is likely to have a beneficial effect on disability. In the study by E. Coudeyre et al.[17] isokinetic training, isometric training, and aerobic training improved muscle strength compared with no therapy, but no obvious distinctions were found between the four training categories. Among them, isokinetic training combined with ultrasound therapy has a better effect on improving muscle strength, and can also improve range of motion. In addition, isokinetic training has also achieved a good curative effect in alleviating pain, and the combination with pulsed ultrasound treatment will have a better curative effect on pain. Isometric training can also improve motor function in KOA patients while being able to control the exacerbation of disability. [17]

3.2 Underwater exercise training

Underwater exercise training is a kind of method for patients to exercise in a constant temperature swimming pool. The physical properties of water can help patients reduce the pressure of weight on the knee joint, but also reduce pain, and provide certain resistance for training, so the application of water sports training is becoming more and more extensive. Water exercise training includes walking in the water, standing on one foot in the water, squatting in the water, etc. [3]. Rana S Hinman et al. [18] randomly divided 71 participants into an underwater physical therapy group and a non-water physiotherapy group, in which the underwater physical therapy group received water exercise training and recorded the data before and after therapy. The outcomes pointed out that water exercise training can decrease joint stiffness and pain, increase muscle strength, function, and quality of life of patients, and the curative effect can be maintained for 6 weeks. In a previous study[19] , it was found that the WOMAC score of patients with water exercise therapy was lower than that of patients without water exercise therapy. The muscle strength, endurance, bodily function, and quality of livelihood of the patients who did water exercise were improved significantly compared with those who did not do water training.

3.3 Aerobic training

Aerobic training, also known as endurance training, is a type of aerobic metabolism-based exercise that can improve the body's metabolic capacity while strengthening cardiopulmonary function. There are also many kinds of aerobic exercise, including jogging, swimming, cycling, qigong and so on. Aerobic training is also suggested by numerous clinical guidelines for the treatment of KOA [4]. In the study of Mohammed Alkatan et al. [20], 24 KOA patients were trained to swim or ride a bicycle for 3 months and the WOMAC scale was used to measure joint pain, functional limitations, and stiffness. The results indicated that there was a significant and statistically marked improvement in joint pain, functional limitations, and stiffness in patients after aerobic training, but there was no obvious difference in improving the function of the knee joint between cycling and swimming. In a previous study [21], 80 patients with KOA were randomly divided into an observation group and a control group, every group had 40 cases. Intra-articular injection of sodium hyaluronate was used in the control group, and aerobic bicycle and intra-articular injection of sodium hyaluronate was treated in the observation group. The results displayed that the total effective rate of therapy in the group undergoing aerobic pedal training was obviously higher than that of the group that was treated with intra-articular injection, and the distinction was statistically marked.

4. Traditional rehabilitation therapy for knee osteoarthritis

With the continuous development of the traditional Chinese medicine industry, more and more KOA patients choose traditional rehabilitation methods for treatment, which is due to its advantages of safety and effectiveness and fewer side effects. Traditional rehabilitation methods include acupuncture, tuina, cupping, Chinese medicine

fumigation, tai—chi, five poultry plays, Baduanjin, etc. Among them, the forms of acupuncture include floating acupuncture, warm acupuncture, electroacupuncture, auricular acupuncture, dry acupuncture, etc. [5], and there are many schools and techniques of tuina. This chapter mainly discusses the efficacy of acupuncture therapy, tuina therapy, and combination acupuncture and tuina in improving symptoms in KOA patients.

4.1 Acupuncture therapy

Acupuncture has a long history in the treatment of knee pain, while acupuncture treatment is safe and effective. In a study by Brian M. Berman et al. [22], 570 KOA patients were stochastically divided into trial and control groups, in which the trial group received real acupuncture therapy and the sham acupuncture therapy was used in the control group. The experimental results indicated that after 26 weeks of treatment, the functional score and pain score of WOMAC in the real acupuncture treatment group were developed compared with the sham acupuncture group.

4.2 Tuina therapy

Tuina therapy can loosen the tense muscles around the knee, accelerate blood circulation around the knee, reduce adhesions, and improve the flexibility of the knee joint [6]. In a previous study,[23] 58 people with KOA were stochastically divided into two groups, with group A being treated with meridian tuina for the trial group and celecoxib for the control group B. The outcomes displayed that after treatment, stiffness, pain, and daily activities improved compared with preconditioning, and the overall result of WOMAC in the meridian tuina treatment group was lower than that of the oral celecoxib group, and the distinction was statistically obvious.

4.3 Acupuncture and tuina combination therapy

Acupuncture and tuina combination therapy relieves pain, improves microcirculation around the knee, removes inflammatory factors, and increases knee range of motion. In a previous study [24], 41 persons with KOA were divided into two groups in outpatient order. Among them, 20 patients received tuina therapy in the control group, and 21 patients in the observation group gained tuina combined with warm acupuncture. The results revealed that the knee joint function of both groups improved compared with before treatment, but the treatment effect of the observation group, namely Tuina combined with warm acupuncture, was significant compared with that of the Tuina therapy group, and the distinction was statistically significant. In another study [25], the investigators randomly divided 136 KOA patients into a joint group and a single group, there were 68 cases in each group. Among them, the joint group carried out Tuina combined with warm acupuncture treatment, and the single group underwent Tuina therapy. The experimental results indicated that the knee pain and functional scores of the combined group were greater than those of the single group, and the distinction was statistically significant. At the same time, the total effective rate of the combination treatment group was better than that of the single group, of which the total effective rate of treatment in the combined group was 95.6%, and the single group had an 80.8% total effective rate of treatment, and the distinction was statistically significant. Furthermore, one study [26] randomly divided 96 KOA patients into a control group and a study group, every group had 48 cases. The control group was gained with tuina and oral celecoxib, and the research group was gained oral celecoxib and tuina combined with warm acupuncture. The results showed that the levels of interleukin-6 (IL-6) and hypersensitive C-reactive protein (hs-CRP) in the treatment group were lower than those in the group treated with tuina and oral celecoxib, and the total effective rate of treatment in the study group was signally greater than that in the control group, of which the total effective rate of treatment in the research group was 95.83%, and the total effective rate of treatment in the control group was 81.25%, the difference was statistically significant.

5. Conclusion and prospect

KOA is a common chronic degenerative disease in clinics, mainly in the elderly and obese populations, where the prevalence is more common in females than in men [5]. Knee cartilage degeneration, damage, and osteoporosis of the subchondral bone are the main features of KOA. Patients will be accompanied by severe knee pain, stiffness, swelling and muscle loss after the onset of KOA, which will affect the daily life of KOA patients and lead to a decline in quality of life. If the disease is not intervened in time, it will further deteriorate the condition, resulting in knee joint deformity, loss of function and even disability. [2-4]. There are many ways to treat KOA in the clinic today, and there are differences between each method, and the direction of treatment and the effect of treatment is also different. This paper mainly discusses the positive impact and effectiveness of non-invasive and safe treatment methods of physiotherapy, exercise therapy and traditional Chinese medicine on the therapy of KOA, aiming to offer a reference for the clinical therapy of KOA.

At present, there are many studies on the etiology and pathogenesis of primary KOA, and there are many clinical statements. but the real etiology and pathogenesis of KOA have not yet been clarified, and further research is needed. In the meantime, although a large number of researchers have demonstrated the effectiveness and safety of current treatments for KOA (such as oral drug treatment, surgical treatment, physical therapy, etc.) [8], these treatments can only alleviate the symptoms of KOA or control the further deterioration of the disease. Therefore, future research on KOA should focus on finding safe and efficient methods. In addition, in recent years, with the acceleration of population aging, the prevalence of KOA has gradually increased, which not only affects the quality of people's daily life but also brings heavy medical pressure to society [1]. Therefore, it is urgent to solve the burden that KOA brings to people and society.

References

1. Qin S, Chi Z, Xiao Y, Zhu D, Zhong G, Xu W, Ouyang X, Li J, Cheng P, Yu T, Li H, Jiao L. Effectiveness and safety of massage for knee osteoarthritis: A protocol for systematic review and meta-analysis. Medicine (Baltimore), 2020. 99(44): p. e22853.
2. Zheng M R, Chen G J, Liu M B. Application of high frequency ultrasound in the evaluation of rehabilitation effect of knee osteoarthritis. China Academic Journal, 2021: p. 4.
3. Peng J Y, Wang Y J, Zhou X L.Advances in Clinical Research on Aqua Exercise Therapy in the Treatment of Knee Osteoarthritis. Massage and Rehabilitation Medicine, 2021: p. 4.
4. Jin H, Chen Z H, Zhang W D, Yao M L, Xu H.Advances in clinical research on exercise therapy for the treatment of knee osteoarthritis. Journal of Gansu University of Traditional Chinese Medicine, 2021: p. 6.
5. Li J, Li Y X, Luo L J, Ye J, Zhong D L, Xiao Q W, Zheng H, Geng C M, Jin R J, Liang F R. The effectiveness and safety of acupuncture for knee osteoarthritis: An overview of systematic reviews. Medicine (Baltimore), 2019. 98(28): p. e16301.
6. Zhang S K, Yang J P, Pu Y. Clinical advances in tuina in the treatment of knee osteoarthritis[J]. Journal of Guangxi University of Traditional Chinese Medicine, 2020, 23(3):3.
7. Ali A, Rosenberger L, Weiss T R, Milak C, Perlman A I, Massage Therapy and Quality of Life in Osteoarthritis of the Knee: A Qualitative Study. Pain Med, 2017. 18(6): p. 1168-1175.
8. Wu H, Yang Q, Pang J, Du J.Application progress of exercise therapy in the treatment of knee osteoarthritis.Chinese contemporary medicine, 2021: p. 5.
9. Liu Q, Yang M, Wu C, Tian J, Lu J M, Xu J, Zhao J, Zhu Y L, Wang N H, Jia J.Effect of modulated medium frequency electrotherapy on pain and quality of life in patients with knee osteoarthritis [J]. China Journal of Rehabilitation Medicine, 2013, 28 (5) : 4.
10. Ding X, Zhang Y, Deng Z H, Yang Y, Yang T, Li H, Lei G H.Meta-analysis of percutaneous nerve electrical stimulation in the treatment of knee osteoarthritis pain [J]. Chinese tissue engineering research, 2015, 19 (11) : 7.
11. Zeng C, Li H, Yang T, Deng Z H, Yang Y, Zhang Y, Lei G H. Electrical stimulation for pain relief in knee osteoarthritis: systematic review and network meta-analysis. Osteoarthritis Cartilage, 2015. 23(2): p. 189-202.
12. Takahashi, K., Kurosaki, H., Hashimoto, S., Takenouchi, K., Kamada, T., Nakamura, H., The effects of radiofrequency hyperthermia on pain and function in patients with knee osteoarthritis: a preliminary report. J Orthop Sci, 2011. 16(4): p. 376-81.
13. Zhang X L.Clinical effect observation and nursing of short wave hyperthermia adjuvant treatment of knee arthritis [J].Health vocational education, 2009,27 (16) : 2.
14. Adam I. Perlman, M., MPH; Alyse Sabina, MD; Anna-Leila Williams, PA-C, MPH; and M.D.L.K. Valentine Yanchou Njike, MD, MPH, Massage Therapy for Osteoarthritis of the Knee A Randomized Controlled Trial. Original Investigation, 2006: p. 6.
15. Perlman, A., Fogerite, S. G., Glass, O., Bechard, E., Ali, A., Njike, V. Y., Pieper, C., Dmitrieva, N. O., Luciano, A., Rosenberger, L., Keever, T., Milak, C., Finkelstein, E. A., Mahon, G., Campanile, G., Cotter, A., Katz, D. L., Efficacy and Safety of Massage for Osteoarthritis of the Knee: a Randomized Clinical Trial. J Gen Intern Med, 2019. 34(3): p. 379-386.
16. Bartholdy, C., Juhl, C., Christensen, R., Lund, H., Zhang, W., Henriksen, M., The role of muscle strengthening in exercise therapy for knee osteoarthritis: A systematic review and meta-regression analysis of randomized trials. Semin Arthritis Rheum, 2017. 47(1): p. 9-21.
17. Coudeyre, E., Jegu, A. G., Giustanini, M., Marrel, J. P., Edouard, P., Pereira, B., Isokinetic muscle strengthening for knee osteoarthritis: A systematic review of randomized controlled trials with meta-analysis. Ann Phys Rehabil Med, 2016. 59(3): p. 207-215.
18. Rana S Hinman, S.E.H., Anthony R Day, Aquatic Physical Therapy for Hip and Knee Osteoarthritis: Results of a Single-Blind Randomized Controlled Trial. American Physical Therapy Association, 2007: p. 12.
19. Zou Z, Zhu J Z, Liao W J. Systematic evaluation of the efficacy of water exercise therapy in elderly patients with knee osteoarthritis [J]. Chinese Journal of Rehabilitation Medicine, 2011, 26 (007) : 659 – 664.
20. Alkatan, M., Baker, J. R., Machin, D. R., Park, W., Akkari, A. S., Pasha, E. P., Tanaka, H., Improved Function and Reduced Pain after Swimming and Cycling Training in Patients with Osteoarthritis. J Rheumatol, 2016. 43(3): p. 666-72.
21. Zhou S R, Xiang T Y, Han X S, etc. Clinical effect observation of aerobic treadmill exercise combined with intra-articular injection of sodium hyaluronate in the treatment of knee osteoarthritis [J].Liaoning Medical Journal, 2019 (2) : 4.
22. Brian M. Berman, M.L.L., PhD; Patricia Langenberg, PhD; Wen Lin Lee, PhD; Adele M.K. Gilpin, PhD; and Marc C. Hochberg, MD, Effectiveness of acupuncture as adjunctive therapy in osteoarthritis of the knee a randomized, controlled trial. Annals of Internal Medicine, 2004: p. 11.
23. Yang Z J, Chen J F, Zhang Y F. Curative effect of Jingjin massage on knee osteoarthritis [J]. Jiangsu medicine, 2014, 40 (21) : 3.

24. Liu M P, Liu S J, Zhang S X.warm acupuncture combined with massage in the treatment of knee osteoarthritis curative effect analysis.General practice : p.2.
25. Zhang Y.Clinical effect of warm acupuncture combined with massage in the treatment of knee osteoarthritis.Materials Research and application, 2021 : p.3.
26. Li L W.Therapeutic effect of warm acupuncture combined with massage on knee osteoarthritis. Renowned Doctor, 2020 : p. 2.