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New Exploration of Early Catheter Removal: The Application of the ERAS Concept in Male Comatose Patients in Neurosurgery

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Keywords

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Abstract

Objective: Neurosurgical male comatous patients need urine catheters. Long-term indwelling can impede recovery with urinary tract infections and retention. Enhanced Recovery After Surgery (ERAS) has shown potential in several domains, expanding urinary catheter management alternatives. This study investigates ERAS applicability. **Methods:** This study included 92 male neurosurgical coma patients who received indwelling urinary catheters, they were split into the study group (46 cases, receiving ERAS treatment) and the control group (46 cases, receiving conventional care) according to random number method. The two groups' age, Body Mass Index (BMI) index, medical history, smoking/drinking history, and primary disease type were compared. The two groups' urinary tract infection, urine retention, early extubation, first urination, and indwelling catheter time were documented during the trial. **Results:** The study group outperformed the control group in all areas. In the study group, urinary tract infections were 2.17% and urine retention was 6.52%, considerably lower than 17.39% and 23.91% in the control group ($p < 0.05$). Early extubation rate was 84.78%, higher than 65.22% in the control group ($p < 0.05$). First urination time was 107.26 ± 13.87 minutes, and indwelling catheter time was 13.00 (12.00, 14.00) days, significantly shorter than the control group (144.37 ± 12.26) minutes and 22.00 (21.00, 23.00) days, respectively) ($p < 0.001$). **Conclusion:** The ERAS concept for early catheter removal in male comatous neurosurgery patients can reduce complications, increase the rate of early catheter removal, and shorten the first urination and indwelling catheter time, which is important for patient rehabilitation.

1 Introduction

In the clinical practice of neurosurgery, male comatous patients, due to their critical condition and loss of consciousness, have difficulty maintaining the function of spontaneous urination, and indwelling urinary catheters have become a common clinical operation [1]. Although this measure can timely drain urine, prevent urinary retention from causing damage to organs such as the kidneys, and facilitate medical staff to monitor urine volume to assess changes in the patient's condition, many problems brought about by long-term indwelling of urinary catheters cannot be ignored [2].

According to relevant studies, the indwelling time of the urinary catheter is positively correlated with the risk of urinary tract infection [3,4]. Long-term indwelling of a urinary catheter disrupts the natural defense mechanism of the urethra, creating conditions for bacterial invasion [5]. Bacteria can ascend through the gap between the urinary catheter and the urethral mucosa, causing urinary tract infections such as cystitis and pyelonephritis. This not only prolongs the hospital stay of patients and increases medical expenses, but also may lead to the deterioration of the condition, seriously affecting the prognosis of patients [6-8]. At the same time, long-term indwelling of a urinary catheter may also lead to urinary retention. This is because the bladder remains empty for a long time, the detrusor muscle gradually atrophy, and bladder function is impaired. As a result, patients are unable to urinate independently after the catheter is removed, further increasing the patient's suffering and the difficulty of care [9,10].

The concept of Enhanced Recovery after Surgery (ERAS) has been widely applied and recognized in the field of surgery since its proposal [11]. This concept aims to reduce the physical and psychological stress responses of patients and promote their rapid recovery by optimizing a series of perioperative management measures, including reasonable nutritional support, effective pain management, early activities [12,13]. In the field of urology, the ERAS concept has achieved remarkable results in the management of urinary catheters for some surgical patients, such as shortening the indwelling time of urinary catheters and reducing the incidence of urinary tract infections [12,14]. However, in the special group of male comatose patients in neurosurgery, the application research of the ERAS concept in urinary catheter management is relatively scarce.

Male comatose patients in neurosurgery have complex and variable conditions, often accompanied by multiple underlying diseases such as hypertension and diabetes. These factors further increase the risk of catheter-related complications [15]. Furthermore, patients in a coma are unable to cooperate with nursing operations, which poses higher requirements for nursing work. Therefore, exploring a scientific and effective catheter management model to ensure smooth urine drainage for patients, reduce the incidence of complications and promote patient recovery has become an urgent problem to be solved in the field of neurosurgical nursing.

This study introduced the ERAS concept into the nursing practice of early catheter removal for male comatose patients in neurosurgery, aiming to explore its application effect. By comparing the differences between nursing under the ERAS concept and conventional nursing, the changes in urinary tract infection rate, incidence of urinary retention, early extubation rate and urodynamic indicators of the two groups of patients were observed, providing new ideas and methods for clinical nursing in neurosurgery. It is expected to improve the nursing quality of male comatose patients in neurosurgery and promote the early recovery of patients. It has important clinical significance and application value.

2 Materials and methods

2.1 Study design and ethical declaration

This study adopted a randomized controlled trial design. This study included 92 male neurosurgical coma patients who received indwelling urinary catheters in our hospital from April 2022 to April 2023. They were divided into the control group (46 cases) and study group (46 cases) according to the random number method, the control group received conventional care, while the study group received care under the ERAS concept, and they were treated for 6 months. By comparing the clinical effective rate and urodynamic and other indicators of the two groups, the application effect of nursing under the ERAS concept on the early removal of urinary catheterization in male comatose patients in neurosurgery was explored. The Medical Ethics Committee of the Second Affiliated Hospital and Yuying Children's Hospital of Wenzhou Medical University Ethics Committee gave its clearance to this study (No. 2022-K-66-02), and the family members of the patient signed the informed consent.

2.2 Study population

Male neurosurgery coma patients who received indwelling urinary catheters in our hospital were selected as the research subjects. Inclusion criteria: (1) patients with stable vital signs; (2) patients with a Glasgow Coma Scale score 4-8; (3) coma caused by neurosurgical diseases and requiring indwelling urinary catheters. Exclusion criteria: (1) presence of congenital malformations of the urinary system; (2) have undergone urinary system surgery recently; (3) combined with severe liver and kidney dysfunction; (4) patients with persistent epileptic symptoms; (5) patients with urinary system diseases (such as urinary tract infections, prostatic hyperplasia, urinary calculi or tumors).

2.3 Treatment method

The control group adopted conventional nursing methods, including regular replacement of urinary catheters and urine bags, perineal care, bladder function training, and monitor the urine situation, etc. The time of urinary catheter removal was determined according to traditional clinical experience.

On the basis of routine care, the study group implemented the nursing plan under the ERAS concept [16]: according to the patient's condition and physiological status, a personalized catheter removal plan was formulated; strengthen health education for patients and their families to enhance their awareness and cooperation with early extubation; optimize the perineal care measures and keep the local area clean and dry; when the condition permits, the urinary catheter should be clamped as soon as possible to train the bladder function. The treatment cycle of both groups of patients was 6 months.

2.4 Observation index

2.4.1 Baseline data

Collect the general clinical data of the patients, including age, Body Mass Index (BMI), history of smoking/drinking, previous medical history (hypertension, diabetes, chronic kidney disease), primary disease type (cerebral hemorrhage, brain tumor, cerebral contusion, Moyamoya disease, spinal canal space-occupying lesion, hydrocephalus, cerebrovascular accident).

2.4.2 Other indicators

Observe and record the urinary tract infection rate, incidence of urinary retention, early extubation rate, time of first urination and indwelling catheter time of the two groups of patients. The diagnosis of urinary tract infection is based on clinical symptoms and the results of urine bacterial culture [17]. Diagnostic criteria for urinary tract infection: fever; urgency, frequent urination and painful urination symptoms; pain in the waist and above the pubic bone; the

number of colonies in urine culture is $\geqslant 10^5$/mL. Urinary retention is judged by the clinical manifestations of a patient's bladder being full but unable to urinate voluntarily. The early extubation rate refers to the proportion of patients whose urinary catheters were successfully removed within the prescribed time on the premise of meeting the extubation indications. The time of the first urination refers to the period from the removal of the urinary catheter to the patient's first spontaneous urination. The indwelling catheter time is the period from the insertion of the catheter to its removal. The responsible nurse recorded in detail the time when the urinary catheter was removed and the time of the first urination after the removal of the urinary catheter.

2.5 Statistical analysis

To do statistical analysis, SPSS 26.0 (CA, USA) was utilized. The Shapiro-Wilk test was used for the normality test. The two groups were compared using the independent sample t-test, and mean ± standard deviation was utilized to produce quantitative data that fit the normal distribution. The two groups were compared using the Mann Whitney U test, and quantitative data that did not follow the normal distribution were represented using the interquartile technique [M (P25, P75)]. Qualitative data presented as component ratios or rates were compared using the χ^2 test. A p value of less than 0.05 was considered statistically significant.

3 Results

3.1 Comparison of two groups of general data

There was no difference in age, BMI, previous medical history (hypertension, diabetes, chronic kidney disease), smoking/drinking history, primary disease type (cerebral hemorrhage, brain tumor, cerebral contusion, moyamoya disease, spinal canal space-occupying lesion, hydrocephalus, cerebrovascular accident) between the study group (n = 46) and the control group (n = 46) (Table 1, p > 0.05).

Table 1 Comparison of two groups of general data.

Index	Study group (n = 46)	Control group (n = 46)	t/χ^2	p
Age (years)	49.89 ± 11.03	49.20 ± 9.09	0.330	0.742
BMI (kg/m^2)	23.23 ± 1.84	23.52 ± 2.67	-0.618	0.538
Previous medical history [case (%)]				
Hypertension	17 (36.96)	12 (26.09)	1.259	0.262
Diabetes	10 (21.74)	8 (17.39)	0.276	0.599
Chronic kidney disease	4 (8.70)	6 (13.04)	0.499	0.503
Smoking/drinking history [case (%)]	28 (60.87)	29 (63.04)	0.046	0.830
Primary disease type [case (%)]			0.322	0.999
Cerebral hemorrhage	8 (17.39)	8 (17.39)		
Brain tumor	6 (13.04)	7 (15.22)		
Cerebral contusion	7 (15.22)	6 (13.04)		
Moyamoya disease	6 (13.04)	6 (13.04)		
Spinal canal space-occupying lesion	5 (10.87)	6 (13.04)		
Hydrocephalus	7 (15.22)	7 (15.22)		
Cerebrovascular accident	7 (15.22)	6 (13.04)		

Abbreviation: BMI, Body Mass Index.

3.2 Comparison of clinical effective rates between the two groups

The urinary tract infection rate in the study group was 2.17% (1 case), while in the control group it was 17.39% (8 cases); the prevalence of urine retention in

the study group was 6.52% (3 cases), while in the control group it was 23.91% (11 cases); the early extubation rate in the study group was 84.78% (39 cases), while in the control group it was 65.22% (30 cases) (Table 2). The study group exhibited a markedly decreased rate of urinary tract infections and incidence of urine retention compared to the control group, whereas the early extubation rate was much greater than that of the control group, the disparities were statistically substantial (Table 2, $p < 0.05$).

Table 2 Comparison of clinical effective rates between the two groups [case (%)].

Groups	Case	Urinary tract infection rate	Prevalence of urine retention	Early extubation rate
Study group	46	1 (2.17)	3 (6.52)	39 (84.78)
Control group	46	8 (17.39)	11 (23.91)	30 (65.22)
χ^2		4.434	5.392	4.696
p		0.035	0.020	0.030

3.3 Comparison of urodynamics between the two groups

The initial urination time in the study group was 107.26 ± 13.87 minutes, whereas in the control group it was 144.37 ± 12.26 minutes (Table 3). The duration of indwelling catheterisation in the study group was 13.00 (12.00, 14.00) days, whereas in the control group it was 22.00 (21.00, 23.00) days (Table 3). The duration until the initial urination and the indwelling catheter duration in the study group were much shorter than in the control group, with a statistically significant difference (Table 3, $p < 0.001$).

Table 3 Comparison of urodynamics between the two groups.

Groups	Case	Initial urination time (min)	Duration of indwelling catheterisation (day)
Study group	46	107.26 ± 13.87	13.00 (12.00, 14.00)
Control group	46	144.37 ± 12.26	22.00 (21.00, 23.00)
t/Z		-13.597	-8.310
p		< 0.001	< 0.001

4 Discussion

This study focused on the application of the ERAS concept in the early removal of urinary catheters in male comatose patients in neurosurgery. The results showed that compared with conventional care, the care under the ERAS concept significantly reduced the incidence of urinary tract infection and urinary retention in patients, increased the early extubation rate, and shortened the time of first urination and indwelling of urinary catheters. This conclusion provides an important reference basis for neurosurgical nursing practice and has multiple meanings.

ERAS is a method for optimizing perioperative care to reduce trauma stress in patients and promote functional recovery, which can effectively shorten the hospital stay while accelerating the recovery of patients [18,19]. In terms of reducing the incidence of complications, in this study, the urinary tract infection rate in the study group was only 2.17%, and the incidence of urinary retention was 6.52%, which were much lower than 17.39% and 23.91% in the control group, respectively. This achievement echoes a number of previous clinical studies. Studies have shown that long-term indwelling of urinary catheters can damage the physiological barrier of the urethra, making it easier for bacteria to invade the urinary system and thereby causing infections [20,21]. The ERAS concept focuses on optimizing nursing details, such as strengthening perineal care and clamping the urinary catheter as early as possible to train bladder

function, which helps maintain the normal physiological functions of the urinary system and reduces the risk of infection. For urinary retention, the traditional long-term indwelling urinary catheter method keeps the bladder in a passive filling state for a long time, and the detrusor muscle function gradually weakens [22,23]. Early extubation and bladder function training under the ERAS concept can effectively prevent detrusor atrophy, maintain its normal contractile function, and reduce the occurrence of urinary retention [24].

The improvement of the early extubation rate is another important achievement of the application of the ERAS concept. The early extubation rate of the study group reached 84.78%, significantly higher than 65.22% of the control group. Early removal of urinary catheters can not only reduce catheter-related complications, but also alleviate the psychological burden of patients and promote their recovery [25]. In other related studies, early extubation has also been proven to help shorten the hospital stay of patients and reduce medical costs [26]. This is attributed to the comprehensive assessment of the patient's condition and the formulation of personalized nursing plans under the ERAS concept, which can more accurately grasp the timing of extubation and ensure that the urinary catheter is removed as early as possible for the patient under the premise of safety [27]. Furthermore, in terms of urodynamics, the time for the first urination in the study group was shortened to 107.26 ± 13.87 minutes, and the indwelling catheter time was reduced to 13.00 (12.00, 14.00) days, which had a positive impact on the rehabilitation of the patients. A shorter indwelling catheter time can reduce the chances of urethral mucosal injury and bacterial colonization, and lower the risk of urinary tract infections [28,29]. The shortening of the first urination time indicates that the patient's bladder function recovers more quickly, which is conducive to the reconstruction of the patient's voluntary urination function. This is consistent with some research results at home and abroad on the application of the ERAS concept in urinary system care [30], further verifying the effectiveness of the ERAS concept in improving urodynamics.

However, this study also has certain limitations. Firstly, the sample size was relatively small, with only 92 patients included, which might not fully represent the conditions of all male comatose patients in neurosurgery. In different regions and hospitals, the conditions of patients and the level of care may vary. In the future, studies with larger sample sizes and multiple centers are needed to further verify the conclusions of this study. Furthermore, this study mainly observed short-term clinical indicators. For the long-term prognosis of patients, such as the long-term impact on urinary system function, no in-depth exploration has been conducted yet.

To sum up, this study confirmed that the ERAS concept has significant advantages in the early removal of urinary catheters in male comatose patients in neurosurgery. It can effectively reduce the incidence of complications, increase the early extubation rate, and improve urodynamic indicators. However, when promoting and applying it in clinical practice, the limitations of this study should be fully considered. Further high-quality research should be carried out to improve the application of the ERAS concept in neurosurgical nursing and provide patients with better nursing services.

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Conflicts of Interest

The authors declare no conflicts of interest.

Author Contributions

Conceptualization, S.P.; Writing – original draft, S.H.; Data curation, H.L.; Writing – review and editing Y.Y.

All authors have read and agreed to the published version of manuscript.

Ethics Approval and Consent to Participate

The Medical Ethics Committee of the Second Affiliated Hospital and Yuying Children's Hospital of Wenzhou Medical University Ethics Committee gave its clearance to this study (No. 2022-K-66-02), and the family members of the patient signed the informed consent.

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Availability of Data and Materials

The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding authors.

Supplementary Materials

Not applicable.

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