

Efficacy of bed exercise in elderly patients after total hip arthroplasty

A retrospective study of 539 patients

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Abstract

The purpose of this study was to observe the necessity of bed exercise therapy in the rehabilitation of elderly patients after hip replacement and to analyze whether bed exercise therapy has an impact on patients' psychological scores, hip function and postoperative complications. From January 2018 to January 2021, a total of 539 patients with end-stage femoral head necrosis or hip osteoarthritis were retrospectively analyzed. According to the method of postoperative rehabilitation exercise, patients were divided into 2 groups: Group A (routine gait) and Group B (bed exercise). There was no significant difference in general information between the 2 groups. There was no significant difference in baseline pain scores between patients in Group A and Group B (25.2 ± 9.6 vs 24.8 ± 10.4 , $P = .429$). However, at 5 weeks post-operatively, the pain scores of patients in Group A were significantly higher than those in Group B (38.6 ± 7.7 vs 34.1 ± 8.1 , $P = .016$). At 17 weeks post-operatively, the difference between Group A and Group B remained (40.9 ± 6.9 vs 37.5 ± 7.5 , $P = .041$). Similar to the pain score, the hip function score compared between the 2 groups was significantly different at 5 weeks (39.7 ± 8.4 in Group A, 45.9 ± 9.2 in Group B, $P < .001$) and 17 weeks post-operatively (41.5 ± 7.6 in Group A, 47.2 ± 8.8 in Group B, $P < .001$). At 17 weeks post-operatively, between the 2 groups, only the range of motion (ROM) of abduction showed no significant difference. Patients in Group B exhibited a better ROM in any other movement posture. The results showed that compared with Group A, bed exercise rehabilitation training could reduce the incidence of deep venous thrombosis. This study demonstrates that bed exercise can improve the hip function and quality of life of elderly patients with total hip arthroplasty (THA) at an early postoperative stage. It can reduce the incidence of deep venous thrombosis of the lower limbs after surgery. For these patients, systematic bed exercise rehabilitation training is recommended in the early postoperative period.

Abbreviations: CI = confidence interval, KL = Kellgren–Lawrence, MCS = mental component summary, PCS = physical component summary, ROM = range of motion, RR = risk ratio, SF-36 = short form-36 health survey, THA = total hip arthroplasty.

1. Introduction

Total hip arthroplasty (THA) is an effective operation.^[1] Although THA is also performed in young and active patients, patients over 65 years old account for 3/4 of surgeries.^[4] Research^[5–7] shows that a certain number of elderly patients will still have persistent dysfunction after THA, such as pain, limited range of joint activity, and decreased muscle strength, and the recovery of social activities, self-care ability, and the ability to participate in housework is not satisfactory. With the deepening concept of rapid rehabilitation, helping elderly patients recover their ability to take care of themselves in daily life has gradually received attention.^[2] The artificial hip prosthesis implanted during surgery has established a new mechanical environment for patients. To adapt to the new joint and restore normal activity, patients often need extra treatment based on exercise rehabilitation in the early

postoperative period.^[3] Studies^[8,9] have confirmed that traditional rehabilitation treatment, including gait reeducation programs after THA, is effective and can improve the mobility and hip function of patients. However, this rehabilitation treatment focuses on the recovery of the patient's single joint function, and the rehabilitation guidance is mostly in the form of oral education and video education, which makes the patient's grasp of rehabilitation knowledge insufficient and cannot push them to recover their ability of daily living. However, at present, there are no guidelines for exercise rehabilitation treatment of THA in elderly individuals. Studies on bed exercise therapy are small sample studies, and the conclusions are still controversial. The purpose of this study was to observe the necessity of bed exercise therapy in the rehabilitation of elderly patients after hip replacement and to analyze whether bed exercise therapy impacts patients' psychological scores, hip function and postoperative complications.

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The datasets generated during and/or analyzed during the current study are not publicly available, but are available from the corresponding author on reasonable request.

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2. Materials and methods

2.1. Study population

From January 2018 to January 2021, a total of 539 patients with end-stage femoral head necrosis or hip osteoarthritis were retrospectively analyzed. All patients met the following criteria: unilateral femoral head necrosis with Association Research Circulation Osseous stage 3 to 4 or osteoarthritis with Kellgren–Lawrence (KL) grade 3 to 4, age ≥ 60 , and healthy, stable, and suitable for anesthesia. The exclusion criteria were as follows: poor general condition, non-weight-bearing after surgery, complex primary THA requiring bone grafting and/or acetabular screw fixation, inability to move independently with or without a walker, hip infection or malignant tumor, and neuromuscular diseases. Among the 653 patients collected, 42 did not meet the inclusion criteria, 71 were excluded because they could not commit to the specified length of follow-up, and one was lost due to death from other diseases not related to THA.

2.2. THA surgery

Each patient included in the study underwent cementless THA with a posterolateral approach. The surgical procedure was as follows: the patient was positioned in the lateral recumbent position and sterilized on the posterolateral skin of the hip. An incision of approximately 10 cm, which was centered around the greater trochanter, was made on the posterolateral side of the hip. The skin, subcutaneous tissue, fascia lata and iliotibial tract were cut layer by layer, with the intention of protecting the quadratus femoris and gluteus medius, and the external rotator muscles were detached. After opening the posterior joint capsule, the femoral neck was detached 1 cm above the lesser trochanter to remove the femoral head. The prosthesis and acetabulum liner were subsequently implanted after exposure of the acetabulum. Then, the prosthesis handle and artificial femoral head were placed after carefully loosening and fully exposing the proximal femur. Finally, after flushing the incision, the joint capsule was closed, and the incision was sutured layer by layer.

The THA surgeries were all performed by the same surgical team. Each surgery was led by 1 doctor with experience in thousands of THA operations in the clinic over 35 years. In addition, 1 first assistant and 2 second assistants participated in the operation and assisted the chief surgeon. The first assistant had 12 years of experience with hip joint arthroplasty using the posterolateral approach, while the other 2 assistants had been performing the operation for at least 5 years.

2.3. Exercise intervention program

The patients were divided into groups according to the method of postoperative rehabilitation exercise. The routine gait rehabilitation exercise group (Group A) adopted the following methods for postoperative rehabilitation training: before gait training with the assistance of a walker after the operation, the patients needed to be able to fully extend the knee joint on the affected side when standing and then undergo standing against the wall training and walking in place training, slowly and gradually transitioning to walking on the ground. The patient stood behind the rear wheel of the walker and stood firmly before walking, trying to keep his body upright and holding the handrails on both sides of the walker tightly with both hands to prevent accidental fall injury. The head and neck were kept in a straight line with the knees and ankles. The walker was moved slowly forward. The step was small, and the walker was moved in a small range. The knee joints of the lower limbs on the affected side were flexed and moved forward as much as possible. The rehabilitation physician protected patients by paying attention to the heel landing first, and the body weight was evenly placed on the whole foot until the next walking cycle. The angle of

flexion and extension in walking were observed carefully, and the angle of hip extension was maximized as much as possible. Walking exercises were carried out at an interval of 2 hours. The distance of the first exercise was not too long. The rehabilitation physician paid attention to the time and the state of the patient. If the patient was weak or the swelling and pain of the affected area were aggravated, the exercise was postponed until the muscle strength and endurance were restored. The length and distance of walking were adjusted according to the physical condition of the patient. This training continued for 17 weeks.

The patients performing bed rehabilitation exercise made up Group B. In addition to the abovementioned routine gait rehabilitation exercises, these patients followed the rehabilitation therapy program in bed from the first day after surgery, including sitting beside the bed and trying to stand and walk with appropriate walking aids. They also received additional training, including active hip flexion, active ankle dorsal and plantar flexion, static quadriceps femoris and static gluteus exercises, and bilateral training in the supine state. The purpose of these exercises was to increase the strength and amount of exercise of the hip, knee and ankle. Patients were advised to perform each exercise 10 times, 5 sets per day. These treatments were taught by the physical therapist in the ward, supervised once a day during admission until discharge. The patients were told that they should adhere to the above rehabilitation exercises for a long time after the operation.

Patients were given an exercise sheet with the detailed programme. The study was approved by the Institutional Review Board of the Third Hospital of Hebei Medical University and was conducted in accordance with the Declaration of Helsinki. As this was a retrospective study and all patient information was deidentified before analysis, informed consent was not needed.

2.4. Outcomes

The general demographic data of the 2 groups, such as age, sex, body mass index, smoking or drinking status, preoperative bone mineral density, postoperative bone mineral density (at the last follow-up after THA surgery), preoperative diagnosis and postoperative complications, were recorded in detail. The Harris hip score, Short Form-36 Health Survey score (SF-36; www.sf-36.org) and complications were recorded before the operation, 5 weeks after the operation and 17 weeks after the operation. The patient's preoperative indicators were defined as the baseline. To compare the joint activity, function and psychological situation of the 2 groups of patients more intuitively, the subscales of pain, physical function and joint activity of the Harris scale were used separately. To observe the changes in joint activity more intuitively and obviously, we compared the total motion score of the 2 groups of patients (converted into the percentage system). The joint motion range was directly expressed by degrees rather than the converted score. The physical subscale and mental subscale of the SF-36 between the 2 groups were also compared. To ensure reliability and validity, goniometry was performed by the same physiotherapist.^[12] At 3 follow-up time points, color Doppler ultrasound of the lower extremity deep vein was used to detect the occurrence of lower extremity deep vein thrombosis.

2.5. Statistical analysis

All statistical analyses were performed with SPSS version 22.0 (SPSS Inc., Chicago, IL). All data were collected, and a database was established to facilitate statistical analysis. The Shapiro–Wilk test was used to test the normality of the data, and the Levene test was used to test the homogeneity of variance. The Mann–Whitney *U* test was used to compare the continuous variables of the 2 groups. The chi-square test was used to compare the categorical variables of the 2 groups. Risk ratio (RR)

was used to compare complications between the 2 groups. The risk ratio was calculated with the 95% confidence interval (95% CI). A *P* value < .05 was considered significant.

3. Results

3.1. General information

A total of 535 elderly patients with THA were involved in this study, including 304 males and 231 females. The average age of the overall population was 69 ± 11 years. According to the method of postoperative rehabilitation exercise, patients were divided into 2 groups: Group A (routine gait) and Group B (bed exercise). There were 284 patients in Group A and 251 patients in Group B. The general demographic data, including age, gender composition, American Society of Anaesthesiologists classification, smoking status, drinking status, preliminary diagnosis, and nutrition risk screening (2002) score, were compared between the 2 groups. There was no significant difference in general information between the 2 groups (Table 1). In addition, it has been reported that bone quality could affect the therapeutic target,^[24] so the BMD of patients in both groups before surgery and at the last follow-up after surgery was compared. There was no significant difference in either the preoperative result (*P* = .872) or postoperative result (*P* = .777).

3.2. Clinical evaluation outcomes

To highlight the differences more obviously in indicators related to patient recovery between groups, the Harris hip score scale was divided into multiple subscales, including pain score (0–44), joint function (0–51), total range of motion

(ROM) score (0–100), and joint motion (including the hip range motion of flexion, extension, external rotation, internal rotation, abduction, and adduction) (Table 2). The patient's preoperative indicators were defined as the baseline. There was no significant difference in baseline pain scores between patients in Group A and Group B (25.2 ± 9.6 vs 24.8 ± 10.4 , *P* = .429). However, at 5 weeks post-operatively, the pain scores of patients in Group A were significantly higher than those in Group B (38.6 ± 7.7 vs 34.1 ± 8.1 , *P* = .016). At 17 weeks post-operatively, the difference between Group A and Group B remained (40.9 ± 6.9 vs 37.5 ± 7.5 , *P* = .041). At baseline, there was no difference in hip function scores between the 2 groups (28.1 ± 13.6 in Group A, 28.4 ± 13.9 in Group B, *P* = .314). Similar to the changing trend of the pain score, the hip function score between the 2 groups was significantly different at 5 weeks (39.7 ± 8.4 in Group A, 45.9 ± 9.2 in Group B, *P* < .001) and 17 weeks post-operatively (41.5 ± 7.6 in Group A, 47.2 ± 8.8 in Group B, *P* < .001). Moreover, the hip function score of patients in Group B was better than that of patients in Group A at all time points. Furthermore, the ROM of the hip, including flexion, extension, external rotation, abduction, and adduction, was compared at any time point between the 2 groups. Since the ROM of patients at baseline between the 2 groups was not significantly different, the post-operative ROM was comparable. At 5 weeks post-operatively, compared with Group A, patients in Group B exhibited a better ROM of the hip. At 17 weeks post-operatively, between the 2 groups, only the ROM of abduction showed no significant difference. Patients in Group B showed a better ROM in any other movement posture (Table 2).

To accurately study the effect of bed exercise on the post-operative quality of life of patients, the SF-36 was divided into a physical component summary (PCS) scale (0–100) and a

Table 1
General information of patients in different groups.

		Group A	Group B	<i>P</i>
Age, yr		69 ± 8	70 ± 10	.191 [#]
BMI, kg/m ²		23.87 ± 4.02	24.06 ± 4.29	.377 [#]
NRS-2002 scores		0.82 ± 1.02	0.79 ± 1.29	.382 [#]
Gender				
	M	159	145	.678*
	F	125	106	
Preoperative BMD				.872
	Normal	35	33	
	Osteopenia	168	151	
	Osteoporosis	79	64	
	Severe osteoporosis	2	3	.777
Postoperative BMD				
	Normal	31	30	
	Osteopenia	169	154	
	Osteoporosis	82	64	.456*
	Severe osteoporosis	2	3	
ASA				.456*
	Grade I	57	49	
	Grade II	188	176	
	Grade III	39	26	.632*
Smoking				
	No	232	209	
	Yes	52	42	.248*
Alcohol consumption				
	No	234	216	
	Yes	50	35	.396*
Diagnosis				
	ONFH	263	237	
	OA	21	14	

Group A: routine gait rehabilitation exercise, Group B: bed exercise.

ASA = American Society of Anaesthesiologists, BMD = bone mineral density, BMI = body mass index, NRS-2002 = nutrition risk screening score, OA = osteoarthritis, ONFH = osteonecrosis of the femoral head.

*Chi-square test.

[#]Mann-Whitney *U* test.

Table 2
Pain, function, and range of joint motion according to the Harris scores of the 2 groups.

		Group A	Group B	P
Pain score (0–44)	Baseline	25.2 ± 9.6	24.8 ± 10.4	.429
	5 w	38.6 ± 7.7	34.1 ± 8.1	.016
	17 w	40.9 ± 6.9	37.5 ± 7.5	.041
Hip function (0–51)	Baseline	28.1 ± 13.6	28.4 ± 13.9	.314
	5 w	39.7 ± 8.4	45.9 ± 9.2	<.001
	17 w	41.5 ± 7.6	47.2 ± 8.8	.027
ROM, degrees, flexion (0°–135°)	Baseline	68.8 ± 21.6	68.4 ± 29.5	.661
	5 w	87.4 ± 15.9	101.8 ± 18.0	.035
	17 w	94.2 ± 13.1	113.7 ± 15.7	<.001
ROM, degrees, extension (0°–20°)	Baseline	5.7 ± 9.4	5.8 ± 8.2	.732
	5 w	11.3 ± 6.4	14.8 ± 6.7	.030
	17 w	13.2 ± 5.8	17.1 ± 4.4	.009
ROM, degrees, external rotation (0°–45°)	Baseline	19.7 ± 12.1	18.8 ± 13.6	.223
	5 w	28.3 ± 7.9	33.9 ± 6.2	.008
	17 w	32.1 ± 6.5	37.4 ± 5.9	.012
ROM, degrees, internal rotation (0°–45°)	Baseline	14.6 ± 9.0	14.7 ± 8.7	.857
	5 w	23.7 ± 12.0	27.9 ± 11.6	.031
	17 w	30.5 ± 7.2	35.9 ± 10.3	<.001
ROM, degrees, Abduction (0°–60°)	Baseline	27.4 ± 15.8	28.2 ± 17.1	.280
	5 w	40.9 ± 13.7	45.5 ± 10.0	.033
	17 w	46.1 ± 9.2	50.3 ± 8.4	.104
ROM, degrees, Adductions (0°–40°)	Baseline	16.7 ± 7.0	16.6 ± 8.3	.511
	5 w	22.0 ± 10.3	27.3 ± 8.9	<.001
	17 w	28.2 ± 7.6	34.6 ± 6.5	.045
ROM, total score (scale of 0–100)	Baseline	53.1 ± 16.2	53.4 ± 15.8	.470
	5 w	74.6 ± 18.0	86.9 ± 14.3	.003
	17 w	83.5 ± 11.7	92.1 ± 16.6	.039

5w = 5 weeks postoperative, 17w = 17 weeks postoperative, ROM = range of motion.

Table 3
Quality of life according to SF-36 score.

		Group A	Group B	P
PCS (scale of 0–100)	Baseline	42.7 ± 23.8	43.4 ± 21.9	.552
	5w	69.3 ± 16.0	79.3 ± 12.6	.019
	17w	82.6 ± 14.1	90.8 ± 11.5	.040
MCS (scale of 0–100)	Baseline	57.2 ± 19.3	58.9 ± 21.7	.281
	5w	74.5 ± 21.4	86.8 ± 18.9	.017
	17w	78.8 ± 17.4	89.6 ± 13.1	<.001

MCS = mental component summary, PCS = physical component summary.

mental component summary (MCS) scale (0–100) (Table 3). The PCS and MCS scores of each group were compared. At baseline, there was no significant difference between groups in PCS score (42.7 ± 23.8 in Group A and 43.4 ± 21.9 in Group B, $P = .552$). At 5 weeks post-operatively, the PCS scores of patients in both groups showed a significant improvement. However, when compared to Group A, the improvement was more apparent in Group B (69.3 ± 16.0 vs 79.3 ± 12.6, $P = .019$). At 17 weeks post-operatively, the PCS score in Group B (90.8 ± 11.5) was still higher than that in Group A (82.6 ± 14.1) and was significantly different ($P = .040$). For the MCS score, patients in any group at baseline were not significantly different (57.2 ± 19.3 in Group A and 58.9 ± 21.7

in Group B, $P = .281$). Although the MCS scores of patients in both groups increased at the 5-week postoperative follow-up, this trend was more obvious in Group B. The MCS score of Group B was significantly higher than that of Group A ($P = .017$). Furthermore, this difference remained until the 17-week follow-up ($P < .001$).

3.3. Complications

In the current study, we observed deep vein thrombosis, pressure sores, respiratory infection, urinary infection, and dislocation as the main complications. The deep vein thrombosis rate was 6.8% (18/266) in Group A and 1.6% (4/247) in Group B,

Table 4
Complications in different groups.

Complications		Group A	Group B	P
Deep vein thrombosis	No	266	247	.006
	Yes	18	4	
Pressure sore	No	279	245	.608
	Yes	5	6	
Respiratory infection	No	277	243	.613
	Yes	7	8	
Urinary infection	No	273	238	.406
	Yes	11	13	
Dislocation	No	278	247	.658
	Yes	6	4	

Table 5
Effect of bed exercise on postoperative complications.

Complications	RR	95% CI	Z	P
Deep vein thrombosis	0.251	0.086~0.733	-2.529	.011
Pressure sore	1.358	0.419~4.395	0.510	.610
Respiratory infection	1.293	0.476~3.515	0.504	.614
Urinary infection	1.337	0.610~2.931	0.726	.468
Dislocation	0.754	0.215~2.643	-0.441	.659

CI = confidence interval, RR = risk ratio.

and difference was significant ($P = .006$). In Group B, 4 patients were diagnosed with intermuscular vein thrombosis and had no symptoms or signs related to deep vein thrombosis, except for abnormal ultrasonic results of deep veins of the lower limbs. However, in Group A, posterior tibial vein thrombosis was detected in 1 patient who had pain in the lower leg of the operative side on postoperative Day 5 with slight swelling and a positive Homans sign. In addition, 17 patients were diagnosed with intermuscular vein thrombosis, 5 of whom had symptoms of pain in the lower leg of the operative side, and 12 of whom had no symptoms or signs. None of the 22 patients with DVT had the sudden respiratory distress that indicates pulmonary embolism. There was no significant difference in other complications between the 2 groups (Table 4). In addition, we also investigated whether bed exercise could reduce the incidence of postoperative complications. The results showed that compared with Group A, bed exercise rehabilitation training reduced the incidence of deep venous thrombosis (RR = 0.251, 95% CI = 0.086~0.733, $P = .011$). However, bed exercise rehabilitation training did not reduce the risk of pressure sores ($P = .610$), respiratory infection ($P = .614$), urinary infection ($P = .468$) or dislocation ($P = .659$) (Table 5).

4. Discussion

The current study showed that in elderly patients undergoing total hip replacement, bed exercise rehabilitation training can effectively improve the hip function score and quality of life score of patients after surgery. Jesudson C et al^[13] and Smith TO^[14] et al believed that the role of bed exercise in restoring hip function was limited, but the observation time points of both studies were in the early postoperative period (6–8 weeks), and the sample size in the former study was only 38 cases with only 19 patients in each subgroup. In our study, the sample size exceeded this value, which can eliminate the occasional results

caused by insufficient sample size. This may be the main reason for the inconsistency with the results of this study. In this study, the included patients were elderly patients, which is not consistent with the inclusion criteria of the former study. This may also be a potential reason for the differences in study results. In the study by Gilbey HJ et al, the strength of the flexor, extensor and abductor muscles of the thigh and the range of motion of the hip joint of patients after hip replacement were significantly improved after exercise rehabilitation training, which is consistent with the current study.^[9] In this study, patients who received bed exercise rehabilitation training experienced a more significant effect on hip function during recovery. The ROM of the hip, pain score and hip function in these patients were higher than those in the control group. When the patients were asked about their feelings after the postoperative bed exercise rehabilitation, they thought that the exercise process could give them more strength to control their condition and rehabilitation. Patients' evaluation of THA surgery is not always consistent with surgeons' judgements and expectations, so measuring patients' perspectives has become an important part of surgery evaluation. Salmon et al^[11] believe that whether before or after hospitalization, repeated evaluation of patients with a self-assessment scale can reflect their own rehabilitation experience. In addition, these self-assessment scales can help clinicians identify patients who deviate from normal recovery. The SF-36 has proven useful in surveys of general and specific populations in comparing the relative burden of diseases and in differentiating the health benefits produced by a wide range of different treatments. The personal view of patients should be the center of surgical efficacy evaluation. Therefore, we used the SF-36 and Harris scores as important evaluation indicators. In this study, there was a significant difference between the SF-36 score and Harris score in the 2 groups at 5 weeks and 17 weeks post-operatively, and this difference seemed to be synchronized. This shows that in elderly patients after THA, pain leads to changes in the patient's physical function, thereby reducing the

patient's SF-36 survival score.^[15] Although patients complain of resting pain in the early postoperative period, resting pain and exercise pain cannot be confused. During the 5-week follow-up after surgery, the patients recalled that with repetition of the exercise, the pain caused by the exercise would decrease and almost disappeared during the subsequent rehabilitation training. For patients who do not receive bed exercise rehabilitation training, the postoperative pain and recovery process will be prolonged, which will make the patients dissatisfied with the postoperative results and adversely affect the SF-36 score and Harris score of the patients. In the study by Conlon et al, the SF-36 score of patients over 65 years old who underwent THA was lower 8 days post-operatively than their score preoperatively.^[16] They suggested that although THA had a certain impact on the quality of life of patients comparing preoperative to postoperative quality of life, postoperative anemia during the early period may be the main reason for this result. That study only observed changes in the SF-36 scores of patients at 8 days post-operatively, and the longer-term follow-up results are unknown, which may be the main reason the results are not consistent with our research. In addition, Di Giorgio L et al reported that bone quality at the time of surgery could affect the clinical status, including the Harris score and SF-36 score, at the end of follow-up.^[24] However, in our study, there was no significant difference in either the preoperative or postoperative distribution of patients with different bone qualities in the 2 groups, which indicated that when analyzing the influence of postoperative bed exercise rehabilitation on patients' psychological scores and hip function, the variable of bone quality could be controlled.

In the process of THA and postoperative rehabilitation, the operation and reduction of lower limb movement are important factors for the formation of deep venous thrombosis. Deep venous thrombosis and limb swelling are the most common and dangerous complications after THA. Consequently, all patients routinely receive anticoagulation therapy after THA operation in our institution, including fixed-dose subcutaneous low-molecular-weight heparin for 5~7 days before discharge (4200 anti-Xa IU, QD) and oral rivarsaban (Bayer) for 1 month after discharge (10mg, QD). In addition, early out-of-bed activity was recommended for patients because it could prevent deep vein thrombosis, strengthen muscles and improve the ROM of the hip joint. In our study, the incidence of thrombosis in Group B was significantly lower than that in Group A (4 vs 18). In addition, compared with the 18 patients in Group A, all 4 patients in Group B had no symptoms or signs of deep vein thrombosis, only intermuscular vein thrombosis tested by color Doppler ultrasound of the lower extremity deep vein. We believe that this difference is caused by the additional active flexion and extension of the ankle in Group B. When the patient performs ankle flexion and extension exercises, the calf muscles can fully contract and relax. This process is conducive to the contraction and relaxation of the intermuscular vein, preventing long-term blood stasis in the vein of the leg. This movement eliminates the thrombotic factor of slow blood flow. McNally et al used strain-gauge plethysmography to study the effect of active ankle flexion and extension on venous reflux of the lower limbs after THA in a group of patients with an average age of 70.6 years. All tests were performed on the 4th postoperative day, and the results showed that the average velocity of venous blood flow increased by 22%.^[17] This result is not unique; in the study by Andrews et al, the results show that active flexion and extension of the ankle can increase the blood flow velocity of the lower limb veins of patients, thereby reducing the incidence of venous thrombosis.^[18] In our study, there was no significant difference in the incidence of pressure sores, respiratory infection, urinary infection or dislocation between the 2 groups. Bed exercise does not seem to be able to reduce the risk of pressure sores, respiratory infection, urinary infection or dislocation. Pressure

sores, respiratory infection, and urinary infection always occur in association with prolonged bed rest and THA surgery.^[19] The patients included in this study were all elderly individuals. In theory, elderly patients stay in bed longer than young patients after surgery and have a higher risk of these complications.^[20] This study confirmed that age, body mass index, American Society of Anaesthesiologists grade and nutrition risk screening-2002 were related factors affecting these complications in patients. However, there was no significant difference in these general data between the 2 groups in this study, which may have caused this result.

Whether bed exercise can reduce the risk of dislocation in patients was also analyzed. However, the results of this study are negative, although some studies have confirmed that dislocation is mostly seen in patients with abductor muscle weakness, soft tissue relaxation caused by extensive lysis, eccentricity changes, femoral greater trochanter upwards displacement, local multiple operations, and primary neuromuscular lesions. Poor positioning of the prosthesis, especially acetabular anteversion, has been considered to be the key factor in determining the stability of the hip joint.^[21,22] Liu et al also reported a similar conclusion.^[23] Therefore, even though the patients in Group B had more abductor training than those in Group A, compared with the impact of poor positioning of the hip prosthesis, the increased abductor strength training seemed to have little impact on the incidence of hip dislocation.

There are some limitations in the current study. First, this study was a retrospective analysis, and there was some retrospective bias. Second, this study only included elderly patients with THA, and these patients had only unilateral hip disease. The contralateral hip was healthy, which may have led to selection bias in our study and artificially narrowed the applicable population of bed exercise rehabilitation training to this range. Third, the follow-up time of this study was the 17th postoperative week, and there was a difference in the clinical results between the 2 groups at this time point. It is unknown whether this difference can be eliminated as time passes, which requires further observation.

5. Conclusion

This study demonstrates that bed exercise can improve the hip function and quality of life of elderly patients with THA at an early postoperative stage. It can reduce the incidence of deep venous thrombosis of the lower limbs after surgery. For these patients, systematic bed exercise rehabilitation training is recommended in the early postoperative period.

Author contribution

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References

- [1] Huo SC, Wang F, Dong LJ, et al. Short-stem prostheses in primary total hip arthroplasty: a meta-analysis of randomized controlled trials. *Medicine*. 2016;95:e5215.
- [2] Sharma V, Morgan PM, Cheng EY. Factors influencing early rehabilitation after THA: a systematic review. *Clin Orthop Relat Res*. 2009;467:1400–11.
- [3] Nuelle DG, Mann K. Minimal incision protocols for anesthesia, pain management, and physical therapy with standard incisions in hip and knee arthroplasties: the effect on early outcomes. *J Arthroplasty*. 2007;22:20–5.
- [4] Claßen T, Scheid C, Landgraaber S, Jäger M, et al. Characteristics of elective hip replacement in the elderly. *Orthopade*. 2017;46:25–33.
- [5] Keeler E, Guralnik JM, Tian H, et al. The impact of functional status on life expectancy in older persons. *J Gerontol A Biol Sci Med Sci*. 2010;65:727–33.
- [6] Rasch A, Dalén N, Berg HE. Muscle strength, gait, and balance in 20 patients with hip osteoarthritis followed for 2 years after THA. *Acta Orthop*. 2010;81:183–8.
- [7] Jeldi AJ, Deakin AH, Allen DJ, et al. Total hip arthroplasty improves pain and function but not physical activity. *J Arthroplasty*. 2017;32:2191–8.
- [8] Fagerson TL. Post-operative physical therapy. In: Fagerson TL, (ed). *The hip handbook*. Oxford: Butterworth Heinemann; 1998. p. 247–90.
- [9] Gilbey HJ, Ackland TR, Ang AW, et al. Exercise improves early functional recovery after total hip arthroplasty. *Clin Orthop*. 2003;408:193–200.
- [10] Taylor NM, Hall GM, Salmon P. Patients' experiences of patient-controlled analgesia. *Anaesthesia*. 1996;51:525–8.
- [11] Salmon P, Hall GM, Peerbhoy D, et al. Recovery from hip and knee arthroplasty: patients' perspective on pain, function, quality of life, and well-being up to 6 months postoperatively. *Arch Phys Med Rehabil*. 2001;82:360–6.
- [12] Jakobsen TL, Christensen M, Christensen SS, et al. Reliability of knee joint range of motion and circumference measurements after total knee arthroplasty: does tester experience matter? *Physiother Res Int*. 2010;15:126–34.
- [13] Jesudason C, Stiller K. Are bed exercises necessary following hip arthroplasty? *Aust J Physiother*. 2002;48:73–81.
- [14] Smith TO, Mann CJ, Clark A, et al. Bed exercises following total hip replacement: 1 year follow-up of a single-blinded randomised controlled trial. *Hip Int*. 2009;19:268–73.
- [15] Wang AW, Gilbey HJ, Ackland TR. Perioperative exercise pro-grams improve early return of ambulatory function after total hip arthroplasty: a randomized, controlled trial. *Am J Phys Med Rehabil*. 2002;81:801–6.
- [16] Conlon NP, Bale EP, Herbison GP, et al. Postoperative anemia and quality of life after primary hip arthroplasty in patients over 65 years old. *Anesth Analg*. 2008;106:1056–61, table of contents.
- [17] McNally MA, Cooke EA, Mollan RA. The effect of active movement of the foot on venous blood flow after total hip replacement. *J Bone Joint Surg Am*. 1997;79:1198–201.
- [18] Andrews B, Sommerville K, Austin S, et al. Effect of foot compression on the velocity and volume of blood flow in the deep veins. *Br J Surg*. 1993;80:198–200.
- [19] Yang Q, Li J, Shi D, et al. Incidence and risk factors associated with hospital-acquired pressure ulcers following total hip arthroplasty: a retrospective nationwide inpatient sample database study. *J Tissue Viability*. 2022;31:332–8.
- [20] Ochiai S, Seki T, Osawa Y, et al. Pelvic incidence affects postoperative dislocation rate in total hip arthroplasty patients with spinal fusion. *Hip Int*. 2021;24:11207000211054332.
- [21] Biedermann R, Tonin A, Krismer M, et al. Reducing the risk of dislocation after total hip arthroplasty: the effect of orientation of the acetabular component. *J Bone Joint Surg Br*. 2005;87:762–9.
- [22] Widmer KH, Zurfluh B. Compliant positioning of total hip components for optimal range of motion. *J Orthop Res*. 2004;22:815–21.
- [23] Liu Z, Hu H, Liu S, et al. Relationships between the femoral neck-preserving ratio and radiologic and clinical outcomes in patients undergoing total-hip arthroplasty with a collum femoris-preserving stem. *Medicine (Baltim)*. 2019;98:e16926.
- [24] Di Giorgio L, Attala D, Gurzi MD, et al. Prosthetic hip revision: relationship between bone stock and quality of life in aseptic loosening of the femoral component. *Clin Ter*. 2013;164:e11–5.