

Original Article

Effect of acupuncture combined with early rehabilitation training on postoperative dysfunction and quality of life of patients undergoing total knee arthroplasty

Runzhi Li^{1*}, Zhendi Xu^{2*}, Yuankuan Li², Jihong Luo³

¹Medical Examination Center, Dianjiang Hospital of Traditional Chinese Medicine, Chongqing 408300, China;

²Clinical Laboratory, Dianjiang Hospital of Traditional Chinese Medicine, Chongqing 408300, China; ³Department of Orthopedics and Traumatology, Dianjiang Hospital of Traditional Chinese Medicine, Chongqing 408300, China.

*Equal contributors and co-first authors.

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Abstract: Objective: This research was designed to determine the effect of acupuncture combined with early rehabilitation training on dysfunction and quality of life of patients after total knee arthroplasty (TKA). Methods: Eighty-nine TKA patients admitted to our hospital from January 2018 to January 2020 were recruited as the research objects. Among them, 44 patients in the control group (CG) were given early rehabilitation training, and 45 in the research group (RG) were given acupuncture treatment additionally. Clinical efficacy, knee-joint visual analogue scale (VAS) score, American Knee Joint Society (AKSS) score, hemorheological indexes, modified Barthel index (BI) scale and SF-36 health survey of both groups were compared. Results: The effective rate of treatment in the RG was dramatically higher than that in the CG. After treatment, the whole blood high, middle and low-shear viscosities, plasma viscosity and erythrocyte aggregation exponent of patients decreased, while these indexes in the RG were remarkably lower than those in the CG. In addition, after treatment, VAS score and knee circumference in the RG were markedly lower than those in the CG, and AKSS score and knee range of motion (ROM) were markedly better. Follow-up showed that BI and SF-36 health survey scale scores of patients increased after treatment, especially in the RG. Conclusion: Acupuncture combined with early rehabilitation training can relieve the pain of patients after TKA, promote the rehabilitation of knee joint function and improve their quality of life.

Keywords: Artificial knee replacement, acupuncture and moxibustion, early rehabilitation training, quality of life

Introduction

Knee osteoarthritis is one of the common disabling diseases of human beings, which involves the whole joint tissue. Its incidence and progression are affected by many factors, and it is an important public health problem [1]. The clinical symptoms are mainly stiffness, pain, muscle weakness and limited range of motion (ROM). Severe knee pain will make patients disabled, resulting in the loss of their activities of daily living (ADL) and seriously affecting the quality of life [2]. Due to the increase of related factors such as population aging and obesity, the prevalence rate of knee osteoarthritis is increasing year by year [3]. Total knee arthroplasty (TKA) is the main operation clinically, and the excellent and good rate

after operation is excellent [4]. However, for patients undergoing TKA, reasonable rehabilitation and exercise after operation have a beneficial effect on the recovery of normal function and rehabilitation of knee joint after operation [5].

There are multiple programs for early recovery of patients undergoing TKA, such as preoperative muscle strength training, postoperative straight leg raising exercise, ankle flexion and extension exercise, etc. [6]. They can accelerate the blood circulation, eliminate swelling and improve muscle tension, but the improvement of some patients is still not ideal [7]. Acupuncture is one of the vital parts in complementary and alternative medicine. Many fracture patients are treated with traditional medi-

cines comprising acupuncture [8]. Research found that acupuncture could dredge meridians, adjust qi and blood, reduce swelling and eliminate blood stasis, and promote fracture healing [9]. Through retrospective research, Barad *et al.* discovered that traditional Chinese medicine acupuncture could effectively enhance the physical function of elderly patients after acute disease, and their intestinal function, defecation function and appetite were obviously improved [10]. Another research demonstrated that acupuncture was an effective auxiliary means for postoperative pain management in adults [11]. Therefore, acupuncture may promote the recovery of patients after operation. But there is little research on the effect of acupuncture combined with early rehabilitation training on patients undergoing TKA.

In this research, we intervened TKA patients by acupuncture combined with early rehabilitation training and observed its effect on their early functional rehabilitation.

Materials and methods

General data

Eighty-nine TKA patients admitted into Dianjiang Hospital of Traditional Chinese Medicine from January 2018 to January 2020 were recruited as the research objects. Inclusion criteria: patients met the diagnostic criteria of knee osteoarthritis [12]; all patients were treated with TKA, and the same group of doctors completed the operation under combined spinal-epidural anesthesia (CSEA); patients had clear consciousness and good comprehension; patients had complete clinical baseline data. Exclusion criteria were as follows: those with severe osteoporosis, nervous system diseases, malignancies, vital organ dysfunction, spinal diseases, hematopoietic system diseases, mental diseases, infection post-operation, lower limb fractures or hip and ankle deformity; people who were allergic to the treatment methods used. This research was approved by the ethics committee of our hospital. All subjects were informed in advance and an informed consent form was signed.

Grouping and treatment methods

All patients were given routine treatment such as analgesia, fluid infusion and anti-infection.

On the day after operation, 44 patients in the control group (CG) used elastic bandage to fix the knee joint to the straight position, showing a foot-high hip-low position. From the 1st day to the 7th day after operation, quadriceps and hamstrings were exercised towards long contraction ankle pump, appropriate leg lifting, ankle dorsiflexion, sitting position auxiliary knee flexion and heel slip knee flexion, etc. Seven days after operation, the patients were instructed to walk with walking aids, bear weight, balance, muscle strength and gait training. Fourteen days after operation, they began to do anti-gravity flexion and extension, squat and stair climbing training. In the process of training, the time of active and passive exercise was adjusted according to patients' tolerance. The RG (n=45) was treated with acupuncture on the basis of the treatment of the CG, and acupuncture was performed at Yanglingquan, Yinlingquan, Liang Qiu, Xuehai, Knee Eye and Zusanli points. Completed by the same acupuncturist, it was strictly in line with aseptic operation criteria during operation. The acupuncture site was fully exposed, and skin was disinfected routinely with 75% ethanol cotton balls taken by sterile tweezers. The sterilized disposable acupuncture needle and SDZ-II Huatuo electro-acupuncture instrument (Hefei Youweikang Trading Co., Ltd., China) were inserted into the needle for about 30 mm, and the output pulse waveform was dense wave, which was adjusted in the light of patients' tolerance. The current intensity was 2-5 mA and the frequency was 2 Hz/100 Hz, with each treatment lasting for 30 min. They were treated 3 days after operation, continuously for 7 days.

Outcome measures

Main outcome measures: 1. The efficacy of patients was evaluated: Markedly effective: the pain and swelling of lower limbs disappeared or obviously reduced, and they could walk down properly; Effective: the pain and swelling of lower limbs reduced, and they could walk with the help of others; Ineffective: the pain and swelling of lower limbs were not alleviated or even aggravated, and they could not walk; (markedly effective + effective) cases/total cases $\times 100\%$ = total effective rate. Patients were followed up for 3 months through outpatient re-examination, WeChat, telephones, etc. Patients' activities of daily living (ADL) were assessed via modified Barthel Index Scale [13],

Table 1. General data of patients in RG and CG [n (%)]/(mean \pm SEM)

Clinical data	Control group (n=44)	Research group (n=45)	χ^2/t	P
Gender			0.271	0.602
Male	27 (61.36)	30 (66.67)		
Female	17 (38.64)	15 (33.33)		
Age (years)	63.47 \pm 8.57	62.73 \pm 8.51	0.409	0.684
Weight (kg)	76.15 \pm 8.63	77.52 \pm 8.79	0.742	0.460
Education level			0.096	0.926
Primary school	8 (18.18)	6 (13.33)		
Junior high school	9 (20.45)	11 (24.44)		
High school	11 (25.00)	14 (31.11)		
University and above	16 (36.36)	14 (31.11)		
Involved joints			0.114	0.736
Left	18 (40.91)	20 (44.44)		
Right	26 (59.09)	25 (55.56)		
Course of disease (years)	4.91 \pm 0.71	4.99 \pm 0.85	0.481	0.632
Anesthesia time (min)	138.18 \pm 10.33	140.25 \pm 8.69	1.024	0.309
Operation time (min)	126.85 \pm 16.53	129.47 \pm 17.25	0.731	0.467
History of smoking			0.044	0.969
Yes	16 (36.36)	13 (28.89)		
No	28 (63.64)	32 (71.11)		
History of drinking			0.109	0.924
Yes	25 (56.82)	26 (57.78)		
No	19 (43.18)	19 (42.22)		

including bathing, eating and dressing. The higher the score, the better the patients' ADL is. Meanwhile, the quality of life of patients was analyzed via SF-36 health survey. It [14] consists of 8 items: role-physical (RP), general health (GH), physiological function (PF), bodily pain (BP), mental health (MH), social function (SF), role emotional (RE) and vitality (VT); the total score of each item is 100 points; the higher the score of patients, the better the quality of life is.

Secondary outcome measures: 1. The knee-joint visual analogue scale (VAS) score [15] and American Knee Joint Society (AKSS) score of patients before and after treatment were evaluated [16]. Thereinto, VAS scores were based on a walking scale of 0-10 cm, with 0 point for painless at both ends, 10 for severe pain, and different degrees of pain in between. The patients marked their pain positions on a straight line. The AKSS score includes 25 points for stability, 25 for ROM and 50 for function. The scores obtained by patients are directly

proportional to joint function. 2. Before and after treatment, 2 mL fasting elbow venous blood was collected in the morning, and the hemorheological indexes such as the whole blood high, middle and low-shear viscosities, plasma viscosity and erythrocyte aggregation exponent were assessed through automatic hemorheological analyzer LB-2A (Shanghai Huanxi Medical Equipment Co., Ltd., China).

Statistical methods

SPSS 22.0 (IBM Corporation, Armonk, NY, U.S.) was applied to data analysis. There were statistical differences when $P < 0.05$. The counting data were represented by [n (%)], and the inter-group comparison was analyzed through Chi-square test. The measurement data were expressed by

mean \pm SEM; the inter-group comparison was assessed via t test, and the intra-group comparison was analyzed via paired samples t test before and after intervention.

Results

General data of RG and CG

We collected the clinical data of two groups of patients. There was no marked difference between the RG and the CG in terms of gender, age, weight, education level, involved joints, course of disease, time of anesthesia and operation, and history of smoking and drinking (Table 1).

Hemorheological changes before and after treatment in both groups

The changes of hemorheological indexes were observed before and after treatment. Before treatment, there was no marked difference in the whole blood high, middle and low-shear vis-

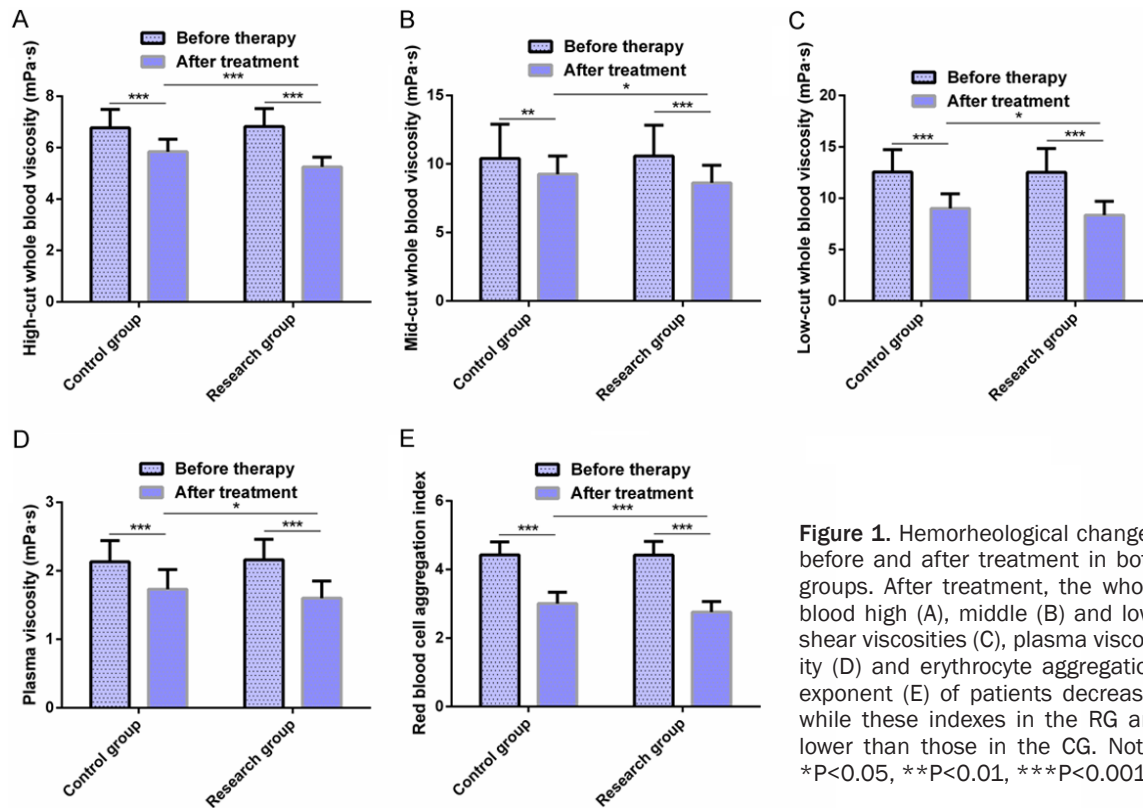


Figure 1. Hemorheological changes before and after treatment in both groups. After treatment, the whole blood high (A), middle (B) and low-shear viscosities (C), plasma viscosity (D) and erythrocyte aggregation exponent (E) of patients decrease, while these indexes in the RG are lower than those in the CG. Note: *P<0.05, **P<0.01, ***P<0.001.

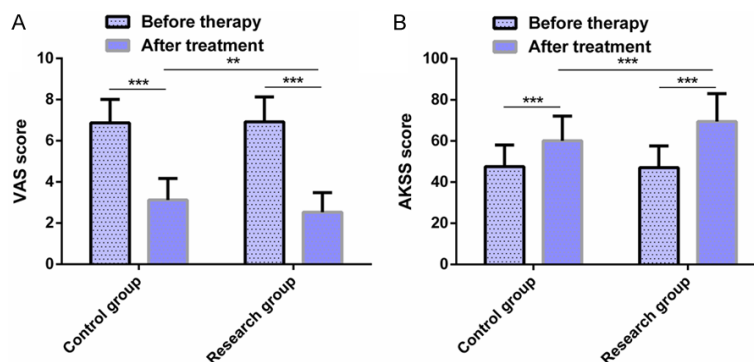


Figure 2. Comparison of VAS and AKSS scores between the two groups before and after treatment. After treatment, the VAS scores (A) of both groups decrease, while the AKSS scores (B) increase. After treatment, the VAS score of patients in the RG is lower than that in the CG, and the AKSS score increases. Note: **P<0.01, ***P<0.001.

cosities, plasma viscosity and erythrocyte aggregation exponent. After treatment, these indexes of both groups decreased markedly. The indexes in the RG were lower than those in the CG (Figure 1).

VAS and AKSS scores of both groups before and after treatment

We evaluated the VAS and AKSS scores before and after treatment. There was no difference in

those scores before treatment. After treatment, the VAS scores decreased, while the AKSS scores increased. In addition, the VAS scores of patients in the RG were lower than those in the CG, and the AKSS scores increased. This meant that this treatment could obviously relieve the pain of patients and restore the function of knee joint (Figure 2).

Changes of knee joint circumference and ROM before and after treatment in both groups

The knee joint circumference and ROM were evaluated before and after treatment. There was no obvious difference between the two groups before treatment. After treatment, the former decreased, while the latter increased. In addition, the circumference of knee joint in the RG was lower than that in the CG, and the ROM was higher. This indicated that the condition of patients' posterior knee joint has been remarkably improved (Figure 3).

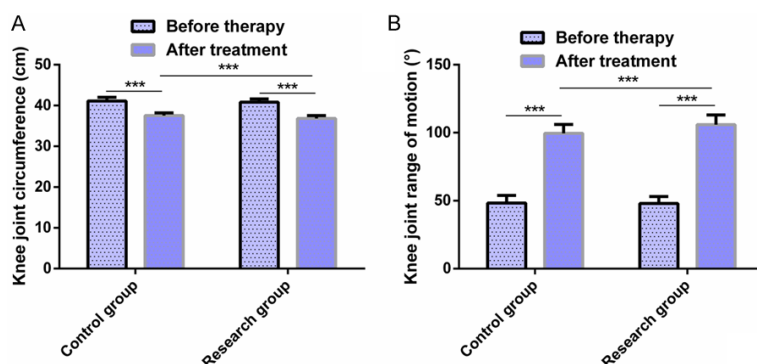


Figure 3. Changes of knee joint circumference and ROM before and after treatment. After treatment, the knee joint circumference (A) in the RG is lower than that in the CG, and ROM (B) is higher. Note: ***P<0.001.

Table 2. Comparison of effective rates of treatment between the two groups [n (%)]

Efficacy	Control group (n=44)	Research group (n=45)	χ^2	P
Markedly effective	20 (45.45)	30 (66.67)	-	-
Effective	18 (40.91)	14 (31.11)	-	-
Ineffective	6 (13.64)	1 (2.22)	-	-
Effective rates of treatment	86.36	97.78	4.000	0.046

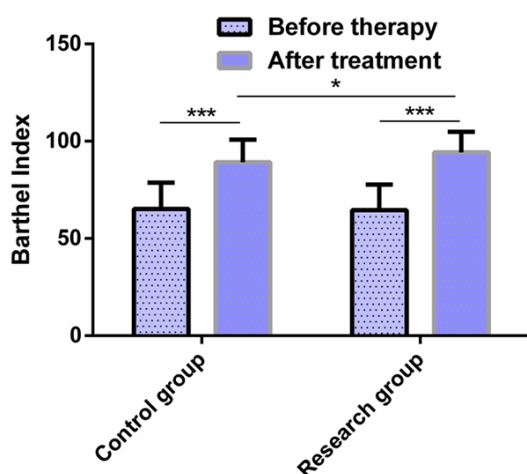


Figure 4. Comparison of BI between the two groups of patients. After treatment, the BI of patients increases, especially in the RG. Note: *P<0.05, ***P<0.001.

Effective rates of treatment in both groups

The efficacy of two groups of patients after treatment was observed. In the CG, 20 cases were markedly effective, 18 were effective, and the effective rate was 86.36%. In the RG, 30 cases were markedly effective, 14 were effective,

and the effective rate was 97.78%. The effective rate of treatment in the RG was higher than that in the CG (Table 2).

BI of the two groups of patients

We compared the BI between the two groups before and after treatment. There was no obvious difference before treatment. After treatment, the BI increased, especially in the RG (Figure 4).

Quality of life of both groups before and after treatment

We compared the SF-36 health survey of patients' quality of life between the CG and the RG. There was no marked difference in RP, GH, PF, BP, MH, SF, RE and VT scores before treatment. After

treatment, the scores of patients increased, while the scores of quality of life in the RG were better than those in the CG (Figure 5).

Discussion

TKA can correct the joint shape and improve the knee function of patients with knee osteoarthritis [17]. However, surgical operation brings trauma and bleeding to patients, causing deep vein thrombosis and other complications easily, which is not conducive to recovery [18]. Thus, it is vital to implement functional rehabilitation intervention for patients after operation.

At the moment, there are specific programs for exercise after TKA [19]. For example, rehabilitation programs such as muscle strength training, ankle flexion and extension exercise, and leg lifting exercise have been widely used in clinical practice [20]. Rehabilitation plan is a simple solution, which can alleviate the limitation of patients' limb function and promote physical exercise, and is thereby considered to be beneficial, but the effect is still not obvious [21]. For example, Piva *et al.*, through random experiments, found that comprehensive behav-

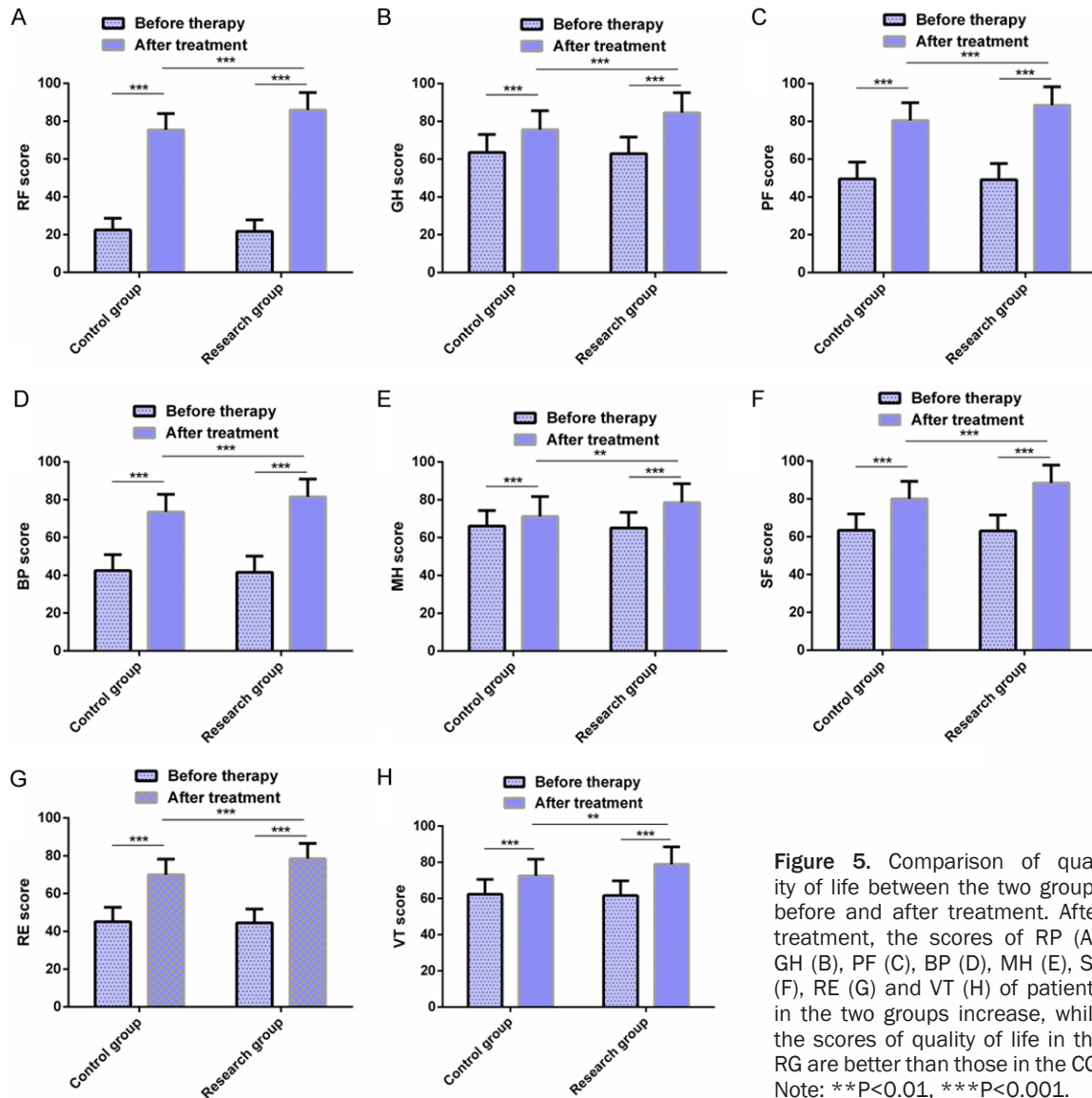


Figure 5. Comparison of quality of life between the two groups before and after treatment. After treatment, the scores of RP (A), GH (B), PF (C), BP (D), MH (E), SF (F), RE (G) and VT (H) of patients in the two groups increase, while the scores of quality of life in the RG are better than those in the CG. Note: **P<0.01, ***P<0.001.

ior and exercise intervention were beneficial to physical function after TKA in the short term, but had no long-term benefit [22]. Based on this, we intervened TKA patients by acupuncture combined with early rehabilitation training. Acupuncture and moxibustion of traditional Chinese medicine has been widely recognized in clinical treatment. For example, *Liu et al.* reported that percutaneous electro-acupuncture stimulation could relieve the pain of patients after tumor resection and reduce the use of narcotic drugs, with no obvious side effects [23]. Another research confirmed that acupuncture could improve the clinical symptoms and hemorheology of diabetic nephropathy patients, and delay disease progression to

a certain extent [24]. TKA has great trauma, which can cause vascular injury, normal blood coagulation in deep veins, etc., and may cause blood reflux obstruction in lower limbs, with the risk of thrombosis [25]. In our research, it was found that acupuncture combined with early rehabilitation training could improve the blood flow of patients, which might be helpful in preventing deep venous thrombosis of lower limbs. Further research manifested that after treatment, the VAS scores of the patients decreased, while the AKSS score and BI increased, and the knee joint circumference and ROM were improved, showing a good clinical effect. Similarly, *Zhang et al.* found that after acupuncture treatment for patients with osteoporotic

vertebral compression fractures, the VAS scores and BI were obviously improved, and they hardly felt pain [26]. This revealed that acupuncture combined with early rehabilitation training could obviously relieve the pain of patients and restore the function of knee joint. It may be the implementation of acupuncture, which can relax muscles and activate collaterals, promote the operation of blood gas, activate blood circulation, relieve spasm and pain [27], maximize the poor operation of blood gas around the knee joint, and accelerate the rehabilitation of patients. Our research also found that after treatment, the scores of SF-36 project dimension increased, which indicated that this treatment could improve the quality of life of patients. Similarly, Schiller *et al.* explained that acupuncture had a lasting effect on osteoporosis patients, and the quality of life of those who could reduce pain related to activities has been continuously and dramatically improved for 3 months [28]. It may be that after acupuncture, the pain of patients can be relieved to the greatest extent, and the function of knee joint can recover quickly. So, it has little influence on their daily quality of life.

Our research proves that acupuncture combined with early rehabilitation training is beneficial to the rehabilitation of patients after TKA, but it still has limitations. For one thing, we did not follow up with the patients for a long time, but investigated the ADL of patients after 1 year. For another, the mechanism of acupuncture in TKA patients is still vague. In addition, the energy, supporting and swing torques of knee joint after treatment were not observed. These need to be further studied in the future.

This research reveals that acupuncture combined with early rehabilitation training can relieve the pain of patients after TKA, promote the rehabilitation of knee joint function and improve their quality of life.

Disclosure of conflict of interest

None.

Address correspondence to: Jihong Luo, Department of Orthopedics and Traumatology, Dianjiang Hospital of Traditional Chinese Medicine, 502 Gongnong Road, Guixi Town, Dianjiang County, Chongqing 408300, China. Tel: +86-13896692187; E-mail: Luojihong123456@163.com

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