Effects of Empowerment-Based Health Education Combined With Refined Pain Management on Postoperative Recovery in Patients Undergoing Laparoscopic Partial Hepatectomy

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AIM: To investigate the impact of empowerment-based health education combined with refined pain management in patients undergoing laparoscopic partial hepatectomy.

METHODS: Clinical data from 165 patients who underwent laparoscopic partial hepatectomy at The First Affiliated Hospital of Soochow University between March 2023 and March 2025 were retrospectively collected and analyzed. Based on documented nursing interventions, patients were assigned to an observation group (85 cases) or a control group (80 cases). The control group received routine nursing care, while the observation group received empowerment-based health education combined with refined pain management. Postoperative clinical indicators, postoperative pain intensity, quality of life, and the incidence of complications were compared between the two groups.

RESULTS: The time to first ambulation, time to first flatus, and time to first defecation were significantly shorter in the observation group than in the control group (all $p < 0.001$). Postoperative pain scores at 12 h, 24 h, and 48 h were significantly lower in the observation group compared with the control group (Wald $\chi^2 = 275.16$, $p < 0.001$). At three months after the intervention, scores across all quality-of-life dimensions, including physical, psychological, social function, and material well-being, were significantly higher in the observation group than in the control group ($p < 0.001$). Additionally, the incidence of postoperative complications was significantly lower in the observation group ($p < 0.05$).

CONCLUSIONS: Empowerment-based health education combined with refined pain management may facilitate early postoperative functional recovery and improve short-term quality of life in patients undergoing laparoscopic partial hepatectomy, while potentially reducing postoperative complications. These outcomes may be related to enhanced patient participation, optimized pain management, and improved adherence to rehabilitation protocols. This integrated nursing model may have potential value for clinical application. However, given the single-center retrospective design and the combined nature of the intervention, causal relationships cannot be established, and further validation through prospective, multicenter randomized controlled trials is warranted.

Keywords: patient empowerment; health education; pain management; postoperative recovery; laparoscopic partial hepatectomy

Introduction

Primary liver cancer is a common malignant tumor of the digestive system and ranks among the leading causes of cancer-related incidence and mortality worldwide. Early diagnosis and the implementation of comprehensive interventions centered on surgical resection are crucial for effectively improving the long-term prognosis of patients [1]. In recent years, with the widespread adoption of minimally invasive surgical concepts and continuous advances in laparoscopic surgical techniques, laparoscopic partial hepatectomy has become a primary treatment modality for primary liver cancer, multiple intrahepatic bile duct stones, and other hepatobiliary diseases. Compared with traditional open surgery, laparoscopic partial hepatectomy is associated with reduced surgical trauma, a milder systemic stress response, fewer postoperative complications, and more rapid postoperative recovery [2,3].

However, surgery remains an invasive intervention, and surgical trauma inevitably induces postoperative pain and systemic stress responses. Under the combined influence of pain stimulation and restricted mobility, patients are highly susceptible to negative psychological states, including anxiety and depression, which can severely impair postoperative quality of life and clinical prognosis [4]. Therefore, the adoption of effective interventions to alleviate postoperative pain and improve adverse emotional states is of significant importance for promoting enhanced recovery after surgery. Refined pain management emphasizes comprehensive pain assessment and the implementation of individualized, targeted analgesic strategies, which have been shown to effectively reduce pain intensity and improve patient comfort [5,6].

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Empowerment-based health education is a patient-centered nursing approach that aims to stimulate the intrinsic abilities of patients and their self-management potential. By guiding patients to actively participate in disease management and health decision-making, this model facilitates sustained behavioral change and may extend its benefits beyond hospital discharge, thereby improving nursing outcomes and long-term prognosis. At present, empowerment-based health education has been increasingly applied in the nursing care of various diseases [7].

Although refined pain management and empowerment-based health education each have their own advantages, previous studies have predominantly examined these approaches separately, with limited attention given to their integrated application. Notably, few studies have explored the systematic combination of empowerment-focused health education, which emphasizes psychological empowerment, with the contemporary concept of refined pain management. The novelty of the present study lies in the integration of these two advanced nursing philosophies into a unified "physiological-psychological" intervention model and its application to the perioperative management of patients undergoing laparoscopic partial hepatectomy, a complex surgical procedure. It is hypothesized that this combined model may exert a synergistic effect, whereby empowerment enhances patient understanding and adherence to pain management strategies, while effective pain control provides the physiological basis for early mobilization and active rehabilitation. Based on this premise, the present study aims to retrospectively evaluate the effects of empowerment-based health education combined with refined pain management on postoperative fast-track recovery in patients undergoing laparoscopic partial hepatectomy, with the objective of providing a more comprehensive, humanistic, and optimized nursing strategy for clinical practice in this field.

Methods

General Information

This retrospective study included clinical data from 165 patients who underwent laparoscopic partial hepatectomy at The First Affiliated Hospital of Soochow University between March 2023 and March 2025. Based on nursing interventions documented in the medical records, patients were allocated to an observation group (85 cases) or a control group (80 cases). This study was conducted in compliance with the relevant principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee of The First Affiliated Hospital of Soochow University (Approval no. 2025794).

Inclusion criteria were as follows: (1) patients with clear indications for laparoscopic partial hepatectomy who underwent the procedure for the first time; (2) normal preoperative gastrointestinal function and stable postoperative vital signs; (3) age between 18 and 80 years; and (4) clear consciousness with intact cognitive function.

Exclusion criteria were as follows: (1) comorbid severe organic diseases involving major organs; (2) coexistence of other malignant tumors or evidence of distant metastasis; (3) abnormal coagulation function; and (4) comorbid infectious diseases, communication disorders, or pregnancy and lactation.

Intervention Measures

As a retrospective study, all nursing interventions were identified and extracted from existing medical records, including nursing notes, care plans, health education logs, medication administration records, and follow-up documentation.

Control Group

Medical records indicated that patients in the control group received routine nursing care following laparoscopic partial hepatectomy. Routine care compromised preoperative health education covering the surgical procedure and perioperative preparations (e.g., fasting and bowel preparation), intraoperative monitoring of vital signs and body temperature, and postoperative nursing interventions, including vital signs monitoring, incision and drainage tube care, pain assessment and routine pain management, positioning, and basic guidance on diet and functional exercise. A routine follow-up visit was generally recommended approximately one month post-surgery.

Observation Group

Based on routine nursing care, a review of nursing records, care plans, health education documentation, and follow-up records revealed that patients in the observation group received a more systematic intervention that combined empowerment-based health education with refined pain management. The intervention components are detailed below.

(1) Empowerment-based health education

Systematic assessment: admission nursing records documented comprehensive assessments, including liver function using the Child-Pugh classification and nutritional risk screening (NRS) with the NRS2002 tool. Nursing notes also summarized assessments of patients' and family members' disease-related knowledge, primary concerns, and psychological status, obtained through structured communication.

Structured health education: medical records confirmed that standardized and structured health education was provided to patients and their families. Documented content included:

Disease-related education: records indicated that patients were informed of the advantages of laparoscopic surgery and the general postoperative recovery process and were

provided with written materials, such as a "Rehabilitation Guide for Liver Surgery".

Individualized guidance: nutrition consultation records reflected personalized dietary guidance, and nursing care plans included tailored dietary recommendation lists according to different recovery stages (recommended, restricted, and prohibited foods). Medication administration records were supplemented with medication instruction sheets detailing drug names, dosing schedules, and management of common adverse reactions.

Complication prevention education: nursing implementation records documented daily rehabilitation activities, such as guided ankle pump exercises and effective coughing training with incision splinting instructions.

Diversified educational methods: nursing notes recorded the use of combined online and offline educational approaches, including postoperative rehabilitation videos delivered via quick response (QR) codes and participation in offline rehabilitation training sessions.

Discharge planning and follow-up: discharge summaries included individualized post-discharge self-management plans that covered pain control, medication use, activity guidance, and monitoring for abnormal symptoms. Telephone and WeChat follow-up records documented weekly post-discharge communications, during which nurses reviewed implementation of the self-management plan, addressed patients' concerns, and provided tailored guidance. The intervention was sustained for a total of three months postoperatively.

(2) Refined pain management

Comprehensive and dynamic pain assessment: nursing records, particularly within the first 48 h post-surgery, demonstrated systematic pain assessments conducted at fixed time points (e.g., 2 h, 12 h, and 24 h after surgery) and prior to specific procedures, such as dressing changes or ambulation. Pain intensity was evaluated using the Visual Analogue Scale (VAS), with distinction between static pain at rest and dynamic pain during activities such as coughing. Pain-related changes in vital signs, including heart rate and blood pressure, were also recorded.

Scheduled and stepwise pharmacological management: physician orders and medication administration records showed that analgesics were administered on a scheduled, around-the-clock basis rather than solely on an as-needed basis. Analgesic selection followed the WHO three-step analgesic ladder [8]. Progress notes detailed dynamic adjustments of analgesic regimen based on VAS scores, with opioids generally used for VAS >3 and non-steroidal anti-inflammatory drugs for VAS ≤ 3. Monitoring and management of adverse drug reactions, such as nausea and respiratory depression, were also recorded.

Non-pharmacological pain management: nursing implementation records documented the application of multiple non-pharmacological interventions, including:

Cognitive-behavioral interventions: instruction in diaphragmatic deep breathing techniques to alleviate pain and the use of music or conversation to distract attention from pain.

Physical interventions: local cryotherapy was applied around trocar incisions for 15 minutes, positioning was maintained in a semi-Fowler's position to reduce abdominal tension, and guidance was provided for family members on gentle abdominal massage.

(3) Adherence monitoring and assurance measures

To ensure continuity of empowerment-based health education during the three-month post-discharge period, medical records indicated the establishment of a standardized follow-up and adherence to the monitoring process.

Pre-discharge adherence assurance: discharge summaries and nursing notes confirmed that, prior to discharge, nurses assisted patients in developing detailed post-discharge self-management plans and evaluated comprehension using the teach-back method. Nursing records documented the ability of patients to independently reiterate key elements of post-discharge wound care and 'red flag' symptoms, ensuring initial understanding of the self-management plan.

Continuous post-discharge adherence monitoring: Telephone and WeChat follow-up logs demonstrated that weekly follow-ups were conducted using a structured adherence assessment framework, rather than informal or courtesy contacts. Nursing records confirmed that nurses, through systematic questioning, evaluated patients' implementation of the various components of the post-discharge self-management plan. Documented assessment items included medication adherence, symptom monitoring, and rehabilitation activities.

Specifically, medication adherence was assessed by reviewing the medication records of patients for the previous week, with no missed or incorrect doses reported. Symptom monitoring adherence was evaluated based on reports of patients completing daily pain diaries as required and their ability to describe pain trends. Rehabilitation activity adherence was assessed by confirming the achievement of prescribed activity targets, such as 20 minutes of daily walking and completion of 10 sets of ankle pump exercises, as outlined in the rehabilitation plan.

Analysis, dynamic intervention, and effect tracking of non-compliance: when poor compliance or misunderstanding was identified during follow-up, nursing records documented not only the management measures taken but also a closed-loop management process characterized by "analysis-intervention-tracking". Follow-up records indicated that nursing staff systematically analyzed and recorded the underlying causes of poor compliance, which were commonly categorized as knowledge-related barriers (e.g., misunderstanding dietary recommendations), psychological barriers (e.g., avoidance of functional exercises due to fear of pain), or skill-related barriers (e.g., insufficient proficiency of family members in wound care techniques).

Specification of improvement strategies and outcome evaluation: nursing records further confirmed that individualized and dynamic intervention strategies were implemented according to the identified barriers, rather than relying on non-specific re-education. For patients experiencing psychological barriers, such as fear of pain during functional exercises, records showed targeted guidance, including coordination with the refined pain management plan. Patients were instructed to administer prescribed pro re nata (PRN) analgesics 30 minutes before planned activities and to break down activity goals into shorter, more frequent sessions. Subsequent follow-up entries documented the effectiveness of the intervention, noting significantly reduced pain during activity, improved completion of the planned activity volume, and increased patient confidence.

For patients with knowledge-related barriers, particularly in terms of dietary guidance, nursing records documenting verbal explanations were supplemented with concrete support measures. These included the delivery of illustrative food images and simplified recipes via WeChat, as well as joint online communication sessions involving primary family caregivers to ensure the information was effectively conveyed. Follow-up records confirmed the effectiveness of these measures, with patients and family members reporting clear comprehension and appropriate dietary adjustments.

Collectively, these closed-loop record entries systematically captured the causes of poor compliance, the individualized interventions implemented by the nursing team, and their subsequent outcomes. This provided an objective basis for assessing the continuity of patient adherence throughout the three-month intervention period and more accurately reflected the dynamic processes and practical effects of the combined intervention model in this retrospective study.

Observation Indicators

All data for the observed outcomes in this study were retrospectively extracted from archived medical records. The data were primarily obtained from two sources: the hospital electronic medical record (EMR) system and a specialized nursing follow-up database maintained by the department.

(1) Postoperative clinical indicators: the time to first ambulation, time to first flatus and defecation were directly extracted from nursing records and progress notes by the physician in the EMR system.

(2) Pain assessment: postoperative pain intensity scores at 12 h, 24 h, and 48 h were obtained from nursing records in the EMR system. According to the records, pain was uniformly assessed using the Numeric Rating Scale [9], with scores ranging from 0 to 10, where lower scores indicate less pain.

(3) Quality of life assessment: quality-of-life data were obtained from the dedicated nursing follow-up database from the department. Between March 2023 and March 2025, as part of a quality improvement initiative, a standardized assessment and follow-up protocol were applied to all patients undergoing laparoscopic partial hepatectomy.

Pre-intervention data collection: under this protocol, the primary nurse conducted a baseline assessment using the hospital-revised Generic Quality of Life Inventory (GQOLI-74) after admission and before any major intervention, and the results were recorded in the follow-up database. For the present analysis, these baseline records were retrospectively extracted.

Post-intervention 3-month data collection: all patients underwent a structured telephone follow-up 3 months after discharge, following the same standardized follow-up protocol. This follow-up included a repeat quality-of-life assessment using the hospital-revised GQOLI-74. The corresponding 3-month records were then retrieved from the database for analysis.

This study employed an in-hospital revised version of the GQOLI-74, originally developed by Li and Yang [10]. The original GQOLI-74 comprises four dimensions: physical, psychological, social functioning, and material life status, with 20, 20, 20, and 10 items in each dimension, respectively, totaling 70 items. Additionally, there are 4 global quality-of-life items, yielding a total of 74 items [11]. Based on long-term clinical application, the nursing team made minor revisions to the scale in 2022. While retaining the original four-dimensional structure, most items, and the scoring method, the four global quality-of-life items were incorporated into the social functioning dimension, with slight wording modifications to better reflect postoperative recovery in family roles, social interaction, and social support. In this hospital-revised version, the social functioning dimension therefore includes 24 items, the global quality-of-life items are no longer presented as an independent domain, and the total number of items remains 74.

The revised version of the scale consists of four dimensions: physical functioning (20 items; theoretical score range 20–100), psychological functioning (20 items; 20–100), social functioning (24 items; 24–120), and material life status (10 items; 10–50), with a total of 74 items. All items are rated using a 5-point Likert scale (1–5). Some items are reverse-scored, and scores were transformed so that higher values indicate better quality of life. In this study, the same hospital-revised GQOLI-74 was applied for both baseline assessment and the 3-month postoperative follow-up.

This approach ensured the acquisition of systematic, complete, and internally consistent pre- and post-intervention quality-of-life data for comparative analysis.

(4) Postoperative complications: including surgical site infection, bile leakage, and intra-abdominal hemorrhage, were determined through retrospective review of surgical reports, imaging reports, laboratory results, and discharge summaries within the EMR system.

Table 1. Comparison of baseline clinical characteristics between the two groups.

Variable	Observation group (n = 85)	Control group (n = 80)	t/χ^2	p-value
Age (years)	51.50 ± 5.25	51.40 ± 4.75	0.128	0.898
Gender (male/female)	47/38	43/37	0.040	0.842
Child-Pugh classification				
Grade A	64 (75.29)	56 (70.00)	0.582	0.445
Grade B	21 (24.71)	24 (30.00)		
Intraoperative blood loss (mL)	698.71 ± 72.30	705.30 ± 70.50	0.592	0.554
Body mass index (kg/m^2)	23.05 ± 2.54	23.20 ± 2.32	0.395	0.693
ASA classification				
Level I	25 (29.41)	28 (35.00)	0.590	0.442
Level II	60 (70.59)	52 (65.00)		
Tumor diameter (cm)	5.30 ± 1.50	5.45 ± 1.60	0.632	0.528

ASA, American Society of Anesthesiologists.

Table 2. Comparison of postoperative clinical recovery indicators between the two groups [M (P_{25}, P_{75}), h].

Group	n	Time to first ambulation	Time to first flatus	Time to first defecation
Observation group	85	45.2 (40.0, 50.5)	30.2 (25.0, 36.0)	35.2 (30.0, 40.0)
Control group	80	54.6 (50.0, 60.0)	46.8 (40.0, 54.0)	48.1 (42.0, 55.0)
Z-value		7.604	8.647	9.661
p-value		<0.001	<0.001	<0.001

Table 3. Comparison of postoperative pain scores between the two groups [M (P_{25}, P_{75})].

Group	n	12 h postoperatively	24 h postoperatively	48 h postoperatively	Wald χ^2	p-value
Observation group	85	4.0 (3.0, 4.0)	3.0 (3.0, 3.0)	2.0 (2.0, 3.0)	275.16	<0.001
Control group	80	5.0 (4.0, 6.0)	4.0 (4.0, 5.0)	4.0 (3.0, 4.0)		

Statistical Methods

All collected data were analyzed using SPSS version 26.0 (IBM, Armonk, NY, USA). The Shapiro-Wilk test was first used to assess the normality of continuous variables. Data conforming to a normal distribution were expressed as mean ± standard deviation and compared between groups using the independent samples t-test. Data that did not follow normal distribution were expressed as median (M) and interquartile range (P_{25}, P_{75}) and compared using the Mann-Whitney U test.

Postoperative pain scores, which represent ordinal categorical data measured repeatedly at multiple time points (12 h, 24 h, and 48 h postoperatively), were analyzed using a generalized estimating equations (GEE) model to account for the inherent correlation among repeated measurements. This GEE model was used to evaluate the overall effects of the different nursing groups (observation group vs. control group) and time on pain scores. Categorical variables were expressed as numbers and percentages (n [%]), and comparisons between groups were performed using the chi-square (χ^2) test or Fisher's exact test, as appropriate. A p-value $<$ 0.05 was considered statistically significant.

Results

General Information

The general characteristics of patients in the two groups are presented in Table 1. There were no statistically significant differences between the two groups, indicating baseline comparability ($p > 0.05$).

Postoperative Clinical Indicators

Following the Shapiro-Wilk normality test, the times to first ambulation, first flatus, and first defecation did not follow a normal distribution; therefore, comparisons between groups were performed using the Mann-Whitney U test. The results showed that the median times for all postoperative recovery indicators were significantly shorter in the observation group than in the control group ($p < 0.001$; Table 2).

Postoperative Pain Outcomes

Generalized estimating equations (GEE) analysis showed a significant overall group effect, indicating that during postoperative follow-up, the postoperative pain score in the observation group was lower than that in the control group ($p < 0.001$; Table 3).

3.4 Quality of Life Assessment

At three months after the intervention, scores for all dimensions of quality of life, including physical functioning, psychological functioning, social functioning, and material/living status, were significantly higher in the observation group than in the control group ($p < 0.001$; Table 4).

Table 4. Comparison of quality-of-life scores between the two groups (mean ± standard deviation).

Group	n	Physical function		Psychological function	
		Before intervention	3 months after intervention	Before intervention	3 months after intervention
Observation group	85	61.49 ± 5.79	86.36 ± 6.93	60.09 ± 8.50	89.09 ± 6.05
Control group	80	62.00 ± 6.28	75.20 ± 7.74	58.60 ± 8.58	78.50 ± 6.77
t-value		0.538	9.770	1.123	10.617
p-value		0.591	<0.001	0.263	<0.001
Group	n	Social function		Material/living status	
		Before intervention	3 months after intervention	Before intervention	3 months after intervention
Observation group	85	81.40 ± 8.20	109.15 ± 5.58	25.80 ± 6.78	41.29 ± 4.16
Control group	80	80.94 ± 5.57	98.50 ± 7.10	26.20 ± 7.04	35.20 ± 4.20
t-value		0.426	10.676	0.372	9.369
p-value		0.671	<0.001	0.711	<0.001

Table 5. Comparison of postoperative complications between the two groups [n (%)].

Group	n	Incision infection	Bile leakage	Abdominal bleeding	Total
Observation group	85	1 (1.18)	0	2 (2.35)	3 (3.53)
Control group	80	3 (3.75)	3 (3.75)	4 (5.00)	10 (12.50)
χ^2					4.569
p-value					0.033

Postoperative Complications

The overall incidence of postoperative complications in the observation group was significantly lower than that in the control group ($p < 0.05$; Table 5).

Discussion

This retrospective study examined the effects of empowerment-based health education combined with refined pain management on early postoperative recovery in patients undergoing laparoscopic partial hepatectomy. The results demonstrated that, compared with routine nursing care, patients in the observation group experienced more rapid recovery in key postoperative clinical indicators, including time to first ambulation, time to first anal exhaust, and time to first defecation. The overall comparative results indicated a significant difference in postoperative pain scores between the two groups within 48 hours after surgery (Wald $\chi^2 = 275.16$, $p < 0.001$). Furthermore, at three months after discharge, quality-of-life scores across all evaluated dimensions, including physical functioning, psychological functioning, social functioning, and material life status, were significantly higher in the observation group. Additionally, the overall incidence of postoperative complications was lower in the observation group. Taken together, these findings suggest that, within the limitations of this study population and design, the integration of empowerment-based health education with refined pain management is associated with improved short-term postoperative recovery and enhanced mid-term quality of life following laparoscopic partial hepatectomy.

In this study, pain scores in the observation group remained consistently lower than those in the control group within 48 h after surgery. This finding suggests that, under current medical and nursing conditions, more systematic and proactive pain assessment and intervention may contribute to maintaining relatively lower pain levels during the early postoperative period. Nursing records indicated that patients in the observation group underwent standardized pain assessments at fixed time points and before key procedures, such as initial ambulation and functional exercises, allowing changes in pain intensity and characteristics to be identified and addressed in a timely manner. On this basis, analgesic regimens were adjusted promptly and supplemented with non-pharmacological interventions, including position adjustment, local cold application, and breathing relaxation training, thereby facilitating continuous pain control [12,13].

Although the design of this study does not allow for causal inference, improved pain control may reduce patients' fear of activity and avoidance behavior, thereby increasing their willingness and ability to participate in planned rehabilitation activities, such as ambulation and respiratory exercises. Increased participation in these activities may, in turn, be associated with earlier recovery of gastrointestinal function and shorter clinical recovery times [14]. It should be emphasized that this proposed "pain relief-increased activity-accelerated recovery" pattern is inferred primarily from observational findings and clinical experience. The potential influence of confounding factors, including age, comorbidities, extent of surgery resection, and anesthetic management, cannot be ruled out. Accordingly, these associations require confirmation in future prospective and controlled studies.

In the present study, a hospital-revised version of the GQOLI-74 scale was used to assess the physical, psychological, social, and material dimensions of quality of life at

baseline and at three months post-surgery. At admission, scores across all dimensions were comparable between the two groups. At the three-month follow-up, however, patients in the observation group showed higher scores across all domains than those in the control group, suggesting an association between the combined intervention and improved quality of life, although the available data are insufficient to establish causality.

In terms of physical functioning, the higher scores observed in the observation group may reflect the combined effects of improved pain control, earlier and more active mobilization, and a lower incidence of postoperative complications, all of which collectively facilitate the recovery of self-care ability and overall physical capacity [15]. For psychological functioning, improved scores in domains such as anxiety, tension, and concerns about prognosis may be associated with an enhanced understanding of the surgical and recovery processes, maintenance of pain at a tolerable level, and sustained professional support during the post-discharge follow-up period [16]. The observed improvement in social functioning suggests that patients in the observation group may have resumed family roles and routine social interactions more smoothly. However, the underlying mechanisms remain unclear and warrant further investigation.

For material life status, although an improvement trend in scores was observed, the lack of objective socioeconomic indicators, such as income level and occupational changes, together with the relatively short follow-up period, limits the interpretation of the stability and long-term significance of this dimension. Therefore, findings related to material life status should be considered exploratory and require validation through longer-term, multicenter follow-up studies.

In this study, empowerment-based health education was primarily implemented to enhance patients' adherence and active participation in postoperative rehabilitation. After admission, patients in the observation group underwent more comprehensive assessments, including evaluations of liver function, nutritional risk, disease understanding, psychological status, and family support. Based on these assessments, individualized health education and nursing plans were formulated. The nursing team not only provided explanations regarding disease characteristics, surgical procedures, and potential postoperative discomforts to patients and their families, but also used written materials, multimedia resources, and group-based activities to translate abstract rehabilitation goals into concrete daily tasks, such as prescribed walking duration, frequency of breathing exercises, and key points of dietary modification [17,18].

Before discharge, nurses collaborated with patients to develop individualized post-discharge self-management plans and applied the teach-back method to verify that patients and their primary caregivers could accurately restate the essential instructions. During the post-discharge period, regular follow-up via telephone and WeChat helped reinforce adherence to the prescribed plan and identify implementation barriers in a timely manner. This process allowed targeted guidance, such as adjusting exercise intensity, clarifying dietary precautions, and encouraging family involvement in supervision [19]. This continuous and bidirectional communication approach may, to some extent, enhance patients' sense of engagement and facilitate more consistent adherence to rehabilitation plans during the postoperative phase, which may be associated with improved quality of life and functional recovery [20,21]. However, as intermediary variables, such as self-efficacy and health literacy, were not quantitatively assessed in this study, these interpretations warrant further validation in future studies using dedicated assessment scales.

For postoperative complications, this study observed a lower overall incidence in the observation group than in the control group, including complications such as incision infection, bile leakage, and intra-abdominal hemorrhage. However, because postoperative complications are influenced by multiple factors, including surgical approach, operative duration, intraoperative blood loss, patient comorbidities, and perioperative management, these findings do not establish a direct causal relationship between the combined intervention and reduced complication risk. Instead, they suggest several plausible explanations. For example, improved pain control and earlier mobilization may facilitate the clearance of respiratory secretions and enhance venous return in the lower extremities, thereby potentially reducing secondary complications such as pulmonary infections and venous thrombosis [22,23]. Additionally, ongoing health education and follow-up may increase patients' and caregivers' awareness of warning signs, such as wound exudates, fever, or progressive abdominal pain, prompting earlier medical consultation and timely intervention, which may help prevent the progression of some complications [24,25]. From a clinical perspective, these findings suggest that, within an enhanced recovery after surgery (ERAS) framework, incorporating refined pain management and empowerment-based health education into a structured perioperative nursing pathway may represent a feasible approach for reducing selected adverse events [26]. Nonetheless, these potential benefits require confirmation through studies with larger sample sizes, longer follow-up periods, and more rigorous prospective designs.

This study suggests that empowerment-based health education combined with refined pain management may be beneficial for postoperative recovery in patients undergoing laparoscopic partial hepatectomy. However, several limitations should be acknowledged, and the findings should be interpreted with caution. First, this was a single-center, retrospective observational study, and the choice of nursing models was not based on random allocation, making it difficult to fully avoid selection and information bias. Potential confounding factors, such as age, educational level, health literacy, and family support, may have differed be-

tween the two groups and were not comprehensively adjusted for in the analysis. Second, several key outcomes (e.g., pain scores and quality-of-life scores) relied on patient self-report and were therefore susceptible to the influence of emotional state, expectations, and nurse–patient interactions, potentially introducing reporting bias. Third, follow-up in this study was limited to 3 months after surgery. Consequently, longer-term outcomes, including chronic postoperative pain, prolonged analgesic use, readmission rates, and return to work, could not be evaluated, and the impact of the intervention on long-term oncological prognosis and healthcare costs remains unclear. Additionally, socioeconomic and clinical baseline variables, such as educational attainment, occupational category, household income, and detailed comorbidity profiles, were not systematically collected or incorporated into the analysis. Moreover, both the overall sample size and the absolute number of complications were relatively small, which may reduce the statistical power and robustness of certain endpoint estimates.

Given these limitations, future studies should further optimize both research design and outcome measures. Multicenter, prospective randomized controlled trials with standardized surgical and anesthetic protocols and clearly defined nursing models are needed to minimize selection bias and enhance the generalizability of the findings. Building on the clinical recovery indicators, pain scores, and quality-of-life assessments used in the present study, future research should also incorporate additional psychosocial variables, such as self-efficacy, health literacy, and levels of anxiety and depression. Extended follow-up periods would allow more systematic assessment of chronic pain, long-term functional recovery, and readmission rates, thereby providing a more comprehensive understanding of the medium- and long-term effects of the combined intervention. In addition, subgroup analyses stratified by age, comorbidity status, and level of family support may help to explore heterogeneity in treatment effects across different patient populations and inform more individualized intervention strategies. Through such further investigations, higher-level evidence may clarify the indications and practical value of empowerment-based health education combined with refined pain management in the perioperative care of patients undergoing laparoscopic partial hepatectomy, thereby supporting its broader application as a comprehensive nursing model in clinical practice.

Conclusions

In summary, the results of this retrospective study indicate that the combination of empowerment-based health education and refined pain management was associated with improved postoperative recovery outcomes. Due to the inherent risks of bias related to the study design, the "black box" nature of the combined intervention, the relatively short follow-up period, and the lack of multivariable analyses to adjust for potential confounding factors, the conclusions should be considered preliminary and exploratory. The primary value of this study lies in hypothesis generation that warrants validation through more rigorously designed, multicenter, longer follow-up periods.

Availability of Data and Materials

The data analyzed are available from the corresponding author upon reasonable request.

Author Contributions

YC and YQ designed the study and conducted this study. YC supervised the data collection and analyzed the data. YQ interpreted the data. YC and YQ drafted the manuscript for publication and reviewed the manuscript. Both authors have been involved in revising the manuscript critically for important intellectual content. Both authors gave final approval of the version to be published. Both authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

Ethical approval was obtained from the Ethics Committee of The First Affiliated Hospital of Soochow University (Approval no. 2025794). Given the retrospective nature of this study, all data were extracted in an anonymized fashion from existing medical records. The research process involved no prospective interventions or exposure of patients' personal identifying information and effectively protected patient privacy and rights. Therefore, the Ethics Committee of The First Affiliated Hospital of Soochow University waived the informed consent. This study was conducted in compliance with the relevant principles outlined in the Declaration of Helsinki.

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Conflict of Interest

The authors declare no conflict of interest.

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