

Effect of acupuncture plus exercise on pain and motor function in patients with knee osteoarthritis

针刺结合运动对膝关节炎患者疼痛及运动功能的影响

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Abstract

Objective: To observe the effects of acupuncture combined with isokinetic eccentric exercise on pain and motor function in patients with knee osteoarthritis (KOA).

Methods: Sixty-four patients with KOA were randomly divided into an observation group and a control group, with 32 cases in each group. The observation group received acupuncture and isokinetic eccentric exercise, and the control group received isokinetic eccentric exercise and oral intake of meloxicam tablets. Both groups were treated for 4 weeks. Before and after treatment, the visual analog scale (VAS) score, the lysholm knee scale (LKS) score, and the quadriceps peak torque (PT) were evaluated.

Results: The total effective rate was 93.8% in the observation group, versus 81.3% in the control group. The difference between the two groups was statistically significant ($P < 0.05$). After treatment, the VAS scores of the two groups were lower than those before the treatment; both LKS score and quadriceps PT were higher than those before treatment, and the differences were statistically significant (all $P < 0.05$). The VAS score, LKS score and quadriceps PT (angular velocity was $60^\circ/\text{s}$) of the observation group were significantly different from those of the control group (all $P < 0.05$).

Conclusion: Acupuncture plus isokinetic eccentric exercise is effective in treating KOA. The combined treatment can reduce the pain of KOA patients, improve joint function, strengthen quadriceps, improve joint stability, and its curative effect is better than isokinetic eccentric exercise plus oral intake of meloxicam tablets.

Keywords: Acupuncture Therapy; Visual Analog Scale; Pain Measurement; Exercise Therapy; Osteoarthritis, Knee

【摘要】目的: 观察针刺结合等速离心运动对膝关节炎(KOA)患者疼痛及运动功能的影响。**方法:** 将64例KOA患者按随机数字表法分为观察组和对照组, 每组32例。观察组接受针刺及等速离心运动治疗, 对照组予等速离心运动及口服美洛昔康片治疗。两组疗程均为4周。治疗前后进行视觉模拟量表(VAS)评分、Lysholm膝关节功能量表(LKS)评分及股四头肌峰力矩(PT)测评。**结果:** 观察组的总有效率为93.8%, 高于对照组的81.3%, 组间差异有统计学意义($P < 0.05$); 治疗后, 两组VAS评分均较本组治疗前下降, LKS评分及股四头肌PT较本组治疗前升高, 组内差异均有统计学意义(均 $P < 0.05$); 观察组VAS评分、LKS评分及股四头肌PT(角速度为 $60^\circ/\text{s}$)与对照组差异均有统计学意义(均 $P < 0.05$)。**结论:** 针刺加等速离心运动治疗KOA疗效确切, 能减轻KOA患者疼痛程度, 改善关节功能, 增强股四头肌肌力, 提高关节稳定性, 其疗效优于等速离心运动加口服美洛昔康片。

【关键词】 针刺疗法; 视觉模拟量表; 疼痛测评; 运动疗法; 骨关节炎, 膝

【中图分类号】 R246.2 **【文献标志码】** A

Knee osteoarthritis (KOA) is a degenerative knee joint disease that commonly affects the middle-aged and elderly people^[1]. With the increasing aging of population, KOA will further increase the social and economic burden and become a worldwide medical problem. Common symptoms in patients with KOA

are pain, joint dysfunction, and decreased muscle strength^[2]. Therefore, reducing pain, improving joint function and strengthening muscles are the goals of treating KOA. Studies have shown that acupuncture has a good effect in relieving pain and improving joint function^[3-4]. Isokinetic eccentric exercise can strengthen quadriceps significantly^[5]. This study was to observe the effect of acupuncture plus isokinetic eccentric exercise on KOA in comparison with isotonic eccentric exercise plus oral intake of meloxicam tablets by measuring pain

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level, joint function and muscle strength. The result is given as follows.

1 Clinical Materials

1.1 Diagnostic criteria

The diagnostic criteria of KOA referred to the *Guide for the Diagnosis and Treatment of Osteoarthritis* (2018 Edition)^[6]: ① recurrent knee pain in the past 1 month; ② X-ray (standing position or weight position) showing narrowing of joint space, subchondral osteosclerosis and/or cystic changes, osteophyte formation at the edge of the joint; ③ age ≥ 50 years; ④ morning stiffness ≤ 30 min; ⑤ crepitus on active motions. KOA can be diagnosed by meeting ① and any two of ②, ③, ④ and ⑤ of the diagnostic criteria.

1.2 Inclusion criteria

Conforming to the above-mentioned KOA diagnostic criteria, Kellgren-Lawrence (K-L) grades I to III^[6]; age between 40 and 70 years old, gender unlimited; unilateral femoral osteoarthritis; informed consent.

1.3 Exclusion criteria

Patients with knee joint replacement surgery;

patients with sacral osteoarthritis; K-L grade 0 or IV; those who took non-steroidal anti-inflammatory drugs or sodium hyaluronate in the past 2 weeks; patients with severe systemic diseases or mental illness; speech or psychological disorders, failed to cooperate with the treatment.

1.4 Statistical methods

The data were processed using SPSS version 21.0 software. Measurement data were expressed as mean \pm standard deviation ($\bar{x} \pm s$) and compared by *t*-test. The enumeration data were analyzed by the Chi-square test while the ranked data were processed by rank-sum test. $P < 0.05$ indicated statistical significance.

1.5 General data

A total of 64 subjects were enrolled, they admitted to our hospital between May 2017 and May 2018. Patients were assigned to an observation group or a control group by the random number table, with 32 cases in each group. There were no statistical significant differences in gender, age and duration between the two groups (all $P > 0.05$), indicating that the two groups were comparable. See Table 1 for details.

Table 1. Comparison of general data between the two groups

Group	n	Gender (case)		Average age ($\bar{x} \pm s$, year)	Average duration ($\bar{x} \pm s$, year)	K-L grade		
		Male	Female			Grade I	Grade II	Grade III
Observation	32	14	18	57.3 \pm 11.6	4.4 \pm 1.6	7	16	9
Control	32	15	17	56.2 \pm 12.4	4.2 \pm 1.9	10	15	7

2 Treatment Methods

Patients in both groups received isokinetic centrifugation^[7]. Isocentric centrifugation training was performed using the ISOMED 2000 isokinetic test training system. Before training, the patient performed a warm-up exercise for 5 min on the power car. Then, under the guidance of the rehabilitation trainer, the flexor and extensor muscles were stretched, and then the isokinetic training was performed. The angular velocity during training was 60-180 $^{\circ}/s$, increased by 30 $^{\circ}/s$. At each angular velocity of the affected limb, the three groups (10 times in each group) were subjected to constant-speed centrifugal training of flexion and extension, and each group was rested for 20 s. After the training, 5 min of finishing activities was performed on the power car. Two sessions per week, and there was a 2-3 d rest between the two sessions.

2.1 Observation group

The observation group was treated with acupuncture based on isokinetic eccentric exercise.

Acupoints: Hedong (EX-LE 2), Dubi (ST 35), Neixiyan (EX-LE 4), Yinlingquan (SP 9) and Yanglingquan (GB 34).

Method: The patient took a supine position. After routine disinfection of the acupoints, acupuncture was performed with disposable sterile acupuncture needles of 0.25 mm in diameter and 40-75 mm in length. Hedong (EX-LE 2) was inserted for 13-20 mm perpendicularly. Dubi (ST 35) and Neixiyan (EX-LE 4) were inserted for 40-50 mm perpendicularly. Yanglingquan (GB 34) was punctured for 50-60 mm with point-toward-point manipulation [the needle tip towards Yinlingquan (SP 9)]. Lifting-thrusting and twirling-rotating manipulations were applied to every needle until qi arrival. The even reinforcing-reducing manipulation was used subsequently. The needle was retained for 30 min and performed once every 10 min for about 30 s during the retention. Treatment was done once a day, 5 times in a week, at a 2-day interval between two weeks.

2.2 Control group

The control group received meloxicam tablets based on isokinetic eccentric exercise, 7.5 mg each time, orally, once a day.

Both groups were treated for 4 weeks, and the efficacy was evaluated after treatment.

3 Therapeutic Efficacy Observation

3.1 Observation items

The following items were measured before and after treatment.

3.1.1 Visual analog scale (VAS)^[8]

VAS was used to evaluate the degree of pain in the knee joint. The higher the score, the severer the pain.

3.1.2 Lysholm knee scale (LKS)^[9]

The LKS was used to evaluate the functional status of the knee joint. The higher the score, the better the joint function.

3.1.3 Quadriceps peak torque (PT)

The ISOMED 2000 isokinetic strength test training system was used to test the isokinetic PT of the quadriceps. The angular velocity was 60 °/s and 180 °/s.

3.2 Criteria for clinical efficacy

The efficacy criteria of this study were formulated with reference to the *Guiding Principles for Clinical Study of New Chinese Medicine*^[10].

Clinical control: Pain disappeared; joint activity was normal; X-ray examination showed normal.

Marked effect: Pain disappeared; joint activity was not limited; X-ray examination showed significant improvement.

Effective: Pain was basically eliminated; joint activity is slightly limited; X-ray examination showed improvement.

Invalid: There was no significant improvement in

symptoms such as pain and joint activity limitation; no change in X-ray examination.

3.3 Results

There were no drop-outs in the two groups during the treatment.

3.3.1 Comparison of clinical effects

The total effective rate of the observation group was 93.8%, versus 81.3% in the control group. The difference between the two groups was statistically significant ($P<0.05$), suggesting that the observation group had a better curative effect than the control group. Please see Table 2 for details.

3.3.2 Comparisons of VAS and LKS scores

There were no significant differences in VAS and LKS scores between the two groups before treatment (both $P>0.05$). After treatment, the VAS scores of the two groups were lower than those before the treatment, and the intra-group differences were statistically significant (both $P<0.05$); the LKS scores were higher than those before the treatment. The intra-group differences were statistically significant (both $P<0.05$). After treatment, the VAS and LKS scores of the observation group were significantly different from those of the control group (both $P<0.05$). These results suggested that both treatments reduced pain and joint dysfunction in KOA patients, and the observation group was better than the control group. Please see Table 3 for details.

Table 2. Comparison of clinical effect (case)

Group	<i>n</i>	Clinical control	Marked effect	Effective	Invalid	Total effective rate (%)
Observation	32	9	17	4	2	93.8 ¹⁾
Control	32	5	13	8	6	81.3

Note: Compared with the control group, 1) $P<0.05$

Table 3. Comparisons of VAS and LKS scores ($\bar{x} \pm s$, point)

Group	<i>n</i>	VAS		LKS	
		Before treatment	After treatment	Before treatment	After treatment
Observation	32	6.4±1.3	2.2±1.1 ¹⁾²⁾	56.8±13.9	75.4±13.5 ¹⁾²⁾
Control	32	6.2±1.7	3.6±1.4 ¹⁾	57.2±12.6	66.8±14.1 ¹⁾

Note: Intra-group comparison, 1) $P<0.05$; inter-group comparison, 2) $P<0.05$

3.3.3 Comparison of PT of the quadriceps

Before treatment, there was no significant difference in the PT of the quadriceps between the two groups ($P>0.05$). After treatment, the PT of the quadriceps of the two groups were significantly higher than those before the treatment (both $P<0.05$). After treatment,

when the angular velocity was 60 °/s, the PT of the quadriceps of the observation group was higher than that of the control group, and the difference between the two groups was statistically significant ($P<0.05$). Please see Table 4 for details.

Table 4. Comparison of PT of quadriceps ($\bar{x} \pm s$, Nm)

Group	n	60 °/s		180 °/s	
		Before treatment	After treatment	Before treatment	After treatment
Observation	32	61.3±11.7	72.6±13.2 ¹⁾²⁾	45.7±11.3	51.3±10.4 ¹⁾
Control	32	59.8±13.4	65.9±11.9 ¹⁾	46.6±9.4	48.9±10.2 ¹⁾

Note: Intra-group comparison, 1) $P < 0.05$; inter-group comparison, 2) $P < 0.05$

4 Discussion

KOA is an aseptic inflammatory reaction caused by knee joint degeneration, leading to changes in joint stress, abnormal biochemical environment in the joint cavity, and osteophyte formation, which in turn aggravate the stimulation of the knee joint^[11]. As the aging population increases, the incidence of KOA is increasing as well. Based on the clinical symptoms, KOA can be classified into Bi-impediment syndrome and knee Bi-impediment in traditional Chinese medicine (TCM). The basic pathogenesis of KOA is liver and kidney deficiency, deficiency of qi and blood, malnourished bones and muscles, plus contraction of external evils, resulting in qi stagnation and blood stasis, as well as meridian blockage. Acupuncture is a natural treatment for painful diseases. It can exert therapeutic effects by dredging meridians, harmonizing qi and blood, eliminating impediment to relieve pain. Studies have shown that acupuncture can treat KOA by promoting local blood circulation, improving the internal environment of the joint, regulating the expression of inflammatory substances, improving joint function, repairing articular cartilage, and regulating KOA-related gene expression^[12-13]. This study chose ‘five needles of knee’ as the acupuncture prescription. ‘Five needles of knee’ is effective in treating KOA. It can alleviate pain and improve joint function. It is a common acupuncture prescription in the treatment of knee diseases^[14-15]. Hedging (EX-LE 2) can smooth joint, dispel dampness, unblock meridians and relieve pain. It is an experienced point for treating knee pain, leg pain, and severe arthritis. Dubi (ST 35) and Neixiyan (EX-LE 4) are located around the knee joint and stimulating them can unblock meridians, dispel wind and dissipate cold, relieving swelling and pain. When stimulating these two points, the needle tip would penetrate the articular cavity, and let qi reach the affected area. Needling Yanglingquan (GB 34) toward Yinlingquan (SP 9) can simultaneously produce the curative effect of both acupoints. It can dispel dampness and swelling, promote blood circulation and collaterals, and relieve pain. The combination of the points can be used to dispel cold, dehumidify the collaterals, smooth the joints, and promote blood circulation and relieve pain.

Muscle strength stabilizes the joint structure and prevents joint instability and the biochemical changes of cartilage. Therefore, the muscle strength around the

knee joint plays an important role in the occurrence and development of KOA. When the quadriceps contract, the combined forces of the muscles around the knee joint are the dynamic factors for maintaining the normal alignment of the patellofemoral joint and the stability of the tibia during normal exercise, thereby maintaining the stability of the knee joint and exerting its normal function^[16]. If the quadriceps strength decreases, the protective effect of the quadriceps on the joints will be weakened, and the joint cushioning capacity will also reduce. In the long-term, the stress surface of the tibia and fibula joints will change, the cartilage wear will accelerate, and KOA will develop^[17]. Therefore, strengthening the muscle strength around the knee joint, especially strengthening the quadriceps strength, is an effective measure to prevent or delay the development of KOA. Studies have shown that there is a correlation between the isometric moment of extensor muscle strength and knee joint pain and joint function in KOA patients^[18], indicating that the constant velocity assessment has significance for the analysis of muscle strength and the formulation of rehabilitation training programs. Isokinetic training is an individualized muscle strength training method that enhances type II muscle fibers, thereby increasing muscle strength in the quadriceps, stabilizing the joint structure, reducing muscle atrophy, and reducing joint damage^[19]. Compared with isometric and isotonic training, isokinetic training can perform full-range and multi-angle muscle training with obvious effects, and the whole process of computer control can provide compliance resistance, high safety and adaptability and less likely to cause secondary damage. So, it is widely used in the treatment of KOA^[20].

In this study, after 4-week treatment in KOA patients, the VAS scores of the two groups were lower, the LKS scores and the quadriceps PT were higher, and the observation group showed more significant improvements than that of the control group. This result suggested that both treatments can lower the pain level of KOA, improve joint function, strengthen quadriceps and improve joint stability; the effect of constant velocity eccentric exercise plus acupuncture should be better than constant velocity eccentric exercise plus oral intake of meloxicam tablets. The reason may be that acupuncture unblocks the meridians, promotes blood circulation, relaxes muscles, and reduces inflammation; the constant velocity

centrifugal exercise enhances muscle strength, stabilizes joint structure, and prevents joint damage. The combination of the two exerts a synergistic therapeutic effect, reflecting the advantages of combining traditional Chinese and Western medicine in treatment of KOA.

Conflict of Interest

The author declared that there was no potential conflict of interest in this article.

Statement of Informed Consent

Informed consent was obtained from the recruited patients in this study.

Received: 8 January 2019/Accepted: 28 February 2019

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