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ORIGINAL RESEARCH

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Effect of enhanced recovery after surgery under a comprehensive nursing framework on urinary continence and quality of life in prostate cancer patients

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Abstract

Background: This study aimed to evaluate the impact of enhanced recovery after surgery (ERAS), implemented within a comprehensive nursing framework. We focused on its effect on urinary continence, erectile function, and quality of life in prostate cancer patients during the perioperative period. **Methods**: A retrospective analysis was conducted on clinical data of 105 patients who underwent laparoscopic radical prostatectomy for prostate cancer in our hospital between June 2020 and June 2021. Patients were retrospectively allocated based on nursing records: the observation group (n = 55) received ERAS nursing under a comprehensive nursing framework, and a control group (n = 50) received conventional nursing care. Differences in urinary continence, erectile function, postoperative pain outcomes, and quality of life were compared between the two groups. **Results**: At 1-year post-surgery, the observation group exhibited a significantly lower International Consultation on Incontinence Questionnaire-Short Form (ICI-Q-SF) score and higher International Index of Erectile Function-5 (IIEF-5) score than the control group ($p < 0.05$). Within the observation group, the subgroup that underwent early, standardized pelvic floor muscle training demonstrated lower ICI-Q-SF scores and significantly higher IIEF-5 scores than the non-standardized training subgroup ($p < 0.05$). At postoperative days 3, 7, and 14, the observation group's pain scores were significantly lower than the control group ($p < 0.05$). Among the observation group patients, those receiving ERAS reported significantly lower pain scores than those who received conventional analgesia ($p < 0.05$). At 1 year after nursing, the observation group showed higher functional domains and overall health scores, lower symptom scores, and fewer complications compared to the control group ($p < 0.05$). **Conclusions**: Incorporating an ERAS program into a comprehensive nursing framework for patients undergoing radical prostatectomy significantly improves urinary continence and erectile function. It also alleviates postoperative pain, enhances quality of life, and reduces complications.

Keywords

Enhanced recovery after surgery; Comprehensive nursing; Prostate cancer; Prostate function

1. Introduction

Prostate cancer, as one of the most common malignancies among Chinese males, severely impacts patients' quality of life [1]. Radical prostatectomy is the primary curative treatment for localized prostate cancer; however, postoperative complications such as urinary incontinence, sexual dysfunction, and pain remain significant clinical challenges [2]. Traditional perioperative nursing models often focus merely on executing medical orders, are monolithic in content, and fail to address the individualized physiological and psychological needs of patients. This, in turn, can adversely affect their recovery process and treatment adherence [3].

In recent years, the Enhanced Recovery After Surgery (ERAS) philosophy has demonstrated significant advantages in accelerating patient recovery by optimizing perioperative management protocols [4]. However, to further enhance nursing outcomes, this study innovatively integrates the ERAS philosophy into a comprehensive, multidisciplinary nursing framework. This model not only encompasses the core principles of ERAS but also incorporates multifaceted support, including psychological, nutritional, and personalized rehabilitation guidance, aiming to address the shortcomings of

conventional care. Therefore, this study aims to investigate the unique advantages and clinical value of this novel, integrated nursing model in improving postoperative urinary continence, sexual function, pain management, and overall quality of life for patients with prostate cancer, compared to traditional nursing care.

2. Materials and methods

2.1 General data

The sample size was estimated using the formula for comparing two independent sample means in a group design (Eqn. 1):

$$n = 2 \times [(\mu_\alpha + \mu_\beta)^2 \sigma^2] \quad (1)$$

The significance level (α) was set at 0.05, the type II error β was set at 0.1, giving the test power ($1 - \beta$) of 0.9. From the table, we find $\mu_{0.05}$ = 1.96 and $\mu_{0.1}$ = 1.282. Based on preliminary clinical observations from 11 cases, the estimated mean difference (δ) between the two groups was 4.5, and the estimated standard deviation (σ) for both groups was 6.5. Substituting these values into the formula, the calculated sample size for each group was $n_1 = n_2 = 43.9$ cases. After accounting for a 15% loss to follow-up and adjusting for a 1:1 allocation ratio between the observation group and control group, the required sample sizes were determined to be 55 cases for the observation group and to cases for the control group.

During the study period, a total of 160 patients underwent the specified surgery. Of these, 30 were excluded due to severe comorbid cardiovascular diseases, and 25 were excluded due to incomplete data records. This resulted in a final cohort of 105 patients for analysis.

A retrospective analysis was conducted on the clinical data of 105 patients who underwent laparoscopic radical prostatectomy for prostate cancer at our hospital between June 2020 and June 2021. Patients were assigned to groups based on the nursing approach recorded in their case files. The observation group (n = 55) received ERAS-based nursing under a comprehensive nursing framework, while the control group (n = 50) received conventional nursing care. Ethical approval was obtained from the hospital's ethics committee.

Inclusion criteria comprising (1) Diagnosis of prostate cancer confirmed by endoscopy, ultrasound, urinalysis, and prostate-specific antigen testing. (2) No recent major surgeries involving pelvic organs, thoracic cavity, or cranial cavity. (3) No history of traditional open abdominal surgery, no severe chronic underlying diseases, and the ability to tolerate CO_2 pneumoperitoneum. (4) Complete surgical data and conscious patients capable of effective communication.

Exclusion criteria include (1) The Presence of organic diseases affecting the heart, kidneys, or liver. (2) Patients with malignant tumors other than prostate cancer. (3) Patients with systemic autoimmune diseases or severe infections. (4) Patients with cognitive disorders or psychiatric conditions.

2.2 Methods

This was a retrospective study, and the nursing methods were obtained from existing case records. Patients in the control group received conventional, protocol-driven nursing care, while patients in the observation group received comprehensive nursing based on the ERAS concept.

2.2.1 Control group: conventional nursing care

Control group (conventional care): This group adhered to a traditional care pathway. Core measures included: fasting from food and fluids for 12 hours preoperatively, routine bowel preparation, an opioid-based analgesic regimen, resumption of diet after the first passage of flatus, ambulation commencing 2–3 days postoperatively, and standard discharge instructions.

2.2.2 Observation group: comprehensive ERAS-based nursing

The observation group received comprehensive nursing care based on the ERAS concept.

(1) Multidisciplinary Team & Planning:

A dedicated ERAS team was established, comprising 2 urologists, 1 psychologist, 2 anesthesiologists, 5 nurses, and 1 nutritionist. The team created an individualized care plan following ERAS principles. This plan addressed the surgical approach, anesthesia, analgesia, nutrition, and psychological support to reduce anxiety and distress.

(2) Preoperative management:

Upon admission, the nursing staff conducted a comprehensive assessment of the patient's condition and provided health education to the patient.

(3) Intraoperative care:

The anesthesiologist applied an individualized, multimodal, opioid-sparing analgesia regimen. Active warming measures (*e.g.*, forced-air warming blankets) were employed to maintain normothermia. Goal-directed fluid therapy was utilized to prevent fluid overload. After the surgery, the catheter was secured, and patients were carefully transferred to the recovery room, monitored for post-anesthesia restlessness, with treatment given if needed.

(4) Postoperative care:

• Pain management: Multimodal analgesia continued postoperatively, prioritizing non-opioid agents and supplemented with patient education on non-drug pain relief. Pain was assessed as soon as the patient was awake, and an individualized pain plan was implemented. Nonsteroidal anti-inflammatory drugs (NSAIDs) were used for mild pain to limit opioid use. Warm compresses were also recommended.

• Postoperative diet: Clear liquids started once the patient was fully awake. A soft diet was introduced within 6–12 hours, without waiting for flatus. If tolerated, a regular diet begins by day 3. Fluid intake was limited to 1–2 liters/day and stopped after passing gas.

• Postoperative activity: On day 1 post-surgery, urologists assessed the patient's recovery and encouraged early postoperative rehabilitation activities such as joint flexion and extension, sitting, and standing, with a total duration of 20 minutes per session, twice a day. By day 2, patients were

encouraged to progress to bedside activities and eventually walk. The room's temperature and humidity were adjusted to create a comfortable, quiet environment, ensuring adequate sleep.

• Complication prevention: Patients were instructed on the proper use of compression stockings to prevent deep vein thrombosis. A rehabilitation physician initiated pelvic floor muscle training (PFMT) early, following a structured, one-on-one program (3 times/day, 10 repetitions each, 6–8 seconds per repetition). Nurses ensured catheter patency, maintained hygiene, monitored fever or hypothermia, and followed orders for anti-inflammatory and electrolyte management.

• Discharge instructions: Before discharge, contact details were collected for follow-up. Patients received enhanced education, access to digital resources, and scheduled check-ups (*e.g.*, 3 months post-discharge).

(5) Psychological nursing:

Led by the team's psychological counselor, psychological nursing is implemented throughout the entire perioperative period.

① Systematic preoperative assessment and education:

• Standardized assessment: Upon admission, in addition to routine nursing assessments, the psychological counselor utilizes standardized assessment scales (*e.g.*, the Hospital Anxiety and Depression Scale, HADS) to establish a baseline psychological profile of the patient. This allows for the precise identification of individuals at high risk for anxiety or depression.

• Multimedia-enhanced patient education: This approach moves beyond traditional, singular oral explanations. The multidisciplinary team employs well-designed presentations (PPT), animated videos, and illustrated brochures to systematically introduce the surgical procedure, anesthesia methods, and key aspects of postoperative recovery (*e.g.*, duration of urinary catheterization, pain management, the importance of early mobilization). This initiative is designed to eliminate fear stemming from the unknown, build patient trust in the treatment plan, and establish realistic expectations for the recovery process.

② Individualized psychological counseling and nursing:

• Proactive communication and empathy: One to two days before surgery, the primary nurse and psychological counselor increase the frequency of their visits to engage in proactive, in-depth, one-on-one communication with the patient. The focus is on listening to the patient's concerns (*e.g.*, fear of surgical failure, postoperative urinary incontinence, impact on sexual function), providing empathy and support, and guiding the patient to fully express their negative emotions.

• Cognitive-Behavioral therapy (CBT): For patients exhibiting significant anxiety, the psychological counselor employs simplified CBT techniques to help them identify and correct catastrophic thinking related to the surgery and to foster a positive mindset.

• Professional relaxation training: Patients are instructed in specific relaxation techniques. For example, they are guided through diaphragmatic deep breathing exercises ("As you inhale, imagine drawing air deep into your abdomen, allowing it to expand; as you exhale, slowly contract your abdomen, fully expelling the used air") and are asked to practice daily. For those with difficulty sleeping, progressive muscle relaxation or the use of specific white noise or light music (music therapy) is applied to help them achieve adequate sleep before the surgery.

(6) Nutritional support:

Managed by the team's dietitian, the nutritional support aims to optimize the patient's nutritional status, reduce surgical stress, and accelerate postoperative recovery.

① Precise preoperative nutritional assessment and optimization:

• Nutritional risk screening: Upon admission, all patients are screened for nutritional risk by the dietitian using a standardized tool (*e.g.*, nutritional risk screening (NRS)-2002). For patients identified as being at nutritional risk (*e.g.*, significant recent weight loss, poor food intake), a further comprehensive assessment is initiated.

• Personalized dietary guidance: Based on the assessment results and the patient's dietary preferences, the dietitian formulates a personalized preoperative dietary plan. The plan typically recommends a high-protein, balanced diet to enhance the body's reserves. Concurrently, patients are explicitly informed that mechanical bowel preparation (enema) is not required, with an explanation that this helps preserve intestinal flora and function.

② Standardized preoperative carbohydrate loading:

• Clear purpose and procedure: Healthcare professionals provide a detailed explanation of the benefits of preoperative oral carbohydrate loading, which is to simulate a "postprandial state". This can effectively reduce postoperative insulin resistance and decrease feelings of hunger, thirst, and anxiety.

• Standardized execution: A strict adherence to the principle of "no solid food for 6 hours and no clear liquids for 2 hours before surgery" is maintained. Two to three hours before the surgery, the patient is instructed, as per medical orders, to consume 200–400 mL of a specialized carbohydrate solution in a single administration.

③ Evidence-based strategy for rapid postoperative dietary resumption:

Dispelling the "waiting for flatus" tradition: Patients are clearly informed that with modern anesthesia and minimally invasive surgery, bowel function recovers quickly, and it is safe to begin eating without waiting for the passage of flatus.

Phased and individualized dietary progression:

0–6 hours post-op: As soon as the patient is fully awake from anesthesia, they may begin to drink small amounts of warm water.

6–24 hours post-op: If there is no nausea, vomiting, or other discomfort after drinking water, the patient can transition to a liquid or soft diet, such as rice soup, nutritional paste, or steamed egg custard, with small, frequent meals being encouraged.

Postoperative days 2–3: Depending on the patient's tolerance, a rapid transition is made to a regular diet of easily digestible foods. Special emphasis is placed on the intake of sufficient high-quality protein (*e.g.*, fish, poultry, soy products) and dietary fiber (*e.g.*, vegetables, fruits) to promote wound healing and prevent constipation. At the same time, routine intravenous fluid supplementation is decisively discontinued once the patient can maintain adequate oral intake.

2.2.3 Pelvic floor muscle training protocol

Pelvic floor muscle training (PFMT) was conducted according to a standardized, stepwise protocol initiated after catheter removal under the supervision of a rehabilitation physician or specially trained nurse. The program comprised three main components:

(1) Muscle identification and activation:

The initial step focused on ensuring accurate identification of the pelvic floor muscles. Patients were instructed in techniques to isolate this musculature, such as voluntarily interrupting the urinary stream (for identification purposes only) or performing concentric anal sphincter contractions. For patients who experienced difficulty, the clinician utilized physical palpation of the perineum or visual biofeedback to confirm correct muscle engagement.

(2) Exercise regimen:

The prescribed regimen included two distinct types of contractions:

• Sustained contractions (Endurance): Patients performed slow, maximal contractions of the pelvic floor muscles, holding for 5–10 seconds, followed by an equivalent relaxation period. This was designed to build endurance for tonic support.

• Rapid phasic contractions (Reactivity): Patients performed a series of rapid, forceful contractions, with each contract-relax cycle lasting 1–2 seconds. This was designed to improve reactivity to sudden increases in intra-abdominal pressure, *e.g.*, during a cough or sneeze.

(3) Personalized training plan:

A progressive training plan was developed for each patient, incorporating:

• Frequency and volume: The standard prescription was three sessions per day, with each session comprising approximately 10 sustained and 10 rapid contractions.

• Postural progression: The protocol included a progressive postural component to simulate daily life conditions. Training began in a supine position and advanced to sitting and, finally, standing positions as the patient's proficiency and strength improved.

• Patient education: Throughout the training, emphasis was placed on key principles for effective execution, including the isolation of pelvic floor muscles (avoiding compensatory use of abdominal or gluteal muscles), maintenance of normal respiration during contractions, and the importance of long-term adherence for optimal outcomes.

2.2.4 Fluid management

Preoperative: To optimize preoperative hydration and energy status, patients received a 200–400 mL oral carbohydrate solution approximately two hours before surgery.

Intraoperative: The objective was to maintain hemodynamic stability and adequate tissue perfusion. A balanced salt solution, *e.g.*, Lactated Ringer's solution, was routinely infused at a basal rate of 1–3 mL/kg/h. The rate was dynamically adjusted based on indicators such as heart rate, blood pressure, and urine output to avoid unindicated excessive infusion. The total infusion volume was aimed at approximating the sum of the patient's physiological needs and surgical losses.

Postoperative: The postoperative protocol emphasized early oral fluid intake. Intravenous fluids were discontinued once oral intake was deemed adequate, *e.g.*, >500 mL/day. If supplemental intravenous (IV) fluids were necessary, the total volume was restricted to 1.0–1.5 L per day and was ceased immediately after the first passage of flatus or the return of bowel function.

2.2.5 Individualized anesthesia protocol

(1) Preoperative assessment and planning:

Each patient underwent a comprehensive evaluation by the anesthesiologist, assessing baseline status, comorbidities, cardiopulmonary function, anesthetic and allergy history, and psychological state. Based on this evaluation, an individualized anesthesia and analgesia plan was developed with the primary goals of minimizing the surgical stress response, facilitating rapid emergence, and preventing postoperative nausea and vomiting (PONV). For patients with significant preoperative anxiety, anxiolytic premedication was considered.

(2) Meticulous intraoperative management:

Multimodal analgesia: Specific measures included:

• Basal anesthesia: Intravenous anesthetics, *e.g.*, propofol or inhalational agents with minimal respiratory and circulatory impact, were selected to facilitate rapid emergence.

• Non-opioid analgesics: Non-steroidal anti-inflammatory drugs (NSAIDs), *e.g.*, flurbiprofen axetil, were administered pre- or intraoperatively to suppress inflammation and nociceptive signaling at the source.

• Regional nerve blockade: Ultrasound-guided nerve blocks targeting the surgical incision site, *e.g.*, transversus abdominis plane (TAP) block, were performed to provide robust incisional pain coverage and significantly reduce postoperative discomfort.

• Adjuvant medications: Low doses of agents such as ketamine or lidocaine were administered to enhance analgesia and further reduce opioid requirements.

Maintaining vital sign stability: Blood pressure and heart rate were closely regulated, with vasoactive drugs titrated according to the patient's baseline values and the degree of surgical stimulation to avoid significant hemodynamic fluctuations.

Active warming: To maintain normothermia, a key ERAS principle, forced-air warming devices were employed throughout surgery, reducing the risk of bleeding, wound infection, and cardiac complications.

(3) Postoperative recovery phase management:

Continuation of the postoperative analgesia plan: The analgesia plan developed by the anesthesiologist was extended into the postoperative period. The recommendation was typically to prioritize oral or intravenous NSAIDs, with small doses of opioids administered only on an as-needed basis for significant pain, thereby enabling the patient to ambulate early in a pain-free or minimally painful state.

2.3 Data collection and subgroup analysis strategy

To investigate the potential effects of key measures within the comprehensive nursing protocol, a series of exploratory subgroup analyses were conducted within the observation group.

These analyses were not pre-specified confirmatory studies; rather, they were designed to preliminarily explore associations between specific nursing measures and outcomes based on the existing retrospective data, thereby generating hypotheses for future research.

Data were stratified for analysis based on the actual implementation recorded in patient medical charts. The primary analyses were as follows:

Early pelvic floor muscle exercise: A comparison of the differences in urinary continence (ICI-Q-SF score) and sexual function (IIEF-5 score) between patients with documented implementation of "early standardized pelvic floor muscle exercise" and those without such documentation.

Multimodal analgesia regimen: A comparison of the differences in postoperative pain scores (NRS) between patients documented to have strictly adhered to the "multimodal analgesia regimen" and those who, for specific reasons, received only conventional analgesia.

Preoperative preparation compliance: A comparison of the differences in quality of life (Quality of Life Questionnaire-Core 30 (QLQ-C30) score) between patients who fully complied with both "preoperative psychological counseling and preoperative carbohydrate loading" and those who did not fully comply.

2.4 Observation indicators

As a retrospective study, all outcome indicators were extracted from existing case records.

(1) Urinary continence assessment:

Urinary incontinence was assessed before nursing and 1-year after nursing using the International Consultation on Incontinence Questionnaire-Short Form (ICI-Q-SF) [5]. This instrument evaluates three aspects: frequency of incontinence, severity, and its impact on quality of life. The total score is the sum of the scores from the three questions, ranging from 0 to 21. A higher score indicates more severe urinary incontinence and a greater negative impact on the patient's quality of life. The interpretation is as follows:

• 0 points: Complete continence, no incontinence symptoms.

• 1–5 points: Slight incontinence; infrequent and small-volume leakage with minimal impact on daily life.

• 6–12 points: Moderate incontinence; symptoms cause substantial disruption to daily and social activities.

• 13–18 points: Severe incontinence; symptoms significantly impair daily functioning and psychological well-being.

• 19–21 points: Very severe incontinence; may involve continuous leakage and profoundly reduced quality of life.

(2) Sexual function assessment:

Erectile dysfunction (ED) severity and treatment efficacy were assessed before nursing and at 1 year after nursing using the International Index of Erectile Function-5 (IIEF-5) [6]. The questionnaire comprises 5 questions regarding erectile confidence, erection firmness, penetration success rate, maintenance ability, and sexual satisfaction. Each question is scored from 1 to 5, and the total score is the sum of the five questions. The scoring criteria are:

• 22–25 points: No ED; normal erectile function.

• 17–21 points: Mild ED; the patient may occasionally encounter some difficulties, but there is little overall impact on sexual life.

• 12–16 points: Mild-to-moderate ED; more noticeable difficulties affecting sexual satisfaction.

• 8–11 points: Moderate ED; frequent difficulty achieving or maintaining erections sufficient for intercourse, with significant impact.

• 5–7 points: Severe ED; inability to achieve or maintain erections, precluding intercourse.

(3) Pain severity:

The Numerical Rating Scale (NRS) [7] was used to assess the pain severity at 3 days, 7 days, and 14 days post-surgery, as well as before the surgery. The scale ranges from 0 (no pain) to 10 (worst imaginable pain), with higher scores indicating more severe pain.

(4) Quality of life:

The patient's quality of life was assessed by the same nursing staff member before nursing and at 1 year after nursing using the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire-Core 30 (QLQ-C30) [8]. The QLQ-C30 consists of 30 items, divided into three parts: functional scales, symptom scales, and overall health status. Scores for both functional and symptom range from 0 to 100. For functional and global health domains, higher scores indicate better outcomes. For symptom scales, higher scores indicate more severe symptoms.

(5) Complications:

Complications recorded included hemorrhage, bladder spasms, infections. These were compared between the two groups.

Criteria for complication assessment:

① Hemorrhage: Postoperative hemorrhage was assessed based on its severity and the required clinical nursing:

Mild (classified as Grade I): Characterized only by transient hematuria with stable vital signs and no significant decrease in hemoglobin, requiring no specific blood transfusion.

Moderate (classified as Grade II): Hemorrhage leading to a decrease in hemoglobin or minor fluctuations in vital signs, necessitating blood transfusion but without the need for surgical or interventional hemostasis.

Severe (classified as Grade III): Persistent or active bleeding unresponsive to conservative management, requiring further treatment.

Grade IIIa: Requiring bladder irrigation, evacuation of blood clots, or interventional embolization for hemostasis without general anesthesia.

Grade IIIb: Requiring a return to the operating room for exploratory hemostasis under general anesthesia.

Life-threatening (classified as Grade IV): Massive hemorrhage causing hemorrhagic shock and leading to multiple organ dysfunction, such as acute kidney injury or respiratory failure.

② Bladder spasm: Bladder spasm is defined as an involuntary contraction of the bladder muscles, often causing lower abdominal pain and a sense of urgency.

Mild (classified as Grade I): The patient reports intermittent, mild lower abdominal discomfort that can be relieved by postural adjustments, conventional analgesics, or psychological reassurance.

Moderate (classified as Grade II): More frequent spasms with significant pain affecting the patient's rest, requiring treatment with anticholinergic agents (*e.g.*, solifenacin) or antispasmodic medications.

Severe (classified as Grade II or IIIa): Intense and persistent pain with a poor response to conventional medication. It is classified as Grade II if resolved solely by escalating medical therapy (*e.g.*, using potent analgesic-antispasmodic drugs); it is classified as Grade IIIa if the spasm leads to urinary catheter obstruction requiring invasive procedures such as bladder irrigation or catheter replacement.

③ Surgical Site Infection (SSI):

The diagnosis of surgical site infection followed the criteria of the U.S. Centers for Disease Control and Prevention (CDC), categorizing infections as superficial incisional, deep incisional, and organ/space. This study primarily recorded superficial and deep incisional infections.

Superficial incisional SSI (classified as Grade I or II): Infection involving only the skin and subcutaneous tissue.

Grade I: Local signs of inflammation at the incision site, such as redness, swelling, heat, and pain, manageable with simple bedside debridement, dressing changes, or drainage.

Grade II: More extensive infection or associated systemic symptoms (*e.g.*, fever), requiring treatment with oral or intravenous antibiotics.

Deep incisional SSI (classified as Grade III): Infection involving deep soft tissues, such as fascial and muscle layers.

Grade IIIa: Requiring incision, drainage, and debridement under local anesthesia.

Grade IIIb: Severe infection necessitating thorough surgical debridement and drainage under general anesthesia.

2.5 Statistical methods

The collected data were analyzed using SPSS 22.0 statistical software (IBM, Armonk, NY, USA) and GraphPad Prism 8.0.2 software (GraphPad Software, Inc., San Diego, CA, USA). Normally distributed continuous variables were expressed as mean ± standard deviation (SD) and compared between groups using independent sample *t*-tests. Non-normally distributed variables or data with unequal variances were analyzed using the Mann-Whitney U test and reported as median (M) with interquartile range (IQR) (M (P25, P75)). Categorical data were expressed as frequency and percentage (%), with intergroup comparisons performed using the chi-square test. A p-value < 0.05 was considered statistically significant.

3. Results

3.1 General data

The general data for the two groups are shown in Table 1. There were no significant differences between the groups ($p > 0.05$).

3.2 Urinary control function and sexual function assessment

At 1 year after nursing, the observation group had lower ICI-Q-SF scores and significantly higher IIEF-5 scores compared with the control group ($p < 0.05$, Table 2). Within the observation group, 45 patients who strictly followed the rehabilitation physician's guidance and completed regular pelvic floor muscle training (the early, standardized training subgroup) had lower ICI-Q-SF scores and significantly higher IIEF-5 scores than the 10 patients with no clear documentation or poor adherence (the non-standardized training subgroup) ($p < 0.05$, see **Supplementary Table 1**).

3.3 Pain severity

At 3-, 7-, and 14-day post-surgery, the pain scores in the observation group were significantly lower than those in the control group ($p < 0.05$, Table 3). Within the observation group, 50 patients adhered strictly to the "multimodal analgesia regimen developed by the anesthesiologist", while 5 patients received only conventional analgesia due to special circumstances, *e.g.*, allergies, patient refusal. Pain scores in the multimodal analgesia subgroup were significantly lower than those of in conventional analgesia subgroup ($p < 0.05$, see **Supplementary Table 2**).

3.4 Quality of life

One year after nursing, the observation group had significantly higher scores in the functional dimension and overall health status, and lower scores in the symptom dimension compared with the control group ($p < 0.05$, Table 4). Patients in the observation group whose records indicated they had "received formal preoperative counseling from a psychological counselor" and "adhered to the prescribed oral intake of preoperative carbohydrates" were classified as the "preoperative preparation compliance" subgroup. The remaining patients were classified as the "incomplete compliance" subgroup. Quality-of-life scores in the preoperative preparation compliance subgroup were significantly higher than those in the incomplete compliance subgroup ($p < 0.05$, see **Supplementary Table 3**).

3.5 Complications

The incidence of complications in the observation group was lower than in the control group ($p < 0.05$, Table 5).

4. Discussion

Prostate cancer remains a prevalent malignancy in men, and laparoscopic radical prostatectomy is considered the primary treatment of choice due to its minimally invasive nature and favorable safety profile [9]. However, the procedure is not without challenges. Potential drawbacks, such as prolonged operation time and the necessity for postoperative drainage, can contribute to patient anxiety and increase the risk of complications like urinary incontinence. These factors may hinder patient recovery and negatively impact long-term prognosis [10]. This underscores the critical need for an optimized perioperative nursing strategy.

Historically, postoperative care for these patients has relied on conventional, protocol-driven nursing models. Such approaches often fall short in addressing the individualized

TABLE 1. Comparison of general data between the two groups.

Item	Observation group (n = 55)	Control group (n = 50)	χ^2/t	p
Age (yr) (mean ± SD)	61.05 ± 5.34	62.05 ± 5.10	0.979	0.330
PSA (ng/mL) (mean ± SD)	7.26 ± 2.02	7.45 ± 2.17	0.488	0.626
Average course of illness (yr) (mean ± SD)	2.50 ± 1.27	2.80 ± 1.50	1.140	0.257
History of adverse events, n (%)				
Smoking	37 (67.27)	40 (80.00)	2.169	0.141
Alcohol consumption	38 (69.09)	36 (72.00)	0.107	0.744
Clinical TNM staging, n (%)				
cT_{1c}	2 (3.64)	2 (4.00)	0.107	0.991
cT_{2a}	17 (30.91)	15 (30.00)		
cT_{2b}	22 (40.00)	19 (38.00)		
cT_{2c}	14 (25.45)	14 (28.00)		
Hypertension, n (%)	32 (58.18)	30 (60.00)	0.036	0.850
Diabetes, n (%)	25 (45.45)	20 (40.00)	0.318	0.573
Obesity, n (%)	20 (36.35)	25 (50.00)	1.989	0.158
Surgical duration (h) (mean ± SD)	2.50 ± 0.35	2.55 ± 0.40	0.784	0.435
Intraoperative bleeding volume (mL) (mean ± SD)	157.50 ± 15.20	160.30 ± 14.70	0.958	0.340

SD: standard deviation; PSA: Prostate-specific antigen; TNM: Tumor, Node, Metastasis; cT: Clinical T stage.

TABLE 2. Comparison of urinary control function and sexual function scores between two groups of patients ($\bar{x} \pm s$, scores).

Group	n	ICI-Q-SF score		IIEF-5 scores	
		Before nursing	One year after nursing	Before nursing	One year after nursing
Observation group	55	15.07 ± 2.43	2.67 ± 1.31	9.44 ± 0.74	23.76 ± 2.29
Control group	50	14.84 ± 2.25	7.10 ± 1.45	9.30 ± 0.65	17.34 ± 1.60
t	-	0.507	16.483	1.001	16.771
p	-	0.613	<0.001	0.319	<0.001

ICI-Q-SF: Incontinence Questionnaire-Short Form; IIEF-5: International Index of Erectile Function-5.

TABLE 3. Comparison of pain levels of two groups ($\bar{x} \pm s$, scores).

Group	n	Before surgery	3 days post-surgery	7 days post-surgery	14 days post-surgery
Observation group	55	7.13 ± 1.29	4.69 ± 1.07	2.87 ± 0.82	0.85 ± 0.45
Control group	50	7.52 ± 1.23	6.10 ± 1.30	5.30 ± 0.95	2.00 ± 0.64
t	-	1.590	6.094	14.042	10.714
p	-	0.115	<0.001	<0.001	<0.001

TABLE 4. Comparison of quality of life ($\bar{x} \pm s$, scores).

Group	n	Functional dimension		Symptom dimension		Overall health status	
		Before nursing	One year after nursing	Before nursing	One year after nursing	Before nursing	One year after nursing
Observation group	55	64.73 ± 7.47	92.18 ± 4.91	85.89 ± 6.34	31.65 ± 6.81	62.25 ± 7.63	95.11 ± 4.18
Control group	50	64.64 ± 8.09	80.10 ± 6.29	83.70 ± 10.72	50.24 ± 8.29	63.24 ± 8.30	78.14 ± 7.10
t	-	0.057	11.027	1.259	12.600	0.634	14.734
p	-	0.954	<0.001	0.212	<0.001	0.528	<0.001

TABLE 5. Comparison of complications (n (%)).

Group	n	Hemorrhage	Bladder spasms	Infection	Total
Observation group	55	1 (1.82)	1 (1.82)	2 (3.64)	4 (7.27)
Control group	50	3 (6.00)	4 (8.00)	4 (8.00)	11 (22.00)
χ^2	-				4.639
p	-				0.031

physiological and psychological needs of patients, which can result in suboptimal clinical outcomes. In response to these limitations, the ERAS concept has been increasingly integrated into clinical practice, forming the basis of a multidisciplinary, comprehensive nursing framework [11]. In contrast to conventional care, the ERAS-modern approach proactively addresses potential risk factors throughout the perioperative period. This model involves a collaborative team of urologists, psychologists, and nutritionists who jointly formulate personalized care plans. Key nursing include tailored nutritional support, proactive psychological counseling, and a strong emphasis on early mobilization. By combining these multifaceted strategies, the comprehensive ERAS-based nursing model has been shown to significantly improve patient recovery, reduce complications, and enhance overall outcomes [12].

The significant improvements in urinary continence and erectile function observed in this study are not the isolated effects of a single nursing, but rather the complex result of the synergistic effect of multiple physiological and psychological mechanisms under the ERAS comprehensive care model.

I. Underlying mechanisms for the improvement of urinary continence (decrease in ICI-Q-SF score). The rapid recovery of urinary continence can be broken down into one core driving force and two major support systems.

(1) Core driving force: High-quality neuromuscular re-education.

Core mechanism: The fundamental basis for improving urinary continence lies in rebuilding and strengthening the function of the external urethral sphincter and the pelvic floor supporting muscles. The "standardized early pelvic floor muscle training" in this study is the central method to achieve this goal.

Physiological analysis: Muscle strengthening and proprioceptive recovery: Radical prostatectomy inevitably damages parts of the sphincter structure and its innervating nerves, leading to decreased muscle strength and a reduced ability to close the urethra. Standardized Kegel exercises, particularly slow, sustained contractions (endurance training), promote hypertrophy of Type II (slow-twitch) muscle fibers, enhancing the muscle's sustained tension and thereby increasing resting urethral closure pressure. In contrast, rapid, explosive contractions (reaction training) specifically train Type I (fast-twitch) muscle fibers, enabling them to react swiftly and powerfully to sudden increases in intra-abdominal pressure (*e.g.*, coughing, sneezing) to prevent stress urinary incontinence [13]. Correcting erroneous compensation: Patients in the control group, even when attempting the exercises independently, are highly prone to using incorrect muscle groups such as the abdominal, gluteal, or inner thigh muscles. This is not only ineffective but can also increase intra-abdominal pressure and worsen leakage. In the observation group, one-on-one guidance from professionals, through verbal commands, palpation, and even biofeedback, ensured that patients could precisely isolate and activate the correct pelvic floor muscles. This is the key distinction between "effective training" and "ineffective motion" [14].

(2) Support system one: Creating an optimal physiological recovery environment.

High-quality pelvic floor muscle training does not occur in a vacuum; it requires a well-recovering, minimally painful body as its foundation. The ERAS protocol constructs precisely such an ideal physiological platform.

Mechanism analysis: ① Effective pain management: Severe pain can trigger protective muscle spasms and significantly deplete a patient's willpower, making it impossible for them to concentrate on fine motor control exercises. The "multimodal analgesia" strategy adopted by the observation group significantly reduced postoperative pain by intercepting pain signals through multiple pathways. A patient in a state of comfort is not only more willing but also more capable of learning and performing pelvic floor muscle exercises [15]. ② Accelerated systemic functional recovery: Early feeding and early mobilization within the ERAS protocol are crucial for the success of pelvic floor muscle training [16]. Early nutritional intake provides the essential proteins and energy for muscle repair and growth. Early ambulation promotes systemic blood circulation, improves tissue oxygenation in the pelvic region, and allows the patient to perform exercises in functional positions (sitting, standing). This is more aligned with the demands of daily life than training solely in a supine position and better facilitates the reconstruction of the body's coordinated control.

(3) Support system two: Building strong psychological motivation and adherence.

Pelvic floor muscle training is a tedious process that requires long-term persistence. The patient's psychological state and adherence are decisive factors in its ultimate success.

Mechanism analysis: ① Preoperative education and expectation management: Detailed preoperative education allowed patients to clearly understand the rationale and importance of pelvic floor muscle training, viewing it as an active, controllable part of their recovery rather than a passive waiting game. This greatly enhanced their sense of participation and self-efficacy. ② Psychological counseling and confidence building: Professional psychological counseling helped alleviate patients' anxiety about the surgery and its

postoperative sequelae. A patient with a more stable mindset and greater confidence in the future is better able to face rehabilitation challenges positively and adhere to the daily exercise regimen. ③ Continuity of care and positive feedback: Post-discharge online follow-up and communication channels formed a continuous support network. When patients encountered difficulties with their exercises, they received timely answers; when they observed small improvements, they received encouragement. This continuous positive feedback is key to maintaining long-term adherence [17].

II. The complex mechanisms for improved erectile function (Increase in IIEF-5 score). The recovery of erectile function is more complex than that of urinary continence, involving an integrated process that includes neurological, vascular, endocrine, and psychological factors. The ERAS protocol promotes this recovery through the following multifaceted approach.

(1) Mechanism one: Maximizing the reduction of surgical physiological stress to protect the neurovascular foundation.

① Core mechanism: An erection depends on the vasodilation of penile arteries and the engorgement of blood sinuses, triggered by parasympathetic nerve signals. Surgery itself, as a form of significant physiological trauma, induces a strong stress response (release of cortisol, catecholamines, *etc.*), a state that is unconducive to nerve repair and vasodilation.

② Physiological analysis: Optimizing the internal physiological milieu: The series of measures within ERAS, such as preoperative carbohydrate loading, goal-directed fluid management, active warming, and multimodal analgesia, share the common objective of blunting the body's stress response. A more "stable" internal environment implies a reduced release of inflammatory factors and more stable hemodynamics. This creates an optimal microenvironment for the self-repair of the extremely fragile neurovascular bundles responsible for erections (cavernous nerves), which may have been stretched or injured during surgery. Avoiding tissue edema: Traditional large-volume fluid infusion often leads to pelvic tissue edema, which can compress the neurovascular bundles, thereby impairing their blood supply and functional recovery. The goal-directed fluid therapy inherent in the ERAS protocol effectively prevents this issue.

(2) Mechanism two: The direct physiological synergism of pelvic floor muscle exercises.

① Core mechanism: The pelvic floor musculature includes not only muscles that control urination but also those crucial for erectile rigidity and ejaculation. ② Anatomical and functional analysis: The Ischiocavernosus and Bulbospongiosus muscles are vital components of the pelvic floor. During an erection, the rhythmic or tonic contraction of these muscles compresses the crura of the penis, temporarily occluding venous outflow. This significantly increases the pressure within the corpora cavernosa, resulting in a harder and more sustained erection [18]. Therefore, the standardized pelvic floor muscle training undertaken by the observation group, while training the urethral sphincter, also inevitably strengthens these "accessory muscles" directly related to erection. This, in turn, produces a direct and positive physiological enhancement of erectile function [19, 20].

(3) Mechanism three: Breaking the psychogenic vicious cycle of "anxiety-failure".

① Core mechanism: Postoperative erectile dysfunction (ED) is often a hybrid of organic and psychogenic factors. The fear of failure and performance anxiety can activate the sympathetic nervous system, leading to the release of adrenaline, which causes vasoconstriction and thus physiologically inhibits an erection.

② Psychological analysis: "confidence spillover effect": This is an extremely important underlying mechanism in this study. When patients witness a significant improvement in their urinary continence—their most pressing and tangible postoperative concern—through their own efforts (pelvic floor muscle training), it greatly enhances their sense of control and self-confidence in their own recovery capabilities. This powerful positive psychological experience "spills over" into other areas of rehabilitation. They develop a positive expectation: "Since I can manage urinary leakage, I can probably manage my erections too.". Lowering the threshold for attempting sexual activity: Urinary incontinence (especially during intercourse) is a major psychological barrier to resuming sexual activity post-surgery. Once the issue of continence is resolved, the psychological threshold and anxiety associated with attempting to resume sexual life naturally decrease. An attempt made with less anxiety and more confidence has a higher probability of success, thereby initiating a virtuous cycle of "success $\rightarrow$ enhanced confidence $\rightarrow$ further success". Preoperative psychological nursing: The counseling provided by a psychological counselor before the surgery had already begun to address some patients' catastrophic thinking regarding the loss of sexual function, laying the groundwork for establishing a positive mindset postoperatively.

In summary, the reason the comprehensive ERAS nursing protocol can effectively improve urinary continence, and erectile function is that it transcends singular technical nursing. It constructs a complete ecosystem that gives equal weight to both physiological and psychological aspects, connects the preoperative and postoperative periods, and integrates active rehabilitation with multidisciplinary support. It not only repairs the damaged "hardware" (muscles and nerves) but, more importantly, optimizes the "software" that drives the hardware's operation (psychological state and neural regulation), ultimately achieving a synergistic rehabilitation effect where $1 + 1 > 2$.

The difference in outcomes between the standardized and non-standardized training subgroups within the ERAS cohort highlights the critical importance of nursing quality and fidelity, not just its mere presence. The superior urinary continence observed in the standardized training subgroup provides strong evidence that the therapeutic benefit of PFMT depends not only on its prescription but also on the fidelity of its implementation. The standardized group received high-fidelity nursing, characterized by one-on-one professional instruction to ensure correct muscle isolation (avoiding compensatory movements) and a structured regimen to deliver an adequate therapeutic dose. In contrast, the non-standardized group likely performed training inconsistently or with technical errors, rendering its effectiveness. Therefore, these findings professionally guided, structured training as the key "active ingredient" responsible for the observed improvements in uri-

nary function.

The "standardized training subgroup" also exhibited higher IIEF-5 scores. Although PFMT is primarily intended to improve urinary continence, it can also have a significant positive impact on erectile function. This influence is explained by both direct physiological mechanisms and indirect psychological or functional associations. Direct physiological synergy: Some pelvic floor muscles, such as the bulbospongiosus and ischiocavernosus muscles, are involved in both urinary control and the mechanics of erection and ejaculation. The forceful contraction of these muscles increases penile rigidity and supports ejaculation. Therefore, regular and correctly executed PFMT not only strengthens urinary control but also "incidentally" enhances the accessory muscles that facilitate erection, producing a direct, beneficial effect on erectile function [21]. Indirect psychological and functional association: Confidence spillover ("Success breeds success"): When patients witness a significant improvement in their most distressing symptom, such as urinary incontinence, achieved through their efforts, their confidence in their overall recovery grows [22]. This psychological boost can extend to sexual rehabilitation, making them more willing and less anxious to resume sexual activity. Functional coupling improvement: Urinary incontinence, especially leakage during intercourse (climacturia), is a major reason for men to avoid sexual activity postoperatively. Resolving incontinence removes this barrier, encouraging patients to resume sexual life. When the fear of leakage is gone, patients are more comfortable to better able to enjoy sexual activity, an improvement reflected directly in higher IIEF-5 scores.

Postoperatively, the advantage of combined care in reducing pain was more significant. This benefit was further supported by the subgroup analysis, which showed that patients receiving a multimodal analgesia regimen reported less pain than those on conventional analgesia. Several integrated components of the ERAS framework contributed to this reduction in pain.

The core reason lies in the systemic advantages of the ERAS protocol. First, individualized multimodal analgesia is a key factor. Through the combined application of techniques such as non-opioid medications and regional nerve blocks, pain signals are interrupted at multiple points, achieving a "preemptive" analgesic effect and avoiding the drawbacks of traditional reliance solely on opioids [23]. The internal subgroup analysis of the observation group further confirmed this: even when receiving other identical ERAS nursing measures, patients who only received conventional analgesia had a significantly worse pain experience, highlighting the central role of multimodal analgesia. Second, professional psychological nursing and proactive pain management education played a significant role. Through standardized preoperative assessment and counseling, patients' anxiety levels were effectively reduced, thereby increasing their tolerance threshold for postoperative pain [24]. The pain education conducted postoperatively helped patients establish a scientific understanding of pain and promoted their adherence to the analgesic regimen. Furthermore, early rehabilitation activities and multidisciplinary team collaboration jointly promoted recovery. In-bed and out-of-bed activities, initiated as early as possible under physician assessment, not only accelerated the recovery of patients' physical functions but also indirectly alleviated the discomfort caused by prolonged bed rest. Meanwhile, the team composed of experts from multiple disciplines—including urology, anesthesiology, psychology, and nutrition—ensured the professionalism and synergy of all nursing measures. From nutritional support to fluid management, they comprehensively optimized the patients' physiological and psychological states, creating optimal conditions for pain reduction and accelerated recovery.

In summary, the ERAS philosophy under comprehensive nursing care is not a simple accumulation of individual measures but rather a multidimensional, systematic nursing system. Through key components such as individualized analgesia, psychological support, early mobilization, and multidisciplinary collaboration, it significantly alleviates pain in prostate cancer patients during the perioperative period, accelerates the overall recovery process, and holds significant clinical value for improving patients' quality of life.

The significant difference in pain scores observed between the ERAS subgroups underscores the pivotal role of the analgesic strategy itself. The mechanisms behind this disparity can be analyzed by contrasting the two approaches. Patients in the multimodal analgesia subgroup received a proactive regimen designed to intercept pain signals at multiple points along the nociceptive pathway. This was achieved by combining peripherally acting agents, such as NSAIDs, with regional nerve blocks. The synergistic effect of this approach provides superior analgesia while minimizing reliance on high-dose systemic opioids, thereby reducing opioid-related side effects. Conversely, the conventional analgesia subgroup, despite benefiting from other ERAS nursing, relied on a reactive, opioid-centric strategy. This approach primarily targets central pain perception and lacks the preemptive and peripheral blockade that defines the multimodal model. This subgroup comparison provides compelling evidence that individualized multimodal analgesia is a critical, independent component for successful postoperative pain management within an ERAS framework. It strongly suggests that, while psychological support and early mobilization are valuable, their effectiveness in controlling pain is significantly diminished if the underlying pharmacological strategy remains unimodal and opioid-reliant.

Collaborative care results in a more significant improvement in patients' quality of life and demonstrates a good safety profile. This ongoing improvement highlights the accumulated, long-term advantages of the ERAS framework, which combines personalized nutritional support, early mobilization, effective pain control, and proactive psychological care to enhance both physical and mental recovery. The improvement in long-term quality of life in the ERAS group can be attributed to its comprehensive, multidisciplinary approach to perioperative care, which simultaneously addresses both physiological and psychological needs. Physiologically, the protocol focused on accelerating recovery and preventing common postoperative complications. Personalized nutritional support, designed by dietitians, enhanced immune function, promoted healing, and reduced the risk of complications. Postoperative guidance for early mobilization improved blood circulation, while a structured protocol mobilization plan, combined with prophylactic measures such as compression stockings and guided pelvic floor muscle training, helped to prevent deep vein thrombosis

and urinary incontinence [25, 26]. Anesthesiologists provided targeted pain nursing that minimized opioid use. Proper temperature management further reduced pain perception, contributing to better postoperative comfort and quality of life [27]. Psychologically, targeted, opioid-sparing analgesia and active warming measures mitigated the physiological stress response to surgery. Concurrently, proactive psychological counseling helped manage patient anxiety, which is known to influence pain perception and the motivation for recovery. The integration of these multifaceted components, covering nutrition, mobilization, pain control, and psychological support, is fundamental to the ERAS model's success. By addressing the patient holistically, this approach improves long-term functional outcomes, reducing complications, and ultimately enhancing the patient's quality of life.

Particularly insightful is the subgroup analysis within the ERAS cohort, which revealed that patients who fully adhered to preoperative preparation protocols achieved significantly better long-term quality of life. This disparity can be attributed to two key factors. First, comprehensive preoperative psychological preparation acts as a form of "stress inoculation". By transforming the surgical event from an unknown threat into a predictable process, it mitigates preoperative anxiety and enhances the patient's sense of control, which are foundational for maintaining long-term psychological well-being. Second, preoperative carbohydrate loading helps establish an optimized metabolic state. Oral carbohydrate intake before surgery can reduce postoperative insulin resistance induced by stress, preserve the body's glycogen and protein stores, and limit muscle catabolism. It also decreases postoperative hunger. These physiological advantages translate into an improved postoperative experience. A patient who has not undergone prolonged fasting and retains better energy reserves will feel stronger and less fatigued after surgery. This early physical advantage serves as the "initial impetus" for initiating the virtuous cycle of rapid recovery (*e.g.*, early ambulation, oral intake). Conversely, the incomplete compliance subgroup may face more severe fatigue and physical weakness in the early postoperative period. This directly affects their motivation and ability to participate in rehabilitation activities, thereby slowing the entire recovery process, which is ultimately reflected in lower long-term quality of life scores.

Therefore, this finding suggests that preoperative optimization is not an ancillary component of ERAS but a cornerstone of the philosophy. It demonstrates that the most effective ERAS pathways are those that begin "upstream", proactively enhancing a patient's physiological and psychological resilience before the surgical stressor is ever introduced.

Within the observation group receiving comprehensive nursing care, this study conducted a series of exploratory retrospective subgroup analyses. These analyses clearly revealed the unique value of several core components within the comprehensive care protocol:

① Quality and quantity of pelvic floor muscle exercise: Within the observation group, the subgroup that strictly adhered to guidance and regularly performed "early standardized pelvic floor muscle exercises" postoperatively demonstrated significantly superior urinary continence (lower ICI-Q-SF scores) and sexual function (higher IIEF-5 scores) compared to the "non-standardized exercise" subgroup, which had no clear records or poor compliance. This highlights that the standardization of and adherence to rehabilitation exercises are crucial for improving postoperative functional recovery. ② Fundamental differences in analgesic strategies: Similarly, within the observation group, patients who strictly followed a "multimodal analgesia protocol" developed by an anesthesiologist had significantly lower postoperative pain scores than those who received only conventional analgesia due to reasons such as drug allergies. This confirms the superiority of multimodal analgesia in effectively alleviating postoperative pain. ③ Profound impact of preoperative preparation: The study defined patients who received formal psychological counseling and consumed preoperative carbohydrates as prescribed as the "preoperative preparation adherence subgroup". Compared to patients within the group who did not fully adhere, this subgroup showed significantly better quality of life scores one year post-surgery. This suggests that adequate preoperative physiological and psychological preparation acts as a "buffer", enabling patients to better cope with surgical stress and exerting a crucial positive impact on long-term quality of life.

In conclusion, these intra-group subgroup analyses strongly demonstrate that the success of the ERAS concept under comprehensive nursing care is not the result of a single measure but rather a reflection of the synergistic effects of its various components. Standardized rehabilitation exercises, optimized analgesic protocols, and meticulous preoperative preparation are all indispensable core elements of this care model. Collectively, they significantly improve patients' postoperative functional recovery, pain experience, and long-term quality of life.

In the study by Jin Kai Zhang *et al*. [28] 128 patients who underwent robot-assisted radical prostatectomy from May 2023 to May 2024 were randomly divided into a control group and an observation group, with 64 cases in each. The control group received routine nursing care, while the observation group received comprehensive nursing care. The IIEF-5 scores, Hamilton Anxiety Scale (HAMA) scores for psychological health, and Generic Quality of Life Inventory-74 (GQOLI-74) scores were compared between the two groups before and after the nursing. The results showed that after the nursing, the IIEF-5 score of the observation group was significantly higher than that of the control group. Compared to the control group, the HAMA and GQOLI-74 scores in the observation group were also significantly improved. This is consistent with the findings of the present study, further demonstrating that the application of comprehensive nursing care during the perioperative period for patients undergoing radical prostatectomy can improve their sexual function, psychological status, and quality of life.

In a related study, Yubo Kang [29] explored the effect of multidisciplinary team (MDT) nursing care on the perioperative outcomes of patients undergoing radical prostatectomy. The study included 146 patients who had undergone radical prostatectomy for prostate cancer, divided into an MDT group (n = 77) and a conventional care (CC) group (n = 69). Data collected during the nursing period were compared. The results indicated that after the implementation of the respective nursing protocols, the MDT group had superior outcomes in

terms of recovery room length of stay, quality of life, and anxiety scores at various stages when compared to the CC group. This suggests that the implementation of a nurse-led multidisciplinary care team plays a significant role in enhancing recovery from anesthesia, while also contributing to improved quality of life and reduced anxiety. This confirms that implementing MDT nursing care for patients undergoing radical prostatectomy can improve their quality of life and psychological state.

The findings of this study are highly consistent with recent literature trends regarding the application of ERAS in urological procedures. Multiple studies have confirmed that ERAS protocols can effectively shorten the length of hospital stay, reduce complication rates, and accelerate overall patient recovery. For instance, the advantages of multimodal analgesia in reducing opioid consumption and lowering pain scores, as well as the positive impact of early pelvic floor muscle training on improving postoperative urinary continence, have been independently validated by previous research [30].

However, the core contribution of this study lies in demonstrating the added value of a model that deeply integrates the ERAS philosophy with a comprehensive, multidisciplinary nursing framework. While many existing ERAS protocols focus more on executing a standardized checklist of medical items, the nursing model in this study places special emphasis on the pivotal roles of psychological counselors and nutritionists within the team. It incorporates personalized psychological counseling, nutritional optimization, and continuous post-discharge support as integral components of the protocol. The result of our subgroup analysis—that patients who achieved full compliance with preoperative preparation had a superior long-term quality of life—provides robust evidence for the superiority of this comprehensive model, suggesting that meticulous preoperative physical and psychological preparation has a profound impact on patients' long-term well-being.

Implications for clinical practice and policy: The findings of this study have clear implications for both clinical practice and healthcare policy.

For clinical practice, this study underscores the necessity of transitioning from traditional, fragmented nursing models to a standardized, multidisciplinary team (MDT) collaborative approach. Close collaboration among urologic surgeons, anesthesiologists, nurses, rehabilitation physicians, psychological counselors, and dietitians should become the "new normal" in the perioperative management of prostate cancer. Secondly, the findings highlight the importance of shifting the focus of care upstream; that is, professional psychological support, nutritional assessment, and rehabilitation guidance must be moved from the postoperative to the preoperative phase, treating them as therapeutic components of equal importance to the surgery itself. Finally, for key rehabilitation measures such as pelvic floor muscle exercise, simple verbal instructions or the distribution of pamphlets are grossly insufficient; it is imperative to establish standardized, one-on-one instructional and follow-up protocols led by trained professionals.

For healthcare policy and hospital administration, the implementation of such comprehensive ERAS nursing models requires institutional support. Administrators should allocate resources to establish and train multidisciplinary teams and to develop clear clinical pathways and collaborative workflows. Although this may require a greater initial investment in human resources, by reducing complication rates and improving patients' long-term functional outcomes and quality of life, the model is poised to decrease readmission rates and long-term healthcare expenditures, ultimately achieving a win-win scenario for both clinical quality and cost-effectiveness. The successful practice demonstrated in this study provides a valuable reference for the development of relevant clinical guidelines and the optimization of healthcare resource allocation.

Although the results of this study indicate that the ERAS philosophy under a comprehensive care framework has a positive effect on improving the postoperative functional recovery of prostate cancer patients, it has several important limitations that must be acknowledged.

First, the retrospective, single-center design of this study is its most significant limitation. As the grouping was not randomized but based on existing medical records, the interference of selection bias and confounding factors cannot be ruled out. Concurrently, the study data originate from a single medical center, whose patient characteristics, medical practices, and resource allocation may be unique, which limits the generalizability (external validity) of the findings to other medical institutions.

Second, the overall sample size of the study is small, and the sample sizes in the exploratory subgroup analyses are severely insufficient. For instance, when comparing the "multimodal analgesia protocol" to conventional analgesia within the observation group, the latter included only 10 patients. Similarly, the comparison between the "early standardized exercise" and "non-standardized exercise" subgroups was also based on very small samples. Such small sample sizes result in extremely low statistical power for the subgroup analyses, making their results highly susceptible to random error. Therefore, they can only be regarded as preliminary, exploratory findings from which no reliable conclusions can be drawn.

Third, the follow-up period of this study is relatively short. The recovery of postoperative urinary continence and sexual function is a long-term process, potentially lasting 18 to 24 months or even longer. While this study's maximum one-year follow-up observed differences between the groups, it may not have fully captured the final recovery trajectory of the patients' functions, thus potentially underestimating the long-term recovery potential of both groups.

Finally, this study lacks an assessment of oncological outcomes. The research focused entirely on functional outcomes such as urinary control, sexual function, pain, and quality of life, and did not collect or analyze key oncological data like biochemical recurrence rates, positive surgical margin rates, or long-term survival rates. Consequently, this study cannot demonstrate whether the comprehensive ERAS nursing protocol is comparable to or superior to conventional care in terms of oncological safety.

When analyzing this study's limitations, it is also crucial to specifically point out that, as a single-center study, its sample population lacks diversity in racial and cultural backgrounds, which may further restrict the external validity of the conclusions. As the research was conducted in China, the patient population is likely relatively homogeneous. Patients

of different races or from different regions may have variations in genetic backgrounds, lifestyle habits, and attitudes and adherence to postoperative rehabilitation, all of which could potentially influence the ultimate effectiveness of the nursing.

In summary, future research urgently needs to shift towards large-scale, multicenter, prospective randomized controlled trials (RCTs) to overcome the aforementioned limitations. Such studies should adopt standardized nursing protocols, set longer follow-up periods (at least 24 months), and incorporate both functional and oncological outcomes into the evaluation system to provide higher-level evidence-based medical evidence for the clinical application of this care model. The regional and ethnic limitations also provide a clear direction for future research. Once the ERAS philosophy and similar comprehensive care models are widely adopted in other countries or regions, it will create excellent opportunities for large-scale, multicenter, international collaborative studies. Such research would not only expand the total sample size but, more importantly, could include patient populations from diverse racial and cultural backgrounds. This would allow for testing the effectiveness and applicability of this comprehensive care model in a broader population, thereby providing a more solid evidence-based foundation for its global promotion.

5. Conclusions

The implementation of a comprehensive nursing framework based on ERAS principles significantly improves urinary continence, erectile function, and quality of life in patients undergoing radical prostatectomy. This approach also effectively alleviates postoperative pain and reduces the incidence of complications, demonstrating good feasibility and safety. Meanwhile, prospective, large-sample, multicenter studies are still needed to validate these findings and to further optimize the combination and implementation strategies of specific ERAS components.

AVAILABILITY OF DATA AND MATERIALS

The authors declare that all data supporting the findings of this study are available within the paper and any raw data can be obtained from the corresponding author upon request.

AUTHOR CONTRIBUTIONS

FLL, MML—designed the study and carried them out; prepared the manuscript for publication and reviewed the draft of the manuscript. FLL, MML HZY, MJ—supervised the data collection; analyzed the data; interpreted the data. All authors have read and approved the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was conducted in strict accordance with the ethical principles of the Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee of Wenzhou Medical University Second Affiliated Hospital (Approval no. 2021-K-331-01). Given the retrospective design of this study, all data were sourced from existing, anonymized clinical records within the hospital's information system. The research involved no additional interventions and posed no physical or psychological harm to the patients. Therefore, the study applied for and was granted a waiver of individual informed consent by the Ethics Committee. All data used for analysis were de-identified prior to extraction to ensure the complete confidentiality of patient information.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found, in the online version, at https://oss.jomh.org/files/article/2005833487553052672/attachment/Supplementary%20material.docx.

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