



# Effect of exercise therapy on lower extremity deep venous thrombosis after total knee arthroplasty

Zhong-Wu Huang<sup>✉</sup>

Department of Rehabilitation, Shanghai Construction Group Hospital, 200083, China

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## ABSTRACT

**Objective:** To explore the effect of exercise therapy in preventing the lower extremity deep venous thrombosis (DVT) after total knee arthroplasty (TKA). **Methods:** A total of 153 patients with osteoarthritis who were admitted in our hospital for TKA were included in the study and randomized into the observation group and the control group. The patients in the observation group were given continuous passive motion (CPM) in combined with exercise therapy, while the patients in the control group were only given CPM. After 2-week treatment, the related coagulation indicators and femoral venous blood flow in the two groups were detected and compared. The occurrence rate of DVT in the two groups was calculated. **Results:** PT and APTT from 2 weeks to 2 months after operation in the two groups were shortened first and extended later when compared with before operation, while FIB and D-D contents were elevated first and reduced later, and the coagulation indicator levels 2 months after treatment in the two groups were significantly different from those before operation. The femoral venous blood flow peak and average velocity 1 week after operation in the two groups were significantly elevated when compared with before operation. The femoral venous blood flow peak and average velocity 1 week after operation in the observation group were significantly higher than those in the control group. The occurrence rate of DVT in the observation group was significantly lower than that in the control group. **Conclusions:** CPM in combined with exercise therapy for patients after TKA can effectively prevent the formation of DVT, with a significant effect.

## 1. Introduction

The knee joint is a main weight-bearing joint of the lower extremity, whose serious lesions can severely affect the patients' daily life[1]. Total knee arthroplasty (TKA) is mainly through placing the artificial joint to alter the joint structure and the axial alignment of the lower extremity to alleviate the joint pain and improve the living qualities[2]. Lower extremity deep venous thrombosis (DVT) is a common complication of TKA; moreover, the secondary pulmonary embolism caused by DVT is a main reason for causing early sudden death in patients after TKA[3]; therefore, how to prevent the occurrence of DVT after TKA is of great significance

for the patients' prognosis. Some researches demonstrate that[4] rehabilitation treatment after TKA, especially the exercise therapy is crucial for the recovery of knee joint function, and can also prevent DVT to a certain degree. The study is aimed to explore the effect of exercise therapy in preventing DVT after TKA.

## 2. Materials and methods

### 2.1. Clinical materials

A total of 153 patients with osteoarthritis who were admitted in our hospital from March, 2012 to June, 2015 for TKA were included in the study, among which 75 were male, and 78 were female; aged from 51 to 79 years old, with an average age of (67.5±8.8) years old; 53 had rheumatoid arthritis, 75 had osteoarthritis, and 25 had traumatic arthritis. The included patients were in accordance with the related diagnostic criteria of osteoarthritis in the Diagnosis and Treatment Guideline of Osteoarthritis[5]. The surgical treatment

<sup>✉</sup>Corresponding author: Zhong-Wu Huang, Department of Rehabilitation, Shanghai Construction Group Hospital, 200083, China.

Tel: 13386079367.

E-mail: huangzw13386079367@yeah.net

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conditions of TKA were in the following: (1) the knee joint bending deformity was exceeding than 30 °; (2) the introversion was exceeding than 20 °. Those who were merged with severe heart, liver, and renal failure, pulmonary dysfunction, aplastic anemia, leukemia, and mental disorders were excluded from the study.

2.2. Methods

The patients were randomized into the observation group (n=77) and the control group (n=76). The comparison of gender, age, and arthritis types between the two groups was not statistically significant (P>0.05), and it was comparable. The patients in the two groups were performed with CPM the second day after operation, 15-30 ° from the beginning, slowly, 20 min/time, 2 times/d, 5-10 ° increased every 1-2 d, continuously for 2 weeks. On this basis, the patients in the observation group were given additional exercise therapy, including strength training and ROM training. Strength training: Quadriceps femoris isometric exercise was performed 1d after operation on the bed. A round pillow was placed under the knee for the knee joint extending in an angle of 10 °, 2 groups every day, 10 times every group, continuously for 10 s every time. The ankle joint extension and flexion were performed for the preparation of out-of-bed activity. Straight leg high elevation training was performed 2 d after operation, 2 groups every day, 10 times every group, continuously for 10 s every time. When the quadriceps femoris force reached above level 3, the patients could get out of bed for walking and partial weight-bearing standing exercise. ROM training: A pillow was placed under the affected leg to let the knee joint being suspended. The knee joint extending training was completed depending on weight and sandbag or under the help of physicians. Moreover, the affected thigh was held with two hands. The knee joint bending ROM was gradually increased through the self-weight of the leg. The knee joint was bent until a pain felt on the patella. Or the patient was sitting beside the bed to let the knee joint naturally bend. The knee joint bending ROM was gradually increased through the uninjured lower extremity or under the help of physicians, 1 time/d, lasting for 5 min every time, and continuously for 2 weeks.

2.3. Observation indicators

A volume of 5 mL morning fasting venous blood before operation, 2 weeks and 2 months after operation in the two groups was collected. PT, APTT, FIB, and D-D were detected. The color Doppler ultrasound was performed for the bilateral lower extremities. The femoral venous blood flow peak and average velocity after operation and 1 week after operation in the two groups were detected. The occurrence rate of DVT in the two groups was calculated.

2.4. Statistical analysis

SPSS 18.0 software was used for the statistical analysis. The measurement data were expressed as mean ± SD. The paired t test was used for the intra-group comparison, while the independent t test was used for the comparison between the two groups. The enumeration data were expressed as percentage and chi-square test was used. P<0.05 was regarded as statistically significant difference.

3. Results

3.1. Comparison of coagulation indicators before and after operation between two groups

The difference of PT, APTT, FIB, and D-D levels before operation between the two groups was not statistically significant (P>0.05). PT and APTT 10 d after operation in the two groups were significantly reduced, while FIB and D-D were significantly elevated when compared with before operation (P<0.05). PT and APTT 2 months after operation were significantly elevated, while FIB and D-D were significantly reduced when compared with 10 d after operation (P<0.05). PT and APTT 2 months after operation in the observation group were significantly higher than those in the control group, while FIB and D-D were significantly lower than those in the control group (P<0.05) (Table 1).

3.2. Comparison of femoral venous blood flow peak and average velocity between two groups

The difference of the femoral venous blood flow peak and average velocity before operation between the two groups was not statistically significant (P>0.05). The femoral venous blood flow peak and average velocity 1 week after operation in the two groups were significantly elevated when compared with before operation (P<0.05). The femoral venous blood flow peak and average velocity 1 week after operation in the observation group were significantly higher than those in the control group (P<0.05) (Table 2).

3.3. Comparison of occurrence rate of DVT between two groups

The occurrence rate of DVT in the observation group (4, 5.2%) was significantly lower than that in the control group (18, 23.7%) (P<0.05).

4. Discussion

TKA is one of the most common joint replacements carried out in the orthopedic surgery after hip replacement[7]. Due to long-term immobilization and lack of appropriate joint movement, DVT is

Table 1 Comparison of coagulation indicators before and after operation between two groups.

Groups	n	Time	PT (s)	APTT (s)	FIB (mg/dL)	D-D (µg/L)
Observation group	77	Before operation	13.0±2.6	31.8±10.9	311.5±152.8	367.4±153.5
		2 weeks after operation	10.2±2.3 <sup>*</sup>	23.5±11.8 <sup>*</sup>	426.9±149.5 <sup>*</sup>	949.3±246.4 <sup>*</sup>
		2 months after operation	13.2±2.7 <sup>#</sup>	29.5±12.0 <sup>#</sup>	352.5±147.6 <sup>#</sup>	423.5±152.2 <sup>#</sup>
Control group	76	Before operation	12.4±2.5	32.3±11.4	315.5±132.8	372.7±155.3
		2 weeks after operation	9.8±2.3 <sup>*</sup>	20.5±10.7 <sup>*</sup>	435.9±145.4 <sup>*</sup>	1549.3±233.9 <sup>*</sup>
		2 months after operation	11.03±1.9 <sup>#</sup>	24.6±11.7 <sup>#</sup>	397.1±142.1 <sup>#</sup>	712.6±149.4 <sup>#</sup>

<sup>\*</sup>P<0.05, when compared with before operation; <sup>#</sup>P<0.05, when compared with 10d after operation; P<0.05, when compared with the control group.

**Table 2**

Comparison of femoral venous blood flow peak and average velocity between two groups (cm/s).

Groups	n	Femoral venous blood flow peak		Femoral venous blood flow	
		Before operation	1 week after operation	Before operation	1 week after operation
Observation group	77	24.5±6.7	53.8±9.9 <sup>#</sup>	14.7±5.1	32.5±6.0 <sup>#</sup>
Control group	76	24.3±6.1	45.2±8.0 <sup>*</sup>	14.1±4.9	25.4±5.1 <sup>*</sup>

<sup>\*</sup>P<0.05, when compared with before operation; <sup>#</sup>P<0.05, when compared with the control group.

easy to be caused. Moreover, due to the activation of coagulation mechanism in the lower extremity deep venous cavity after operation, the blood is normally coagulated to block the venous cavity and venous returning, which is also one reason for causing DVT.

DVT is a common complication after TKA. The reduced lower extremity activity and local swelling after operation, and tourniquet and long-time knee-bending position during operation can slow down the lower extremity venous blood flow, while the slow lower extremity venous blood flow, vascular wall injury, and hypercoagulation are the main factors for developing DVT[12,13]. CPM is a rehabilitation training method commonly used after TKA. Some researches demonstrate that[8] CPM in combined with exercise therapy can significantly enhance the rehabilitation effect in patients after TKA. The exercise therapy refers to that in a condition of maintaining no tension or relaxing, the coordinated contraction of muscle group around the knee joint and the stability of dynamic muscle to the joint are strengthened to improve the extension and flexion ROM of knee joint and the blood circulation of injured knee, and avoid the muscle atrophy, which can prevent the occurrence of DVT to a certain degree[9]. The exercise therapy can enhance the lower extremity muscle strength, recover the knee joint stability and ROM, promote the repair of knee joint injury, and can also make up for the passiveness and limitation of CPM[10,11]. PT, APTT, FIB, and D-D are currently the most common indicators used to detect the coagulation function, among which D-D is a specific degradation product of cross linked fibrin, whose high level can reflect a hypercoagulation, and is also one of the thrombosis markers; FIB is a kind of protein possessing the coagulation function, whose elevation is also one of the risk factors for developing thrombosis[14,15]. The results in the study showed that PT and APTT 10d after operation in the two groups were significantly reduced, while FIB and D-D were significantly elevated when compared with before operation; PT and APTT 2 months after operation were significantly elevated, while FIB and D-D were significantly reduced when compared with 10 d after operation; PT and APTT 2 months after operation in the observation group were significantly higher than those in the control group, while FIB and D-D were significantly lower than those in the control group; the femoral venous blood flow peak and average velocity 1 week after operation in the two groups were significantly elevated when compared with before operation, indicating that CPM in combined with the exercise therapy can effectively stimulate the dilation of muscle tissue vessels in patients after TKA, regulate the blood circulation of muscles around the knee joint, improve the coagulation indicators level, accelerate the blood flow, and inhibit the occurrence of DVT, which can reduce the occurrence rate of DVT[16].

In conclusion, CPM in combined with exercise therapy for patients after TKA can effectively prevent the formation of DVT, with a significant effect.

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