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Impact of an ERAS based nursing program on postoperative recovery in patients undergoing grade IV day surgery: a randomized controlled trial

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Abstract

Aim Early mobilization (EM) is essential for an Enhanced Recovery After Surgery (ERAS) program. This study aimed to develop and evaluate a specific early postoperative mobilization program for grade IV day surgery patients.

Methods Patients who underwent grade IV surgery at our center between January and October 2022 were divided into a control group ($N=96$) and an experimental group ($N=95$) using random digitization. The control group followed the standard rehabilitation guidelines, whereas the experimental group adhered to a quantitative rehabilitation approach. We compared outcomes such as time to first-in-bed and out-of-bed activities, pain scores at 6 h post-surgery, and at discharge, and overall satisfaction.

Results The time to first postoperative in-bed activity and time to first postoperative out-of-bed activity in the experimental group was significantly shorter than that in the control group ($P<0.05$). The pain scores at 6 h postoperatively and before discharge were also significantly lower in the experimental group, with statistically significant differences ($P<0.05$). No significant differences were observed in adverse events, emotional states, or overall satisfaction.

Conclusion Quantitative rehabilitation guidance enhanced early recovery compared with standard protocols and maintained similar safety levels, proving to be an effective method for day surgery patients.

Trial registration This study passed review by the Chinese Clinical Trial Registry (Registration No. ChiCTR2400090566) and registration date is October 8th, 2024 (https://www.chictr.org.cn/).

Keywords Early mobilization, Enhanced recovery after surgery, Rehabilitation, Hospital optimization, Day surgery

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Introduction

Day surgery is the pattern of patients completing admission, surgery, and discharge within 24 h [1]. The development of day surgery significantly shortens the hospitalization time of patients, reduces the hospitalization cost of patients, improves the turnover rate of beds, and optimizes medical resources. According to statistics, the proportion of day surgeries in China is approximately 20–25% [2]. In China, surgeries are often classified into four levels based on complexity and risk. Grade IV surgery refers to highly complex, resource-intensive procedures, such aslaparoscopic colon cancer resection and thyroid cancer resection etc.At present, our center has carried out grade IV surgeries including thoracoscopic lung nodule resection, laparoscopic colon cancer resection, thyroid cancer resection, and endoscopic mastectomy for breast cancer, all of which have been proven to be safe and feasibility [3–6]. Based on the concept of Enhanced Recovery After Surgery (ERAS), besides managing perioperative pain and diet, Early mobilization (EM) is an indispensable part of the ERAS protocol. With the increasing number of grade IV surgeries, patients lack precise postoperative nursing and rehabilitation activities, leading to difficulties in completing postoperative recovery as scheduled, which could cause further delays in patient discharge. Therefore, postoperative management of patients is particularly important.

EM, supported by evidence-based practices in rapid rehabilitation, encompasses both bedside and out-of-bed activities. This integration is pivotal for nursing staff, enabling them to incorporate the concept of ERAS into their clinical work. Scientifically guided postoperative rehabilitation activities have proven beneficial for the recovery of multiple organ functions [7] and have contributed to reducing hospital stays [8]. The Recommendations from the ERAS® Society for standards for the development of enhanced recovery after surgery guidelines [9] suggest that patients should get out of bed on the first day after surgery. However, the lack of specific activity plans, low patient compliance with EM, limited clinical applications, and absence of clear guidelines for activity definitions and methods have led to prolonged postoperative bed rest and challenges in returning to the preoperative level [10]. Surveys have highlighted that patients undergoing day surgery lack sufficient knowledge guidance and nursing support [11]. In response to these challenges, and guided by the ERAS concept, we developed a management system for day surgery patients using evidence-based medicine. The objective of this study is to establish a standardized early mobilization protocol for day surgery patients and implement it in clinical practice. This protocol aims to provide healthcare professionals with evidence-based guidelines for early postoperative mobilization, thereby reducing patients' bed rest time, enhancing their awareness of early mobilization, and ultimately accelerating postoperative recovery.The results of this study are detailed below.

Objects and methods

Type of study design

This study is a randomized controlled trial (RCT). Participants were randomly allocated into either the experimental group or the control group. The experimental group received a perioperative rehabilitation activity management protocol for day surgery patients, while the control group received standard care. The feasibility, applicability, and effectiveness of the intervention were compared between the two groups.

Randomization method

Starting from the number in the sixth column and sixth row of the random number table, 82 random numbers were sequentially obtained from left to right. These random numbers were divided by the number of groups. Participants with numbers divisible by 2 were assigned to the experimental group, while those with numbers not divisible by 2 were assigned to the control group.

Randomization concealment

The generated random allocation sequence was placed into sequentially numbered, sealed, and opaque envelopes by a research assistant. The allocation scheme was stored in a filing cabinet. After the researcher confirmed that the participants met the inclusion and exclusion criteria, the envelopes were opened in sequence, and the participants were assigned to either the experimental group or the control group accordingly.

Declarations

Ethics approval and consent to participate

Designed and reported in accordance with the CONSORT guidelines and conducted in compliance with the Declaration of Helsinki, this study received approval from the ethics committee of West China Hospital.The approval number was Review 2020(1001). Informed consent was obtained from all participants, who were thoroughly briefed on the study's objectives, privacy protocols, and voluntary participation.

Study subjects

Grade IV surgery patients (colon cancer, thyroid cancer, breast cancer, lung cancer) admitted to the day surgery center between January 2022 and October 2022 were selected as study subjects. The inclusion criteria were as follows: (1)(Age 18–75 years, with no serious complications before surgery and no significant abnormalities in vital organ function. (2) American Society of Anesthesiologists (ASA) grade < grade III. (3) Pulmonary

nodules ≤ 3 cm and malignant thyroid masses ≤ 1 cm. (4) No distant or focal lymph node metastasis. The exclusion criteria were as follows: (1) Individuals with a history of fractures or joint pathologies that impair normal mobility. (2) Patients who develop severe complications during the study period requiring secondary surgical intervention. (3) Participants who, after enrollment, fail to comply with study protocols or complete the trial due to personal reasons. (4) Hospitalization exceeding 24 h.

Sample calculation

The primary outcome measure of this study was the time to first postoperative Out-of-bed activity.Based on preliminary research data and pilot study results, we assumed a mean inter group difference (Δ) of 30 min with a standard deviation (σ) of 60 min. The study was powered at 80% ($\beta = 0.2$) with a two-sided significance level of 0.05 ($\alpha = 0.05$).Using a two-sample mean comparison approach for sample size calculation, the minimum required sample size was determined to be 32 participants per group. After accounting for a potential 10% attrition rate, the adjusted sample size increased to 35 participants per group. The final enrollment included 96 participants in the control group and 95 in the intervention group, exceeding the minimum sample size requirements to ensure adequate statistical power.

Intervention method

Set up research team

The team's including four medical directors, and one chief nurse, were responsible for guiding the scientific rigor, feasibility, and meticulousness of the program and for promptly addressing any irrational aspects.

Early activity plan construction

By consulting the guidelines, expert consensus, and original studies, this study integrated the current situation, time, manner, intensity, and frequency of early postoperative activity. Finally, early postoperative activity was defined as bed activities, sitting, standing, walking, and walking before discharge. Ahn et al. [12] used a phased activity approach to combine low-intensity resistance exercise activity with quantified activity at various postoperative time points.

Implementation of the early activity program

Primary nurse: Explain the knowledge of diploma diseases to patients and relatives, describing early postoperative mobilization and clinical outcomes, providing one-to-one guidance on various aspects of EM, tailoring personalized goals based on the patient's disease situation, and utilizing a combination of written and video educational materials for patients to refer to at any time.

Postoperative management: Activities are performed in a gradual and sequential manner based on the patient's medical condition. Immediate postoperative activities were assigned according to the type of surgery performed. After returning to the ward, patients were instructed to exercise in bed as follows: (1) Facilitate effecting coughing: Position the patient in a sitting or semi-recumbent position and lean forward. Place the hands lightly on the abdomen (if the incision is painful, the hands can press on the incision). Slow deep breaths were taken twice, breath was held for 2 s, and abdominal muscle strength was used to cough three times. Exhale the remaining air slowly for- 2 h/session. If necessary, combined with back percussion (percussion principle: cup hands together, using wrist strength, evenly and rhythmically tap from bottom to top, from outside to inside) to help clear phlegm. (2) Ankle pumping: flex the toes toward the sole for 5–10 s, then dorsiflex the toes toward the leg for 5–10 s. We performed 360° circular motions around the ankle joint to maximize the range of motion. Three movements make up one set, frequency: 1 h/10 sets. (3) Lip reduction of abdominal breathing: the patient takes a deep breath through the nose, holds the breath for 30–60 s, then exhale slowly with a pursed-lip whistle-like motion. The abdomen should rise during inhalation and contract during exhalation. The inhalation-to-exhalation ratio was 1:2 or 1:3. Perform 4 or 5 sets per day, 8–10 times per set. (4) Turn-over in bed: Turn Over axis after thyroid cancer surgery (keeping the head, shoulder, neck, waist, and legs on the same line, and turn in the same direction without twisting, 2 h/time; turn over according to the patient's comfortable position for other operations). (5) Elbow and wrist joint movements: movement of the elbow and wrist (including making a fist and rotating the wrist), 10 times/set, 5–6 times/day. Flexion and extension of the elbow joint, 20 times/set, 5–6 times/day. (6) Incentive spirometer training (post-lung cancer surgery only). The patient sat in a relaxed position, held the inspiratory training device with one hand, took a deep breath, fully inhaled, held the mouthpiece in the mouth, ensured a tight seal, and then slowly inhaled, raising the float to a preset target value. The mouthpiece was removed, breath was held for approximately 5s, and exhaled. Postoperatively, every 2 h/6–10 times. (7) Early Ambulation: Includes standing and walking 4–6 h postoperatively, encouraging patients to stand and perform bedside activities according to their medical condition. Ambulation before discharge: Assist patients in walking in the ward or corridor for 5–10 min each time, adjusting the duration based on the patient's tolerance. After each activity, we observed changes in the patient's condition and vital signs and recorded the content, frequency, and adverse reactions after the activity (Table 1).

Table 1 Early mobilization program for day surgery

Period	Project	Category of disease	Content
Pre-operation	Health education	Conlon cancer Lung cancer Thyroid cancer Brest cancer	Imparting knowledge of related diseases, the specific contents and purpose of early mobilization
Post-operation	Aerobics		Aerobics Ankle pump Pursed-lip abdominal breathing Turning over in bed Elbow and wrist joint movements Incentive spirometer training (Lung cancer surgery only)
	Early ambulation		Encouragement of standing and walking 4 to 6 h after surgery Each walking in the ward corridor lasts for 5–10 min before discharge
	EM indication		The patients are conscious with vital signs being stable and VAS score less than 4, without symptoms of nausea, dizziness, wound bleeding
	EM suspension indication		Suspending with any following criterion: 20% higher than baseline blood pressure VAS ≥ 4 score Blood oxygen saturation under 90% The heart rate reaching the target heart rate (Karvonen formula)

Early mobilization (EM); Visual Analog Scale (VAS)

Implementation of the protocol

Both groups of patients received the ERAS [13] protocol for treatment and nursing care, including: (1) Preoperative health education, covering diet, pain management, and activity guidance. (2) Intraoperative measures: general anesthesia, prophylactic warming, and restrictive fluid administration. (3) Postoperative care: Adherence to the "2-4-6 h" dietary principle—patients were allowed to drink water 2 h after regaining consciousness, consume liquids at 4 h, and resume a regular diet at 6 h, with early oral intake encouraged. (4) Pain management: Prophylactic and multimodal analgesia were applied in both groups.

Control group interventions

(1) Preoperatively, primary nurse instructed patients on early mobilization methods, precautions, and benefits. (2) Postoperatively, after regaining consciousness, patients were guided by primary nurse to engage in early mobilization. Assistance was provided for out-of-bed activities based on patient willingness, with no strict requirements on duration or frequency. (3) The researcher recorded the total activity level from the previous day on the following morning.

Experimental group interventions

(1) The experimental group followed the EM protocol developed in this study (see Table 1). (2) Under the guidance and assistance of researchers and primary nurse, patients performed early mobilization with monitored activity content and duration to ensure safety and efficacy. Adjustments were made based on patient tolerance and physical capacity.(3) The researcher recorded the total activity level from the previous day on the following morning.

EM indication

The patient was conscious, vital signs were stable, VAS [14] score was < 4, and all tubes were securely fixed, with no symptoms of nausea, dizziness, or wound bleeding.

EM suspension indication (Suspend with any one criterion)

Before the activity, if the patient's Visual Analog Scale (VAS) score was ≥ 4, or if the patient experienced obvious symptoms such as dizziness, nausea, and difficulty breathing; blood oxygen saturation was < 90%; during the activity, if the patient's blood pressure exceeded 20% of their baseline, or if the heart rate reached the Target Heart Rate calculated according to the Karvonen formula: Target Heart Rate = ([220 - Age] - Resting Heart Rate) × (50–60%) + Resting Heart Rate; if blood oxygen saturation was < 90%, systolic blood pressure was < 90 mmHg (1 mmHg = 0.133 kPa), and/or diastolic blood pressure was < 50 mmHg; and in case of wound bleeding or intolerance to standing.

Outcome indicators

The duration of first bed activity, activity during hospitalization, patient pain, emotional state at discharge, and hospital satisfaction were observed and recorded. Among them, active adverse events included orthostatic hypotension, wound bleeding, falls, and unplanned pipe loss; pain was assessed by VAS out of 10; and emotional status was assessed using the Zung Self-Rating Anxiety Scale (SAS) and the Self-Rating Depression Scale (SDS) [15, 16], which consists of 14 items, 7 items rated depression, and 7 items for anxiety. According to the criteria of the original author's score, the scores of anxiety and depression were classified as 0–7 as asymptomatic,8–10 as suspicious symptoms, and 11–21 as definite symptoms. All

of the above scales have good reliability and validity and are widely used.

Statistical methods

Statistical analyses were performed using SPSS 26.0. Measurement data followed a normal distribution, mean ± standard deviation ($\bar{x} \pm s$); skewed distribution, median, and interquartile interval M (Q_R) for the statistical description. Count data were statistically described using the frequency or composition ratio. The general and baseline data before the intervention were analyzed, and the measurement data met the precondition of normal distribution and equal variance. The independent sample t-test was used for group comparison. For skewed data distribution, the nonparametric Wilcoxon Mann–Whitney U rank sum test was used for group comparison. Count data were counted using the square (χ^2) Test or Fisher's exact test for comparison between groups.

For comparisons between groups, measurement data met a normal distribution and equal variance, and groups were compared at different time points using independent sample t-tests. For skewed data distribution, the nonparametric Wilcoxon Mann−−Whitney U rank-sum test was used to compare groups at different time points.

Results

Flowchart of Patient Enrollment and Intervention Allocation (Figure 1).

Comparison of general data between the two groups

A total of 194 patients were included, among which there was 1 case in the control group (with a hospital stay of more than 24 h) and 2 cases in the experimental group (1 case with postoperative bleeding and 1 case transferred to the specialized ward). The final sample sizes of the control group and the experimental group were 96 cases and 95 cases respectively. Comparison of two groups of general data.The final sample size was 96 and 95 patients in the control and experimental groups, respectively. The comparison of general data between the two groups (Table 2).

Intervention outcomes

A comparison of postoperative rehabilitation (Time to first postoperative In-bed activity, Time to first postoperative Out-of-Bed activity, Active adverse events) is shown between the two groups.Control group has two patients experienced orthostatic hypotension during activity, no adverse events occurred in the Experimental group, and there was no significant difference between the two groups ($P > 0.05$) (Table 3).

The comparison of SDS, SAS scores, and satisfaction scores between the two groups showed no statistically significant difference ($P > 0.05$) (Table 4).

Comparison of pain conditions between the two groups ($N = 191$). The experimental group showed significantly lower pain scores than the control group at both 6 h postoperatively (mean difference: -1.8, 95% CI [-2.5, -1.1]) and before discharge (mean difference: -1.3, 95% CI [-2.0, -0.6]), with the differences being statistically significant ($P < 0.05$).

Discussion

Under the concept of ERAS, perioperative rehabilitation activities, as an economical, safe, and effective treatment mode, have been proven to improve the cardiopulmonary function and exercise ability of surgical patients, reduce the incidence of complications and hospital length through a series of biological mechanisms, and have a positive impact on the long-term quality of life of postoperative patients [17, 18]. The systematic evaluation of 167 patients with lung cancer surgery that included five randomized controlled trials conducted by Cavalheri et al. [19] showed that preoperative exercise training could reduce the risk of postoperative pulmonary complications by 67% and reduce the intercostal catheter band time and hospital length of the exercise group by 3 days and 4 days, respectively, and the 6-minute walking distance in the exercise group was significantly higher than that in the control group. One of the key measures of the ERAS treatment protocol is early ambulation. To our knowledge, early mobilization is currently underutilized in clinical practice due to the lack of specific guidelines. There is no standardized definition of early mobilization, nor are there uniform protocols for activity types or detailed mobilization plans. The patient did not know how to move after surgery or fear of activity, leading to a general reduction in early postoperative activities compliance [20, 21].

The day surgery EM program constructed in this study is safe and feasible and can improve postoperative activity outcomes

This study developed an early mobilization protocol for day surgery postoperative patients and quantified the mobilization content, which was subsequently implemented in clinical practice. The results demonstrated that promoting early mobilization did not increase the incidence of adverse events. The experimental group exhibited significantly earlier time to first postoperative in-bed activity and time to first postoperative out-of-bed activityto the control group ($P < 0.001$), indicating that quantified early mobilization combined with low-intensity resistance exercises enhances mobilization efficacy and reduces bed confinement duration, which aligns

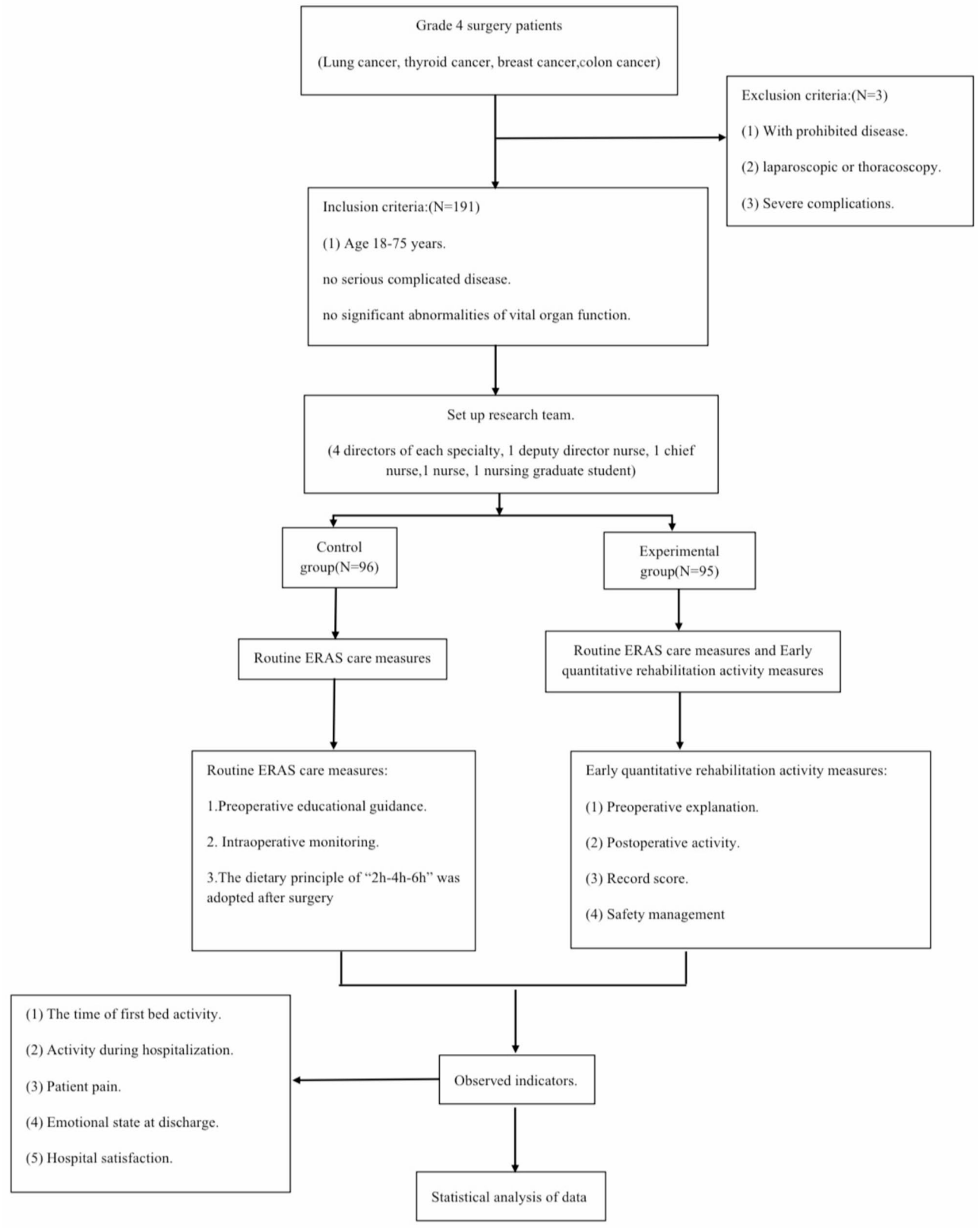

Fig. 1 Scheme construction flowchart. VAS, Visual analog rating. SAS, Self-Rating Anxiety. Scale SDS, Self-Rating Depression Scale. ASA, American Society of Anesthesiologists.ERAS, Enhanced recovery after surgery

Table 2 Comparison of basic data of 191 patients

Project	Control group (*n* = 96) [$\bar{x} \pm s/n\,(\%)$]	Experimental group (*n* = 95) [$\bar{x} \pm s/n\,(\%)$]	t/χ^2	*P*-value
Gender (male/female)	14/82	7/88	2.54	0.11[B]
age	43.2 ± 9.6	45.3 ± 11.7	1.36	0.05[A]
BMI				
≤ 18.4	7(7.3%)	8(8.4%)	1.09	
18.5–23.9	62(64.6%)	63(66.3%)		
24-27.9	22(22.9%)	20(21.1%)		0.56[A]
≥ 28	5(5.2%)	4(4.2%)		
degree of education				
Junior high school and below	16(16.7%)	26(27.4%)	7.54	
High school/technical secondary school	9(9.4%)	15(15.8%)		
Junior college and undergraduate	61(63.5%)	50(52.6%)		0.57[B]
postgraduate	10(10.4%)	4(4.2%)		
Operation time				
< 1 h	16(16.7%)	3(3.2%)	7.10	
1–2 h	57(59.4%)	27(28.4%)		
2–3 h	20(20.8%)	39(41.1%)		0.002[A]
3 h and more	3(3.1%)	26(27.4%)		
Amount of bleeding				
<20 ml	86(89.6%)	78(82.1%)	0.90	0.253[A]
21–50 ml	7(7.3%)	14(14.7%)		
51–100 ml	2(2.1%)	3(3.2%)		
>100 ml	1(1.0%)	0(0.0%)		

Note: [A] means: independent sample T test; [B] means:χ^2checkout. Body Mass Index (BMI)

Table 3 A comparison of postoperative rehabilitation is shown between the two groups (*N* = 191)

Project	Control group (*n* = 96)	Experimental group (*n* = 95)	Statistical Test	*P* Value	Cohen's d
Time to first postoperative In-bed activity(minutes)	60(30, 120)	30(12, 30)	Z=-8.300	< 0.001	0.87
Time to first postoperative Out-of-Bed activity (minutes)	240(180, 360)	180(120, 240)	Z=-5.986	< 0.001	0.50
Active adverse events	2(2.08)	0(0.00)	0.231[A]		0

[A] means: Fisher exact probability method is adopted

Table 4 The anxiety SAS, depression, SDS, and satisfaction scores before discharge between the two groups are shown. (*N* = 191)

Project	Control group (*n* = 96)	Experimental group (*n* = 95)	T Value	*P* Value	Cohen's d
SDS	4.27 ± 3.17	4.56 ± 3.37	− 0.606	0.687	-0.09
SAS	4.08 ± 2.44	4.33 ± 3.17	− 0.594	0.100	-0.09
Satisfaction score	87.09 ± 4.99	86.03 ± 5.57	1.380	0.980	0.20

Anxiety Scale (SAS); Self-Rating Depression Scale (SDS)

with findings from previous studies [22, 23].The primary methodology involved researchers recording patients mobilization times and activities in real-time at the bedside. This approach ensured patient safety while providing guidance to help patients achieve early mobilization goals effectively by discharge. Consequently, patients in the experimental group demonstrated significantly greater awareness of the importance of early mobilization and a better understanding of specific mobilization procedures compared to the control group.

EM can alleviate postoperative pain and enhance rehabilitation outcomes for patients

Studies have shown that over 80% of patients still experience pain after surgery, with 75% experiencing moderate to severe pain immediately after surgery [24]. Effective pain management is a prerequisite for early rehabilitation [25, 26]. In this study, both groups utilized the ERAS protocol during the perioperative period, employing prophylactic analgesia, multimodal pain management, and individualized pain control strategies. The results indicated that the experimental group reported lower pain scores 6 h postoperatively ($P = 0.002$) and before discharge ($P = 0.005$) than the control group, demonstrating that early postoperative mobilization does not increase pain perception when effective pain management is in

place. Therefore, patients can achieve high quality completion of their activity goals during early rehabilitation.

There was no statistically significant difference in emotional state and satisfaction between the experimental and control groups at discharge ($P > 0.05$), possibly due to the comprehensive medical and nursing support received by day surgery patients throughout the perioperative period. This support, ensuring the quality and safety of perioperative care, contributes to a positive healthcare experience for patients [27, 28].

Conclusion

This study constructs an early activity plan for postoperative patients and applies it to clinical practice, providing a basis and reference for nursing practice. It is safe and feasible, effectively improves the early postoperative recovery time of day-patients, and does not increase early activity-related adverse events, which is conducive to accelerating the postoperative rehabilitation of day-patients.

Limitations and future work

The sample size calculation was based on previous research, anticipating a mean difference of 30 min between groups. However, this estimate may be subject to uncertainties in the actual effect size. Although a statistically significant difference in surgery duration was observed between groups, this discrepancy is unlikely to have confounded our primary outcomes, as all patients received identical anesthetic and analgesic regimens—the primary determinants of early functional recovery. Additionally, while a 10% dropout rate was accounted for, the actual rate might have been higher, potentially compromising the study's statistical power. Consequently, future studies should: Expand sample sizes and employ propensity-score matching for surgical duration to mitigate residual confounding; Determine sample sizes using more precise effect size estimates derived from robust preliminary data; Incorporate higher statistical power requirements (> 90%) in study design.

This single-center trial utilized nurses (without rehabilitation therapists) to guide postoperative exercises. The rapid discharge protocol also limited collection of post-discharge recovery metrics. To address these limitations, future research should: Implement multidisciplinary collaboration with rehabilitation specialists; Establish structured long-term follow-up systems to comprehensively track recovery trajectories; Validate sustained functional outcomes beyond the immediate postoperative phase.

Abbreviations

EM Early mobilization
ERAS Enhanced recovery after surgery
VAS Visual Analog Scale
SAS Self-Rating Anxiety Scale
SDS Self-Rating Depression Scale
ASA American Society of Anesthesiologists

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Author contributions

M.J.H: Conceptualization, data analysis, interpretation of the data, writing-original draft & revising. H.Z: Data collection, resource, study supervision, project administration. X.Q.L: Data collection, study supervision, project administration. C.L.L: Data collection, resource, project administration. F.L: Data analysis, interpretation of the data.

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Data availability

All data generated or analyzed during this study are included in this published article and its supplementary information files. No additional external datasets were used.

Declarations

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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