Clinical Application of a Functional Exercise Program for Patients with Kinesiophobia after Total Hip Arthroplasty Based on the Health Action Process Approach (HAPA) Theory

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Abstract: Objective: To explore the clinical application effect of a functional exercise program for patients with kinesiophobia after total hip arthroplasty based on the Health Action Process Approach (HAPA) theory on the functional recovery of patients with kinesiophobia after total hip arthroplasty. Methods: A total of 46 patients with kinesiophobia after total hip arthroplasty in the Department of Traumatic Hip Surgery of Tianjin Hospital from February to May 2024 were selected and randomly divided into a control group and an experimental group, with 23 patients in each group. The control group received the conventional functional exercise program for hip arthroplasty, while the experimental group received a functional exercise program for patients with kinesiophobia after hip arthroplasty based on the HAPA theory. The kinesiophobia scores and hip joint function scores of the two groups were compared before surgery, at discharge, and at 1 and 3 months after surgery to explore the clinical application effect of the functional exercise program for patients with kinesiophobia after hip arthroplasty based on the HAPA theory. Results: The longitudinal analysis of the experimental group (n=23) and the control group (n=23) showed that the kinesiophobia scores of the experimental group were significantly lower than those of the control group after surgery (at discharge: 26.91±2.37 vs. 36.04±2.35; at three months: 20.09±1.12 vs. 28.04±2.84, with P values all <0.001), and the interaction effect of time×group was significant (F=289.54, P<0.001, partial η^2=0.768), indicating that the intervention accelerated symptom relief. Meanwhile, the hip joint function scores of the experimental group were significantly higher than those of the control group (at discharge: 48.65±4.12 vs. 40.52±3.85; at three months: 87.78±5.76 vs. 66.57±5.02, all P<0.001), with a strong interaction effect (F=498.26, P<0.001, partial η^2=0.847), suggesting that the intervention effectively promoted functional recovery. The time, group, and interaction effects were all highly significant (P<0.001, partial η^2>0.76), confirming that the intervention could significantly reduce the level of kinesiophobia and accelerate hip joint rehabilitation, with the effect continuously increasing over time. Conclusion: Compared with the conventional functional exercise program for hip arthroplasty, the functional exercise program for patients with kinesiophobia after hip arthroplasty based on the HAPA theory can more effectively reduce the perception of movement fear in patients with kinesiophobia after hip arthroplasty and improve hip joint function.

***Keywords*:** HAPA Theory, Total Hip Arthroplasty, Kinesiophobia, Functional Exercise, Hip Joint Function

1. Introduction

With the increasing aging population in China, the growing base of osteoporosis patients, and the increasing social activities with gradually increasing forms and volumes of activities, the incidence rates of hip fractures and avascular necrosis of the femoral head caused by various reasons are increasing year by year. Total hip arthroplasty, as the ultimate treatment for hip fractures and avascular necrosis of the femoral head in clinical practice, has also seen a yearly increase in the number of surgeries performed. Studies have shown that more than 1 million people worldwide undergo total hip arthroplasty each year [1]. In the mid-2010s of this century, nearly 400,000 patients in China underwent total hip arthroplasty each year, accounting for 60% of the total number of joint surgeries in China, and this number is growing at a rate of 25% to 30% per year [2]. At the same time, a large number of studies have shown that about 30%-50% of patients after total hip arthroplasty have varying degrees of kinesiophobia, that is, the phenomenon of avoiding movement due to excessive fear of pain or injury after surgery. This not only prolongs the rehabilitation cycle of these patients but can also lead to complications such as muscle atrophy and joint stiffness, and even affect the service life of the prosthesis [3]. Therefore, it has become an urgent problem in clinical nursing work to explore a set of functional exercise programs for patients with kinesiophobia after hip arthroplasty. The Health Action Process Approach (HAPA) theory, as an emerging health behavior theory, has shown significant application value in the fields of chronic disease management and public health interventions in recent years [4], but its research in orthopedic nursing is still in its infancy, especially in the in-depth exploration of postoperative

rehabilitation, improvement of patient compliance, and integration of psychosocial factors [5]. In the nursing of patients after hip arthroplasty, patients often face problems such as postoperative pain management, low compliance with functional exercises, and psychological fear. Traditional nursing plans mostly focus on physiological indicators such as joint range of motion and muscle strength recovery, neglecting the psychosocial driving factors of behavioral change [6]. Therefore, this study attempts to use a functional exercise program for patients with kinesiophobia after hip arthroplasty based on the HAPA theory to explore the application effect of the HAPA theory in the functional exercise and recovery of such patients, and to provide clinical references and examples for relevant researchers.

2. Subjects and Methods

2.1 Subjects

This study was approved by the hospital ethics committee (No.: 2024 Med. Eth. Rev. 046) before the start of the experiment. From February to May 2024, a total of 46 patients with kinesiophobia after total hip arthroplasty in the Department of Traumatic Hip Surgery of Tianjin Hospital were included as subjects. Inclusion criteria: ① Patients with kinesiophobia (TSK score >37) after unilateral total hip arthroplasty, aged ≥18 years old; ② Patients who underwent unilateral primary total hip arthroplasty; ③ Patients with clear consciousness and no other mental diseases; ④ Patients who voluntarily participated in this study and signed the informed consent form. Exclusion criteria: ① Patients with other bone diseases affecting limb function recovery; ② Patients with severe organic diseases, severe hematological diseases, congenital immunodeficiency, and mental diseases; ③ Patients who have undergone psychological treatment in the past six months. Dropout criteria: □ Patients who withdrew from the study midway. ② Patients who developed severe complications during the study and were not suitable to continue, such as dislocation of the joint, thromboembolism, periprosthetic fracture, etc. ③ Patients who were transferred to other departments due to sudden other diseases during hospitalization. ④ Patients with failed follow-up.

2.2 Grouping Method

This study is a cluster randomized controlled trial (CRCT). Patients collected from two independent wards during the same period were randomly assigned to the control group and the experimental group, respectively, to compare the therapeutic effects of the two interventions.

Ultimately, each group had 23 people, and there was no statistically significant difference in the general information of the two groups of patients ($P > 0.05$).

2.3 Methods

With the consent of the hospital and department leaders, a research group was established. The research group consisted of nine professional technicians, including one chief physician of orthopedics, one chief nurse, three specialized nurses in hip joint surgery, one professor of nursing, one psychological consultant, and two graduate students who had received evidence-based courses. Before the start of the rehabilitation nursing intervention, all members received centralized training in professional theoretical knowledge such as the HAPA theory, nursing precautions for hip arthroplasty, and psychology of patients with kinesiophobia.

2.4 Control Group

The conventional rehabilitation nursing measures were implemented for three months. Nursing staff provided health education to patients and their main caregivers at the beginning of hospitalization and professionally and carefully answered their questions. Corresponding nursing measures were taken for different nursing problems of patients after surgery until they were discharged from the hospital. Psychological counseling was provided to patients during the treatment period, and analgesic and antispasmodic interventions were given according to the doctor's orders. Patients were urged to perform early functional exercises of the affected limb after surgery, and healthy diet was guided, with regular follow-up.

2.5 Experimental Group

On the basis of conventional rehabilitation nursing intervention, a stage-based rehabilitation nursing intervention was implemented for three months using the HAPA model as a framework. The rehabilitation nursing was divided into four stages: ① Pre-intention stage: Targeting the patients' lack of disease knowledge and weak rehabilitation awareness, the responsible nurse and psychological consultant conducted motivational interviews. One-on-one open-ended questions were used to assess their cognition and psychological state. At the same time, knowledge was popularized to patients and caregivers in the form of picture books, PPT, videos, etc., and content was pushed and questions were answered through social software. A rehabilitation lecture was given by a doctor every week. ② Intention stage: Targeting patients' rehabilitation fear and low

cooperation, medical staff strengthened communication, guided patients to describe pain, and provided analgesic treatment for those with intolerable pain according to the doctor's orders. ③ Action stage: Patients had the intention of rehabilitation but lacked a plan. Targeted training was carried out according to the time node after surgery: After the anesthesia subsided, under the guidance of a specialized nurse, patients performed active and passive activities such as ankle pump and knee flexion and extension, each time for 10-15 minutes, three to four times a day; one to two days after surgery, muscle contraction and relaxation training was carried out, and patients were encouraged to practice hip bridge exercises; three to six days after surgery, patients were assisted to sit and stand by the bed; seven to twelve days after surgery, patients were guided to walk slowly and gradually increase the duration; two to three weeks after surgery, hip joint special training was carried out; four to seven weeks after surgery, patients practiced going up and down stairs with the accompaniment of family members; eight to twelve weeks after surgery, patients were encouraged to dress themselves independently, avoid hip flexion, and combine aerobic exercise with adjustment of dietary structure. ④ Maintenance stage: Targeting patients' insufficient self-care after discharge, the responsible nurse followed up through multiple channels to understand the rehabilitation progress and condition, dynamically adjusted the nursing plan, and reminded patients to visit the doctor on time.

3. Research Tools

3.1 Kinesiophobia Scale (Tampa Scale for Kinesiophobia, TSK)

The Kinesiophobia Scale has been widely used in many countries and is the main survey tool for assessing the level of kinesiophobia in patients with pain. The Cronbach's alpha coefficient is 0.883, and the test-retest reliability is 0.798, with the correlation coefficient of each item being >0.4. The scale consists of 17 items, with a score range of 17-68. A score >37 can be preliminarily diagnosed as kinesiophobia, and the higher the score, the more severe the degree of kinesiophobia [7].

3.2 Harris Hip Score (Harris Hip Score)

The Harris Hip Score, designed by Harris and first published in 1969, is used to assess hip joint function. This scale consists of four parts: pain, function, deformity, and range of motion, with a total of 10 items and a total score of 100 points. The higher the score, the better the hip joint function, and it can specifically assess the degree of hip joint flexion, abduction, internal and external rotation, adduction, and limb shortening deformity. The scale has been tested and has high reliability and validity, with high correctness, stability, and internal consistency after retesting. The Cronbach's alpha coefficient after translation into Chinese is 0.811-0.904, and it has been widely used in China and other countries to assess hip joint function [8].

3.3 Data Collection

The study collected the general sociodemographic and disease information of patients before surgery and collected the TSK kinesiophobia scale and Harris hip joint function scale at four time points: before intervention, at discharge, one month after surgery, and three months after surgery.

3.4 Statistical Methods

All data in this study were entered by two graduate students and analyzed using IBM SPSS 23 statistical software. $P<0.05$ was considered statistically significant, and $P>0.05$ was considered not statistically significant. Count data were described using frequency and composition ratio (%), and the chi-square test was performed. Measurement data were described using mean±standard deviation. If the data obeyed normal distribution and homogeneity of variance, independent sample t-test and repeated measures analysis of variance were performed. If the data did not obey normal distribution and homogeneity of variance, non-parametric tests were performed.

3.5 Results

There was a significant dynamic difference in kinesiophobia scores between the experimental and control groups. Before surgery, there was no statistical difference in the scores of the two groups (experimental group: 42.30±3.15 vs. control group: 42.78±2.56, $P=0.564$), but at each time point after surgery, the scores of the experimental group were significantly lower than those of the control group (at discharge: 26.91±2.37 vs. 36.04±2.35; at three months: 20.09±1.12 vs. 28.04±2.84, all $P<0.001$). Repeated measures analysis of variance showed that the time effect ($F(3,132)=852.36$, $P<0.001$, partial $\eta^2=0.913$) and the group effect ($F(1,44)=412.17$, $P<0.001$, partial $\eta^2=0.824$) were both highly significant, and the interaction effect of time and group was significant ($F(3,132)=289.54$, $P<0.001$, partial $\eta^2=0.768$), indicating that the improvement speed and extent of kinesiophobia in the experimental group were significantly better than those in the control group. The Bonferroni-corrected pairwise comparison further confirmed that the scores of the experimental group continued to decline at each

stage after surgery compared with those before surgery (all P<0.001), and the scores at three months were further reduced compared with those at discharge (P<0.001), while the control group only showed limited postoperative improvement. See Table 1.

Table 1. Longitudinal Comparison and Effect Analysis of Kinesiophobia Scores in the Two Groups

Time Point	Experimental Group (n=23)	Control Group (n=23)	F	P
Preoperative	42.30±3.15	42.78±2.56	0.58	0.564
Discharge	26.91±2.37a	36.04±2.35a	12.76	<0.001**
One Month	22.65±1.52ab	32.70±2.29a	17.42	<0.001**
Three Months	20.09±1.12abc	28.04±2.84a	12.84	<0.001**
Overall Effect				
Group Effect (F,P)	412.17, <0.001**			
Time Effect (F,P)	852.36, <0.001**			
Interaction Effect (F,P)	289.54, <0.001**			
Partial η^2 (Time/Group/Interaction)	0.913/0.824/0.768			

Notes: ** Indicates that the difference between groups is highly statistically significant (P<0.01); a indicates a comparison with preoperative, P<0.001; b indicates a comparison with discharge, P<0.001; c Indicates a comparison with one month (Pairwise comparisons were corrected by Bonferroni);

The trend of hip joint function score changes was opposite to that of kinesiophobia score. The experimental group had significantly better postoperative functional recovery. There was no difference in the scores of the two groups before surgery (experimental group: 17.91±3.04 vs. control group: 16.43±3.82, P=0.149), but the scores of the experimental group at each time point after surgery were significantly higher than those of the control group (at discharge: 48.65±4.12 vs. 40.52±3.85; at three months: 87.78±5.76 vs. 66.57±5.02, all P<0.001). Repeated measures analysis of variance showed that the time effect (F(3,132)=1265.72, P<0.001, partial η^2=0.952) and the group effect (F(1,44)=675.83, P<0.001, partial η^2=0.892) both reached extremely high levels, and the interaction effect was significant (F(3,132)=498.26, P<0.001, partial η^2=0.847), indicating that the improvement trend of hip joint function in the experimental group was significantly faster than that in the control group. The Bonferroni-corrected analysis showed that the scores of the experimental group gradually increased at each stage after surgery compared with those before surgery (all P<0.001), and the scores at three months were further increased compared with those at discharge (P<0.001), while the control group only showed a slow linear improvement. The above results, with partial η^2 all >0.80, indicate that the intervention measures have a great clinical effect size on the improvement of hip joint function. See Table 2.

Table 2. Longitudinal Comparison and Effect Analysis of Hip Joint Function Scores in the Two Groups

Time Point	Experimental Group (n=23)	Control Group (n=23)	F	P
Preoperative	17.91±3.04	16.43±3.82	1.47	0.149
Discharge	48.65±4.12a	40.52±3.85a	7.12	<0.001**
One Month	72.04±5.21ab	55.39±4.63a	11.63	<0.001**
Three Months	87.78±5.76abc	66.57±5.02a	13.89	<0.001**
Overall Effect				
Group Effect (F,P)	675.83, <0.001**			
Time Effect (F,P)	1265.72, <0.001**			
Interaction Effect (F,P)	498.26, <0.001**			
Partial η^2 (Time/Group/Interaction)	0.952/0.892/0.847			

Notes: ** Indicates that the difference between groups is highly statistically significant (P<0.01); a Indicates a comparison with preoperative, P<0.001; b Indicates a comparison with discharge, P<0.001; c Indicates a comparison with one month (Pairwise comparisons were corrected by Bonferroni);

4. Discussion

Based on the Health Action Process Approach (HAPA) theory, this study designed and implemented a stage-based rehabilitation nursing intervention program for patients with kinesiophobia after total hip arthroplasty. The results showed that the experimental group was significantly better than the control group in the improvement of kinesiophobia symptoms

and the recovery of hip joint function. Through stage-based behavioral intervention strategies, the kinesiophobia scores of the experimental group showed a continuous downward trend from before surgery to three months after surgery (all $P<0.001$), and the improvement extent gradually increased with the passage of time (partial $\eta^2=0.768$). Specifically, the intervention measures started from the pre-intention stage, and through motivational interviews and diversified health education (such as picture books, videos, lectures, and social software push), the patients' cognition of postoperative rehabilitation was systematically improved, solving the problem of weak rehabilitation awareness caused by lack of knowledge. In the intention stage, medical staff enhanced the patients' acceptance and compliance with rehabilitation training by guiding patients to accurately describe their pain feelings and combining personalized analgesic programs to alleviate their fear. In the action stage, the gradual training according to the time node (such as early postoperative ankle pump training and mid-late hip joint special training) fully conformed to the physiological recovery laws of patients. It not only avoided the risk of prosthesis loosening caused by early weight-bearing but also promoted the recovery of muscle strength and joint range of motion through gradually increasing load stimulation. In the maintenance stage, the responsible nurse dynamically tracked the patients' rehabilitation progress through telephone follow-up, home visits, and reminders for follow-up visits, timely adjusted the nursing plan, effectively consolidated the patients' self-management ability, and reduced the attenuation of rehabilitation effects caused by insufficient self-care after discharge. This integrated intervention model, starting with psychological intervention, taking behavioral training as the core, and dynamic follow-up as the guarantee, not only significantly reduced the level of kinesiophobia in patients but also accelerated the recovery process of hip joint function through the synergistic effect of psychology and behavior [9]. The Harris hip joint function score of the experimental group at three months after surgery reached 87.78±5.76 points, which was significantly higher than that of the control group (66.57±5.02 points) ($P<0.001$), and the interaction effect (partial $\eta^2=0.847$) indicated that the functional improvement speed of the experimental group was faster, further confirming the clinical value of the HAPA theory in optimizing the "psychology-behavior-physiology" synergistic path through stage-based intervention [10].

Existing studies support the application potential of the HAPA theory in postoperative pain management and behavioral change. For example, a study pointed out that interventions based on the HAPA theory can significantly reduce patients' catastrophic cognition of pain, thereby reducing movement-avoidance behavior [11]. The results of this study not only verified this view but also further expanded the applicability of the theory in the management of kinesiophobia after orthopedic surgery. The data of this study showed that the kinesiophobia score of the experimental group had dropped to 26.91±2.37 points at discharge after surgery, which was significantly different from that of the control group (36.04±2.35 points) ($P<0.001$), and the score continued to decline over time, indicating that the stage-based intervention had a dynamic regulatory effect on the patients' psychological state. This dynamic improvement may originate from the HAPA theory's reinforcement of self-efficacy in the process of behavioral change: in the pre-intention stage, the rehabilitation goal was established through motivational interviews; in the intention stage, the patients' sense of control over rehabilitation training was enhanced through pain management; in the action stage, the design of the stage-based training program enabled patients to gradually accumulate successful experience, thereby enhancing their self-confidence in rehabilitation behavior [12]. In addition, the continuous follow-up mechanism adopted in this study (such as regular assessment and plan adjustment at one month and three months after surgery) is highly consistent with the concept of continuous care proposed in another study. The hospital-based support system reduced the interruption of rehabilitation caused by changes in the environment, further consolidating the long-term stability of the intervention effect [13].

It is worth noting that there is a significant negative correlation between hip joint function recovery and kinesiophobia improvement in this study. The Harris score of the experimental group at three months after surgery was close to the normal level (87.78±5.76 points), while that of the control group was only 66.57±5.02 points. This gap may originate from the synergistic effect of psychological intervention and functional exercise [14]. On the one hand, the reduction of kinesiophobia score directly reduced the patients' fear-avoidance of activities, enabling them to participate in rehabilitation training earlier and more actively, thereby accelerating the recovery of muscle strength and joint stability. On the other hand, the structured training plan (such as muscle contraction and relaxation training one to two days after surgery, and slow walking training seven to twelve days after surgery) scientifically allocated the load to avoid the risk of secondary injury caused by excessive exercise, while gradually increasing the intensity to promote tissue repair and functional reconstruction. This "psychological support reduces movement avoidance, and behavioral training optimizes physiological recovery" bidirectional mechanism provides a new practical idea for orthopedic postoperative rehabilitation [15]. In addition, the partial η^2 values in the study results (time effect 0.913, group effect 0.824, interaction effect 0.768) were all higher than 0.80, indicating that the intervention measures had a great clinical effect size on the improvement of kinesiophobia and hip joint function, further highlighting the advantages of the HAPA theory in postoperative rehabilitation.

Although this study has achieved positive results, it is necessary to face its limitations. First, the sample size is small (a total of 46 cases) and the research objects all come from the Department of Traumatic Hip Surgery of the same hospital, which may lead to selection bias and limit the universality of the conclusions. Future studies need to further verify the applicability of the intervention measures in different populations through multicenter and large-sample studies. Second, the follow-up time only lasted up to three months after surgery and failed to assess the long-term (such as more than one year) rehabilitation effects and prosthesis survival rate. The functional recovery after total hip arthroplasty usually requires a longer period of observation, especially the bone integration around the prosthesis and the risk of long-term complications. Therefore, extending the follow-up cycle and including imaging assessment (such as X-ray examination of prosthesis position) will help to comprehensively evaluate the clinical value of the intervention measures. Third, the implementation of the intervention measures highly depends on the professional level of medical staff. For example, the conduct of motivational interviews and the formulation of stage-based training plans require solid HAPA theoretical knowledge and clinical experience, which may lead to implementation differences between different research teams. Future studies need to further formulate standardized operating procedures (such as stage division standards and training intensity guidance manuals) and reduce the impact of human factors on research results through standardized training. In addition, the conventional nursing adopted in the control group in this study, although it includes psychological counseling and rehabilitation guidance, lacks a systematic stage division and dynamic adjustment mechanism, which may underestimate the potential effect of traditional nursing. Future studies can design more refined control programs (such as conventional nursing + partial HAPA intervention) to further clarify the independent contribution of different stages of intervention in the HAPA theory.

5. Conclusion

Compared with the conventional functional exercise program for hip arthroplasty, the functional exercise program for patients with kinesiophobia after hip arthroplasty based on the HAPA theory can more effectively reduce the perception of movement fear in patients with kinesiophobia after hip arthroplasty and improve hip joint function. Despite the limitations of small sample size (46 cases), short follow-up cycle (three months), and implementation dependence on professional level, the study results provide theoretical basis and practical path for orthopedic postoperative rehabilitation. Future studies need to verify the universality through multicenter and large-sample studies and extend the follow-up to assess long-term effects.

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