Int J Clin Exp Med 2018;11(9):10009-10014
www.ijcem.com /ISSN:1940-5901/IJCEM0077734

Original Article

Effects of exercise therapy for knee osteoarthritis

Haibin Wang[1,2,3], Yong Ma[1,2], Yang Guo[1,2], Yalan Pan[1,2]

[1]Institute of Traumatology and Orthopedics, [2]Orthopedics and Traumatology of Traditional Chinese Medicine Faculty Working Office, Nanjing University of Chinese Medicine, Nanjing, Jiangsu Province, China; [3]Department of Orthopedics, Nanjing Jiangbei People's Hospital, Nanjing, Jiangsu Province, China

Received April 11, 2018; Accepted June 14, 2018; Epub September 15, 2018; Published September 30, 2018

Abstract: Objective: The aim of this study was to evaluate the effects of exercise therapy for knee osteoarthritis. Methods: A total of 100 patients with knee osteoarthritis were enrolled in this study, diagnosed in Nanjing University of Chinese Medicine, from January 2015 to June 2017. All patients were randomly divided into an observation group (50 cases) and control group (50 cases). Patients in the observation group were given exercise therapy for 12 weeks, while patients in the control group were given simple quadriceps femoris training for 12 weeks. After treatment, patients in both groups were followed up for 6 months. WOMAC scores, gait parameters, and recurrence rates were compared between the two groups. Results: There were no statistical differences in WOMAC scores between the two groups before intervention (P=0.109). After intervention, WOMAC scores were reduced in both groups compared to before intervention. WOMAC scores of the observation group were significantly lower than the control group (P=0.019). There were no statistical differences in gait parameters of the two groups before intervention, including step length (P=0.288), step frequency (P=0.396), step width (P=0.519), step angle (P=0.331), total support phase (P=0.699), and swing (P=0.190). After intervention, step length, step frequency, total support phase, and swing were significantly improved in the observation group compared to before intervention (P=0.019, P=0.030, P=0.026, P=0.031, respectively). Moreover, step length, step frequency, total support phase, and swing phase were significantly better than those of the control group, (P=0.016, P=0.021, P=0.040, P=0.033, respectively). In the control group, only total support phase was significantly improved compared to before intervention (P=0.031). In addition, during the 6-month follow up period, recurrence rates of the observation group were significantly lower than the control group (P=0.001). Conclusion: Exercise therapy can effectively improve clinical symptoms and joint function of knee osteoarthritis, while reducing recurrence rates.

Keywords: Knee osteoarthritis, exercise therapy, WOMAC scale, gait analysis, recurrence

Introduction

Osteoarthritis (osteoarthritis, OA) is a kind of articular cartilage damage of chronic joint disease with high incidence in the elderly [1]. The highest incidence of OA, incidence of knee osteoarthritis was 15.6% and increased in the elderly population in China [2, 3]. Main pathological features of knee osteoarthritis include degeneration of articular cartilage and periosteum, proliferation of articular capsule, synovium, and bone, and relaxation and spasm of ligaments and muscles around joints [4, 5]. Clinical manifestations include swelling of the joints, joint pain, limited activity, and even ankyloses. Therefore, based on clinical significance, it is important to strengthen prevention and treatment of knee osteoarthritis.

Exercise therapy can enhance muscle strength and joint activity around the knee, promoting the recovery of sensation through active or passive movement. Previous studies have shown that exercise therapy is a simple and convenient training method that can improve clinical symptoms of knee osteoarthritis, promote recovery of joint function, and reduce recurrence rates [6, 7]. In addition, the combination of drug and non-drug therapy has been recommended as a treatment for osteoarthritis [8]. However, evaluation of the therapeutic effects of osteoarthritis has mainly been based on subjective complaints and subjective feelings of the patients. Thus, there is an urgent need for more effective objective evaluation indexes which can improve accuracy.

Table 1. Clinical characteristics of the two groups

Clinical characteristics	Observation group	Control group	P
Age (years old)	56.3±13.9	58.1±14.6	0.390
Gender (male/female, n)	13/37	11/39	0.639
BMI (kg/m^2)	24.3±3.6	23.9±3.3	0.691
Injured positon (n)			0.426
Left knee	11	10	
Right knee	13	19	
Both knees	26	21	
Grading of X-ray (n)			0.757
I	9	12	
II	21	20	
III	20	18	

Table 2. WOMAC score evaluation of the two groups before and after intervention

Group	Before intervention	After intervention
Observation group	67.31±25.16	28.16±13.29$^{*,\#}$
Control group	68.01±23.63	46.09±18.81*

Note: *P < 0.05 compared with before intervention, $^{\#}$P < 0.05 compared with the control group at the same time point.

In recent years, exercise therapy has been carried out for knee osteoarthritis patients, adopting the subjective and objective evaluation index to evaluate effects of exercise therapy on knee osteoarthritis.

Materials and methods

Patient enrollment

Inclusion criteria were: (A) Patients in line with diagnostic criteria of knee osteoarthritis according to guidelines for osteoarthritis (2007 Edition); (B) Patients with conditions improving and reaching discharge standards; (C) Patients aged < 75 years old; and (D) Patients with grade 0-III (X-ray). Exclusion criteria were: (A) Patients with knee joint diseases affecting normal gait (such as tuberculosis of knee joint and knee joint infections, rheumatism, rheumatoid arthritis and gout, and knee tumors); (B) Patients with knee, ankle, and foot deformities; and (C) Patients with severe cardiovascular and nervous system diseases that affect normal gait.

A total of 100 patients with knee osteoarthritis were enrolled in this study, diagnosed in Nanjing University of Chinese Medicine, from January 2015 to June 2017. All patients were randomly divided into two groups (observation group and control group, n=50 cases/group). As shown in **Table 1**, there were no statistical differences in clinical data between the two groups (P> 0.05). This study was approved by the Ethics Committee of Nanjing University of Chinese Medicine. All patients provided informed consent before the start of the study.

Methods

For the observation group, patients were given exercise therapy, including supine leg training, prone leg training, supine tensile stretch training, and sitting tensile stretch training [6, 7]. For the control group, patients were only given quadriceps femoris training.

Continuous 3 times training was considered as one set and the interval between two sets was 2 minutes. Patients in the two groups were trained every day. Training started from the affected limb or severe side. Patients were trained 3 times per week according to their respective regimen. After 12-week training period, patients in both groups were followed up for 6 months.

Observation indexes

The scale for WOMAC scores of international osteoarthritis was used to evaluate WOMAC scores in both groups, before and after intervention. The scale of WOMAC scores is widely used by health professionals to evaluate conditions of patients with osteoarthritis of the knee, including pain, stiffness, and physical functioning of the joints. WOMAC measures five items for pain (score range 0-20), two for stiffness (score range 0-8), and 17 for functional limitation (score range 0-68). Lower scores indicate better knee function.

Gait analysis parameters were used to analyze kinematic and kinetic gait measurements, before and after intervention, including step length, step width, and step angle. Recurrence of the two groups was recorded every month during the follow up period.

Table 3. Gait parameters in the two groups before and after intervention

Gait parameters	Observation group		Control group	
	Before intervention	After intervention	Before intervention	After intervention
Step length (cm)	47.01±3.63	61.01±6.63*,#	49.60±3.39	53.01±4.63
Step frequency (pace/min)	99.31±9.88	128.61±12.18*,#	101.90±9.61	106.61±10.18
Step width (cm)	10.39±3.09	10.86±3.10	10.41±3.13	10.99±3.00
Step angle (°)	12.99±6.10	13.31±6.09	13.19±6.01	13.29±6.20
Total support phase (%)	66.10±5.10	53.21±4.30*,#	68.03±5.29	58.10±4.01*
Swing (%)	36.19±3.31	49.18±3.91*,#	35.09±3.09	41.00±3.39

Note: *P < 0.05 compared with before intervention, #P < 0.05 compared with the control group.

Table 4. Recurrences during the follow up period

Clinical data	Observation group	Control group
1st month (n/%)	0/0	0/0
2nd month (n/%)	0/0	1/2%
3rd month (n/%)	0/0	4/8%
4th month (n/%)	1/2%	6/12%
5th month (n/%)	2/4%	6/12%
6th month (n/%)	4/8%	5/10%

Statistical analysis

SPSS19.0 software was used for data analysis. Count data are expressed as percentage (%) and were compared with Chi-square test. Measurement data are expressed as mean and standard deviation and were compared with t-test (paired t-test), for intra-group comparison, and independent t-test for inter-group comparison at same time points. P < 0.05 was considered statistically significant.

Results

Clinical characteristics of patients

As shown in **Table 1**, there were no statistical differences in clinical data between the two groups (P>0.05)

WOMAC score evaluation of the two groups before and after intervention

As shown in **Table 2**, there were no significant differences in WOMAC scores between the two groups before intervention (P=0.109). After intervention, WOMAC scores were reduced in both groups compared to before intervention. WOMAC scores of the observation group were significantly lower than the control group (P=0.019).

Gait parameters in the two groups before and after intervention

As shown in **Table 3**, there were no significant differences in gait parameters between the groups before intervention, including step length (P=0.288), step frequency (P=0.396), step width (P=0.519), step angle (P=0.331), total support phase (P=0.699), and swing (P=0.190). After intervention, step length, step frequency, total support phase, and swing were significantly improved in the observation group compared to before intervention (P=0.019, P=0.030, P=0.026, P=0.031, respectively). Moreover, step length, step frequency, total support phase, and swing phase were significantly better than the control group (P=0.016, P=0.021, P=0.040, P=0.033, respectively). In the control group, only total support phase was significantly improved compared to before intervention (P=0.031). After intervention, there were no significant differences between the two groups in step width and step angle (P=0.081, P=0.120).

Recurrence during the follow up period

Regarding the 6-month follow up period, the first recurrence occurred at the fourth month in the observation group. The first recurrence occurred at the second month in the control group (**Table 4**). A total of 7 recurrences occurred in the observation group, yielding a recurrence rate of 14%, significantly lower than that of the control group (P=0.001, **Table 5**).

Discussion

Knee osteoarthritis is the most common chronic bone and joint disease in middle-aged and elderly-aged population. Epidemiological investigation reveals that incidence of osteoarthritis

Table 5. Recurrence rate in both groups

Clinical data	Observation group	Control group
Recurrence (n)	7	22
Non-recurrence (n)	43	28
Recurrence rate (%)	14.0%*	44.0%

Note: *P < 0.05, compared with the control group.

increases year by year as the population ages. Therefore, prevention and treatment of knee osteoarthritis requires much attention.

More and more scholars are beginning to realize that knee osteoarthritis is a result of biomechanical and biological factors. Biomechanical factors play an important role in occurrence and development of knee osteoarthritis [7-9]. In addition, the guidelines for diagnosis and treatment of osteoarthritis in China recommend combination of non-drug and drug treatment for treatment of knee osteoarthritis [8]. Combination has been more effective in reducing joint pain and promoting recovery of joint function, compared to the single method. Main methods of non-drug treatment include self-education, aerobic exercise, muscle strength training around the knee joint, and activity training of the knee joint [8].

Exercise therapy has been widely used for treatment and rehabilitation of knee osteoarthritis. In addition, some exercise therapies have been identified as important means of preventing and curing knee osteoarthritis, including muscle strength training of quadriceps femoris. This present study used exercise therapy for knee osteoarthritis. After a 12-week intervention, it was found that exercise therapy intervention was superior to quadriceps femoris training, alone, regardless of WOMAC scores or gait parameters. Results showed that exercise therapy had a better effect on reliving pain and stiffness of knee osteoarthritis and reducing daily activity difficulties. Moreover, exercise therapy can more effectively improve gait movement parameters of patients with knee osteoarthritis and enhance the stability of walking activities. In addition, exercise therapy can also effectively reduce recurrence rates in patients with knee osteoarthritis. This study used WOMAC scale and gait parameters to analyze and evaluate efficacy. Compared with previous evaluation methods [7, 8], these methods can evaluate clinical symptoms, objectively, and accurately reflect changes of the disease based on biomechanics. Biomechanics have been used for diagnosis and treatment of many diseases, gradually extending to diagnosis and treatment of knee osteoarthritis.

Development of knee osteoarthritis is closely related to biomechanical factors [9, 10]. There are no blood vessels in articular cartilage with nutrition obtained from the synovial fluid in capsules through joint movement. Therefore, joint repair and regeneration has been greatly limited [2]. When knees are subjected to high pressure stress, biomechanics changes in the cartilage can further cause cartilage degeneration, leading to development of knee osteoarthritis [11, 12]. In patients with joint pain, joint swelling gradually appears, including changes in joint function and walking ability [13-15].

The joint capsule of the knee, surrounding muscles, and ligaments can absorb stress of the knee joint to avoid local high stress of the cartilage. Therefore, these structures play an important role in maintaining stability of the joint and ensuring normal activity of the knee joint. Some researchers have pointed out that it is beneficial to enhance stability of the knee joint and improve walking ability by employing functional exercise of the knee muscles and surrounding ligaments [16]. This present study used a 12-week exercise therapeutic intervention cycle. Training intensity enabled patients to feel fatigue, effectively changing muscle atrophy and joint instability and preventing knee cartilage degeneration. Previous studies have suggested more than 8 weeks of training with a slight sense of acid and fatigue. This could help improve muscle strength, restore knee proprioception, and improve stability of the knee joint [17, 18]. This exercise could also significantly improve walking function, relieve joint pain, and stiffness. This study used muscle training around the knee joint and joint activity training. This kind of training loosens the adhesive contracture around the knee, recovers muscle strength, and improves the ability of joint activity. A previous study reported that the stability of knee joint and stability of the gait could be improved, to a certain extent, through quadriceps femoris training [19, 20]. Jiang's study also confirmed that quadriceps

femoris training could significantly improve the daily walking ability of patients with knee osteoarthritis [16]. Moreover, Yin's study found that hamstring tendon training could effectively improve clinical symptoms of patients with knee osteoarthritis, enhance joint function, and stabilize gait [21]. Therefore, exercise therapy can train these important muscle groups, comprehensively and systematically, and increase the degree of joint activity, further improving clinical symptoms, reducing recurrence rates, and improving quality of life in patients with knee osteoarthritis.

There are some limitations to the present study, including group size and short-term follow up. These may have caused statistical bias. Therefore, further in-depth study is necessary, with expanded group size and long-term follow up, to identify and confirm subjective and objective evaluation indexes for efficacy evaluation regarding exercise therapy for knee osteoarthritis.

In conclusion, exercise therapy can effectively reduce clinical symptoms, improve joint function, and reduce recurrence rates in patients with knee osteoarthritis.

Disclosure of conflict of interest

None.

Address correspondence to: Yong Ma, Orthopedics and Traumatology of Traditional Chinese Medicine Faculty Working Office, Nanjing University of Chinese Medicine, No. 138 Xianlin Avenue, Qixia District, Nanjing 210023, Jiangsu Province, China. Tel: +86-025-86617141; E-mail: yongma2nd@163.com

References

[1] Hunter DJ, Felson DT. Osteoarthritis. BMJ British Medical Journal 2011; 25: 801-81.

[2] Bacardit J, Mobasheri A, Kluzek S, Edwards M, Spector T. Metabolic profiles associated with radiographic knee osteoarthritis in a population-based cohort of middle-aged women. Osteoarthritis & Cartilage 2016; 24: S70-S70.

[3] Liu Y, Zhang H, Liang N, Fan W, Li J. Prevalence and associated factors of knee osteoarthritis in a rural Chinese adult population: an epidemiological survey. BMC Public Health 2015; 16: 1-8.

[4] Sakellariou G, Conaghan PG, Zhang W, Bijlsma JWJ, Boyesen P. OP0118 development of the Eular recommendations for the use of imaging in the clinical management of osteoarthritis. Ann Rheum Dis 2016; 75: 100, 1-100.

[5] Damen J, Schiphof D, Wolde ST, Cats HA, Bierma-Zeinstra SM. Inter-observer reliability for radiographic assessment of early osteoarthritis features: the CHECK (cohort hip and cohort knee) study. Osteoarthritis Cartilage 2014; 22: 969-974.

[6] Lin HD, He CQ. Foreign research progress of movement therapy in the treatment of knee osteoarthritis. Chin Rep Reg Surg J 2008; 22: 1389-1392.

[7] Gibbs N, Diamond R, Sekyere EO, Thomas WD. Management of knee osteoarthritis by combined stromal vascular fraction cell therapy, platelet-rich plasma, and musculoskeletal exercises: a case series. J Pain Res 2015; 8: 799-806.

[8] Department of bone science of the Chinese Medical Association. Guidelines for diagnosis and treatment of osteoarthritis (2007 Edition). Chin Orthopedics 2007; 27: 793-796.

[9] Rooij MD, Lems WF, Leeden MVD, Dekker J. Comorbidity, obesity, and exercise therapy in patients with knee and hip osteoarthritis. Springer New York 2014.

[10] Oseph A. Buckwalter. Basic science of orthopedics. Beijing: People's Health Press 2001; 461.

[11] van Oudenaarde K, Jobke B, Oostveen AC, Marijnissen AC, Wolterbeek R, Wesseling J, Bierma-Zeinstra SM, Bloem HL, Reijnierse M, Kloppenburg M. Predictive value of MRI features for development of radiographic osteoarthritis in a cohort of participants with pre-radiographic knee osteoarthritis-the CHECK study. Rheumatology (Oxford) 2017; 56: 113-120.

[12] Sharma L, Nevitt M, Hochberg M, Guermazi A, Roemer FW. Clinical significance of worsening versus stable preradiographic MRI lesions in a cohort study of persons at higher risk for knee osteoarthritis. Ann Rheum Dis 2015; 75: 1630-1636.

[13] Gelber PE, Isart A, Erquicia JI, Pelfort X, Tey-Pons M, Monllau JC. Partial meniscus substitution with a polyurethane scaffold does not improve outcome after an open-wedge high tibial osteotomy. Knee Surgery Sports Traumatology Arthroscopy 2015; 23: 334-9.

[14] Maruyama H. Clinical kinematics (3rd Edition). Beijing: Chinese Medicine Publishing House 2002; 194.

[15] Phinyomark A, Osis ST, Hettinga BA. Gender differences in gait kinematics for patients with knee osteoarthritis. BMC Musculoskelet Disord 2016; 17: 1-12.

[16] Jiang SY, Zhu LX. The gait characteristics of knee osteoarthritis treated by tendon manipulation combined with functional training. Chin J Rehabil Med 2011; 26: 1056-1059.

[17] Knoop J, Steultjens MP, Roorda LD. Improvement in upper leg muscle strength underlies beneficial effects of exercise therapy in knee osteoarthritis: secondary analysis from a randomized controlled study. Physiotherapy 2015; 101: 171-177.
[18] Tian BW. Impact of Wuqinxi on feeling and body balance function in female patients with knee osteoarthritis. Beijing Sport University 2012.
[19] Evcik D, Sonel B. Effectiveness of a home-based exercise therapy and walking program on osteoarthritis of the knee. Rheumatol Int 2002; 22: 103-106.
[20] Bryk FF, Dos Reis AC, Fingerhut D, Araujo T, Schutzer M, Cury RP, Duarte A Jr, Fukuda TY. Exercises with partial vascular occlusion in patients with knee osteoarthritis: a randomized clinical trial. Knee Surg Sports Traumatol Arthrosc 2016; 24: 1580-1586.
[21] Yin L. A clinical study of knee joint motion therapy and tendon manipulation in the treatment of knee osteoarthritis. Shanghai University of Traditional Chinese Medicine 2010.