EFFECT OF BED CYCLING ON REHABILITATION AFTER TOTAL KNEE ARTHROPLASTY

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ABSTRACT

Introduction: *The traditional CPM rehabilitation mode and the new CMB rehabilitation mode were analyzed and compared in detail, in order to improve the methods of postoperative functional rehabilitation of orthopedic TKA patients.*

Materials and methods: *A total of 194 patients who underwent TKA in our hospital from October 2019 to June 2021 were divided into control group (CPM training) and experimental group (CMB training) according to different training methods of preoperative education. ADL score, HSS score, and NRS score were performed at 1, 3, 5 and 7 days after operation, and the measured value of knee joint range of motion, muscle strength and muscle bundle diameter were recorded, and the postoperative adverse reactions of patients were counted.*

Results: *The ADL score and HSS knee function score of patients in hospital for 7 days showed that the activities of daily living and knee rehabilitation scale scores of patients in the experimental group were higher than those in the control group at different times from 1 to 7 days after operation, and the scores of patients in the experimental group were significantly higher than those in the control group at 5 and 7 days after operation. The average NRS scores of patients in the experimental group were significantly lower than those in the control group 3-7 days after operation. The ROM of knee joint activity of patients in the experimental group was higher than that in the control group within 7 days after operation. The ROM score of average knee joint activity of patients in the experimental group was significantly higher than that in the control group at 5 and 7 days after operation. The muscle strength test values of the experimental group were higher than those of the control group, but the difference was not significant. There was no significant difference in the number of four complications between the two groups. The total incidence of the control group was higher than that of the experimental group, but the degree of difference did not constitute statistical significance.*

Conclusion: *The training method of CMB can provide some help for the rehabilitation of patients after knee replacement, and has a certain reference value for their postoperative functional recovery. The new training mode and rehabilitation equipment are worth promoting.*

Keywords: *Total knee arthroplasty, perioperative nursing, accelerated rehabilitation surgery mode, cycling in bed, knee disease.*

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Introduction

The knee joint is the largest and most complex joint in the human body, which bears most of the weight in human daily activities. Total knee arthroplasty (TKA) is an effective surgical operation in the treatment of various end-stage diseases of the knee at present[1]. With the deepening of various studies and the popularity of TKA in clinic, postoperative rehabilitation nursing is considered to be the key to the recovery of joint function[2, 3]. Physical rehabilitation is often needed after TKA[4] to improve function and promote overall recovery. At present, there is no recognized clinical guide for continuous functional rehabilitation of TKA patients[5]. Since the 1970s, people have proposed that continuous passive motion (CPM) can improve the knee function of patients. The significance of its rehabilitation application has been clinically recognized for more than 40 years[6]. In China, the application of CPM has been popularized in the rehabilitation treatment after TKA, in preventing

joint adhesion, increasing joint mobility, promoting swelling regression and so on, The role of CPM has been recognized by the majority of patients and medical staff. With the gradual increase of clinical application of CPM, its own defects are particularly obvious. Due to the shortcomings of CPM's own design and the immature research of supporting risk response schemes, pure CPM can no longer meet the current clinical needs. Some studies have found that atrophy in the first month after operation is closely related to insufficient knee extension[7], and some scholars suggest that intensive exercise training before atrophy can enhance mitochondrial function to prevent muscle atrophy[8].

The medical team of our department preliminarily confirmed that cycling motion in bed (CMB) is effective and feasible through a small sample size pre-test in the early stage. Compared with traditional CPM training, it can significantly accelerate the postoperative rehabilitation process, but the specific effect needs to be further studied and clarified[9]. Therefore, this paper makes a follow-up survey of patients who use two different training modes after operation to clarify the rehabilitation effect of bed cycling after total knee arthroplasty.

Materials and methods

Research object and acceptance criteria

A total of 194 patients who underwent knee arthroplasty in our hospital from October 2019 to June 2021 were studied.

The selected cases were all from TKA patients in osteoarthritis department and were randomly divided into two groups by Zelen method. 97 cases in the control group were trained with traditional passive CPM, and 97 cases in the experimental group were trained with new active CMB.

Inclusion criteria[10]:

• At least 18 years old;

• Understand and cooperate with relevant instructions and complete the assessment;

• First unilateral TKA.

Exclusion criteria:

• Complicated with severe internal organ diseases;

• Those who cannot participate and evaluate the whole process safely;

• Knee revision;

• Hip replacement was performed at the same time.

The content of this project has passed the ethics committee and the informed consent of patients (ethics No.: PKU Shenyi lunshen (Yan) [2020] No. (033)). All patients enrolled in the trial were between 53 and 76 years old, with a median age of 64 years. BMI ranged from 19.11 to 32.60kg/m^2, with a median BMI of 24.18±2.14kg/m^2, including 104 males (53.61%) and 90 females (16.39%). Total knee arthroplasty was performed in 74 cases (38.14%) of left knee joint and 120 cases (61.86%) of right knee joint. The sex ratio of patients in the control group was male/female (50/43), the average BMI was 23.46±2.09kg/m^2, the proportion of surgical site was left/right (37/59), the sex ratio of the experimental group was male/female (54/47), the average BMI was 24.29±1.98 kg/m^2, and the proportion of surgical site was left/right (37/61). There was no significant difference between the two groups in gender ratio, weight distribution and surgical site data (P>0.05), which was comparable.

Methods

• Control group (CPM group): from the first day of TKA operation, patients were trained according to the CPM training before operation, twice a day, once for 30 minutes, with an interval of 6 hours. On the third day after the operation, after confirming that the patient's knee joint is in the correct position, the range of motion of the joint can be adjusted according to the actual situation of the patient, once every 9 minutes, twice a day, until 90 degrees and 0 degrees.

• Experimental group (CMB, 30min group): from the first day after TKA, fix a special bicycle on the bed at the end of the bed, and train according to the guidance method of preoperative education, with a frequency of twice a day, an interval of 6 hours, and 30 minutes each time.

The intensity of exercise requires personalized management of patients, which depends on the feeling and degree of pain of patients. Before training, patients should be treated for psychological problems such as fear of pain, dare not get out of bed, lack of confidence and so on. Take the initiative to care about and discuss the treatment plan with the patient, so that the patient can understand the effect of active cooperation with the exercise. During the training, the nursing staff should confirm the patient's progress in time, so as to improve the patient's confidence and determination.

Evaluation methods

ADL score, HSS score and NRS score were performed at 1, 3, 5, and 7 days after operation, and

the measured value of knee range of motion, muscle strength and muscle bundle diameter were recorded:

• ADL score: evaluate the daily living ability of patients, including 10 items completed by patients in the hospital, including eating, bathing, walking, etc. The total score of the project is 100 points. According to the high score, it indicates that they have strong ability of daily living activities.

• HSS knee function score: the HSS knee rehabilitation scale was used to evaluate the pain, function, and range of motion of the patient's left and right knee joints, with a full score of 100. The higher the score, the better the knee function recovery.

• NRS score of pain: according to the clinical performance of patients, use the digital pain quantification table to evaluate the pain of patients, with a total score of 10 points, 1-3 for mild pain, 4-6 for moderate pain, and 7-10 for severe pain.

• ROM measurement value of knee joint mobility: the nurse placed a foldable measuring ruler in parallel with the connecting line between the femoral lateral condyle and the greater trochanter of the femur, indicating that the patient actively flexed and extended the knee, judging the maximum pain value of the patient according to the patient's situation, and timely measured the value parallel to the connecting line between the fibular head and the lateral malleolus at the other end of the foldable measuring ruler, and recorded the included angle of knee flexion and extension. Normal value of buckling: 0 to 135 degrees.

• Muscle strength measurement of lower limb extensor and knee muscles: it was evaluated by microfet-2 digital muscle strength tester. Experimental method: first, make the subject sit on the high platform, keep the feet off the ground, bend the knees by 5~15°, and at the same time, fix the middle of the subject's thigh with both hands, place the tester 5 cm above the patient's ankle, and let the subject support for 3 seconds. The results are expressed in kg.

• The adverse symptoms of patients in the hospital were recorded and counted. The complications included in this study were skin rash, blurred vision, hearing loss, and urinary retention.

Data analysis

All statistical analyses were completed by SPSS 22.0. ADL score, HSS score and other measurement data of patients are expressed by mean ± standard deviation. The mean of the two groups of samples is compared by t-test, and the mean between groups is compared by one-way ANOVA test. The number of postoperative complications and other conditions were analyzed by variance, and the difference was judged to be statistically significant with $p<0.05$.

Statistical method

SPSS 22.0 statistical software was used for statistical analysis. The measurement data were expressed as ($\bar{x}\pm s$), using T-test and variance analysis. Statistical data were tested by x^2 test. Paired sample t test was used for pairwise comparison before and after treatment in the same group. The comparison of different groups at the same time was conducted by one-way ANOVA and pial comparison was conducted by q test with the test level 0.05.

Results

Comparison of ADL score and HSS score between the two groups

The results of ADL scores and HSS knee function scores of patients in hospital for 7 days are shown in Table 1. The activities of daily living and knee rehabilitation scale scores of patients in the experimental group are higher than those in the control group at different times from 1 to 7 days after operation. There is no significant statistical difference between the ADL scores and HSS scores of patients in the two groups at 1 and 3 days after operation. With the development of time, the scores of the two scales of the patients in the experimental group were significantly higher than those in the control group on the 5th and 7th day after operation, and the difference between the groups was significant.

Groups	ADL score				HSS score			
	1day	3day	5day	7day	1day	3day	5day	7day
Control group	40.35± 1.94	42.12± 2.07	46.88± 2.14	52.37± 3.18	39.47± 3.66	45.42± 3.08	54.31± 2.97	59.11± 3.18
Test Group	43.94± 2.07	49.30± 1.95	54.09± 2.33	57.87± 2.10	43.86± 2.49	49.36± 3.48	60.42± 2.35	67.13± 2.35
t	1.542	3.542	6.321	4.621	2.383	1.642	3.661	3.954
P	0.156	0.046	0.002	0.033	0.423	0.362	0.042	0.036

Table 1: Comparison of ADL score and HSS score between the two groups (n=97, $\bar{x}\pm s$).

Comparison of NRs scores and ROM measurements between the two groups

As shown in Table 2, one day after operation, the average NRS score of the experimental group was lower than that of the control group, but the difference was not significant (t=1.453, P=0.156). 3-7 days after

operation, the average NRS score of patients in the experimental group was significantly lower than that in the control group (t=3.688, t=3.445, t=4.621; p=0.040, p=0.041, p=0.038). ROM of patients' knee joint activity in the test group was greater than that in the control group within 7 days after operation, but there was no significant difference at 1 and 3 days after operation.

At 5 and 7 days after operation, the ROM score of the average knee joint activity in the experimental group was significantly higher than that in the control group (t=3.661, t=3.954; p=0.048, p=0042).

Groups	NRS score				ROM			
	1day	3day	5day	7day	1day	3day	5day	7day
Control group	6.21± 1.94	5.94± 1.23	5.33± 1.17	5.21± 1.08	90.66± 2.95	91.59± 2.66	92.59± 2.71	93.48± 2.96
Test Group	5.99± 1.57	4.97± 1.34	4.52± 1.74	3.97± 1.32	92.32± 3.37	93.88± 3.35	98.67± 3.04	101.41± 2.84
t	1.453	3.688	3.445	4.621	1.594	1.658	3.661	3.954
P	0.156	0.040	0.041	0.038	0.665	0.778	0.048	0.042

Table 2: Comparison of NRs scores and ROM measurements between the two groups (n=97, $\bar{x}\pm s$).

Comparison of muscle strength measurements between the two groups after TKA

The muscle strength test of knee extensor group of lower limbs was carried out by muscle strength tester. The results are shown in Table 3. The muscle strength test values of patients in the test group were higher than those in the control group, but the difference was not significant.

Groups	Muscle strength measurement			
	1day	3day	5day	7day
Control group	10.62±2.29	10.94±2.60	12.01±2.60	14.73±2.49
Test Group	10.38±2.60	11.38±2.33	13.38±2.48	15.44±2.27
t	1.542	1.542	1.321	0.621
P	0.656	0.846	0.722	0.831

Table 3: Comparison of muscle strength measurements between the two groups after TKA (n=97, $\bar{x}\pm s$).

Comparison of postoperative complications of TKA between the two groups

As shown in Table 4, there is no significant difference in the number of four complications between the two groups.

The total incidence of the control group is higher than that of the test group, but the degree of difference does not constitute a statistical significance (x^2=2.645, P=0.874).

Groups	Rash	Blurred vision	Hearing loss	Urinary retention	Total incidence (%)
Control group	3	4	3	1	11 (11.34)
Test Group	1	0	3	1	5 (5.15)
X^2	2.645				
P	0.874				

Table 4: Comparison of postoperative complications of TKA between the two groups (n=97, %).

Discussion

The recovery of knee joint standing, walking, and other functions in patients with various end-stage diseases of the knee is not only related to surgery[11], the selection of prosthesis[12], but also related to the formulation and implementation of correct rehabilitation treatment plan[13, 14]. With the popularization of TKA, the corresponding supporting nursing training program after operation is also gradually mature, and the research on rehabilitation treatment during the perioperative period is gradually increasing, suggesting that postoperative training is extremely important for the recovery of joint function[15].

Studies have shown that appropriate postoperative training can significantly improve the patient's joint function and stability, shorten the postoperative bed rest time, and avoid complications such as muscle atrophy, joint stiffness, deep vein thrombosis[16]. Physical rehabilitation is often needed after TKA to improve function and promote overall recovery. Although there are great changes in the optimization and development of surgical technology and prosthesis design at present, patients with end-stage knee disease still have dysfunction problems, which affect the postoperative functional rehabilitation and even determine the curative effect[17]. The poor effect of patients' functional exercise can affect diet and sleep, increase complications, prolong hospital stay, affect patients' subjective feelings and reduce postoperative satisfaction[18], and also increase economic burden. Research shows that the elderly who receive knee replacement are more likely to fall down, especially for patients with limited knee and ankle movement. Exercise therapy and safety education can help to improve joint mobility and thus prevent more complications, suggesting that rehabilitation training is really important.

By comparing the results of ADL score and HSS knee function score of patients in hospital

for 7 days, we found that there was no significant difference between the two groups in ADL score and HSS score at 1 and 3 days after operation. With the development of time, the scores of the test group were significantly higher than those of the control group on the 5th and 7th day after operation. The results show that bed cycling (CMB) is effective and feasible, and can significantly accelerate the postoperative rehabilitation process compared with traditional CPM training. The medical team of our department preliminarily confirmed the effectiveness and feasibility of bed cycling (CMB) through a small sample size pre-test in the early stage, which can significantly accelerate the postoperative rehabilitation process compared with the traditional CPM training.

Through the digital pain quantification table for TKA patients to evaluate the pain and ROM measurement of knee joint activity, we found that the average NRS score of the experimental group was lower than that of the control group one day after operation, but the average NRS score of the experimental group was significantly lower than that of the control group 3-7 days after operation. At the same time, the ROM of the knee joint activity of the patients was tracked and investigated. The results showed that the ROM score of the experimental group was higher than that of the control group within 7 days after operation, but there was no significant difference at 1 and 3 days after operation. On 5 and 7 days after operation, the ROM score of the average knee joint activity of the experimental group was significantly higher than that of the control group. Studies have shown that CPM can increase the range of motion of the knee to a certain extent and reduce pain(19,20). As mentioned above, with the increasing use of CPM in clinical practice, its own defects are becoming more and more obvious.

The shortcomings encountered in its application can be summarized as follows:

• CPM knee bending training mainly focuses on knee bending, ignoring the function of knee bending and the actual situation of patients, so that some training angles are not taken into account;

• Some patients' knee joint straightening, flexion and bending movements lack training, resulting in dysfunction;

• Patients have excessive dependence on CPM, which reduces the patient's active exercise and further reduces the limb strength, which is not conducive to the stability of the joint;

• It has little effect on the recovery of body and muscle strength. In view of the shortcomings of CPM, we used a muscle strength tester to evaluate the muscle strength of knee extensors of lower limbs. The results showed that the muscle strength test values of patients in the test group were higher than those in the control group, but the difference was not significant. There was no significant difference in the number of four complications between the two groups. The total incidence of the control group was higher than that of the experimental group, but the degree of difference did not constitute statistical significance. Although domestic and foreign experience has proved that CPM alone can no longer meet the current clinical needs, the conclusion of active exercise in the early postoperative period is still valid, and appropriate training is beneficial to the recovery of patients' limb function[21, 22].

According to the research on mitochondrial dysfunction and skeletal muscle atrophy, atrophy in the first month after operation is related to insufficient knee extension[23]; The functional rehabilitation of CMB training system developed by our hospital in TKA patients after operation can prevent knee adhesion and restore knee function, and improve the quality of life of patients. However, its effectiveness still needs to continue to expand the observation time to verify its long-term use effect.

In conclusion, the results of this study show that bed cycling exercise for patients after total knee replacement has a certain rehabilitation effect, and the new training mode and rehabilitation equipment are worth promoting.

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