

# Clinical application of enhanced recovery after surgery in the treatment of choledocholithiasis by ERCP

Yue Zhang, BS, Zuhua Gong, BS, Sisi Chen, BS\*

## Abstract

This study aims to investigate the effect of applying enhanced recovery after surgery methods (ERAS) in perioperative nursing of choledocholithiasis following endoscopic retrograde cholangiopancreatography (ERCP) for treatment of biliary calculus.

Clinical data from 161 patients who underwent ERCP surgery in Wuhan Union Hospital from January 2017 to December 2019 were retrospectively analyzed. A total of 78 patients received perioperative nursing using the ERAS concept (experimental group) and 83 patients received conventional perioperative nursing (control group). Group differences were compared for the time to first postoperative ambulation, exhausting time, time to first defecation and eating, intraoperative blood loss, postoperative complication incidence (pancreatitis, cholangitis, hemorrhage), white blood cell (WBC), and serum amylase (AMS) values at 24 hours, duration of nasobiliary duct indwelling, length of hospital stay, and hospitalization expenses.

No significant between-group differences were noted for demographic characteristics (age, sex, BMI, ASA score, and comorbidity) ( $P > .05$ ). Time to first ambulation, exhausting time, time to defecation and eating, and nasobiliary drainage time were shorter in the experimental group than the control group, and the differences were statistically significant ( $P < .05$ ). There was no significant between-group difference in postoperative WBC values at 24 hours ( $P > .05$ ), but the experimental group's AMS values at 24 hours postoperation were significantly lower than those of the controls ( $154.93 \pm 190.01$  vs  $241.97 \pm 482.64$ ,  $P = .031$ ). Postoperative complications incidence was 9.1% in the experimental group, which was significantly lower than the 20.4% in the control group, and this difference was statistically significant ( $P = .039$ ). Compared with the control group, nasobiliary drainage time ( $26.53 \pm 7.43$  hours vs  $37.56 \pm 9.91$  hours,  $P < .001$ ), hospital stay ( $8.32 \pm 1.55$  days vs  $4.56 \pm 1.38$  days,  $P < .001$ ), and hospitalization expenses ( $36800 \pm 11900$  Yuan vs  $28900 \pm 6500$  Yuan,  $P = .016$ ) were significantly lower in the experimental group.

ERAS is a safe and effective perioperative nursing application in ERCP for treating choledocholithiasis. It can effectively accelerate patients' recovery and reduce the incidence of complications; therefore, it is worthy of being applied and promoted in clinical nursing.

**Abbreviations:** AMS = serum amylase, ASA score = American Society of Anesthesiologists score, BMI = body mass index, ERAS = enhanced recovery after surgery, ERCP = endoscopic retrograde cholangiopancreatography, EST = endoscopic sphincterotomy, WBC = white blood cell.

**Keywords:** choledocholithiasis, enhanced recovery after surgery, postoperative complications, retrograde cholangiopancreatography

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The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Department of Hepatobiliary Surgery, Union Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, China.

\* Correspondence: Sisi Chen, Department of Hepatobiliary Surgery, Union Hospital, Tongji Medical College, Huazhong University of Science and Technology, 1277 Jiefang Avenue, Wuhan 430022, China (e-mail: wang\_whuh@163.com).

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## 1. Introduction

Changes in diet and lifestyle are contributing to an increasing incidence of hepatobiliary diseases. Surgery is the most common treatment, but some patients are prone to a variety of postsurgical complications, so it is particularly important to incorporate nursing intervention during the operation.<sup>[1]</sup> ERAS comprises a series of evidence-based optimization measures incorporated into perioperative treatment.<sup>[2]</sup> Multi-dimensional and comprehensive care, combined with surgery and anesthesia techniques, can reduce patients' physiological and psychological traumatic stress, lowering the incidence of postoperative complications and allowing patients to recover quickly.<sup>[3,4]</sup> ERAS has overturned the perioperative management thinking formed over the past hundred years, and several previous studies have reported obvious advantages over traditional methods for shortening hospital stays, lowering the incidence of postoperative complications and mortality, and reducing medical costs.<sup>[5]</sup> Currently, ERAS concepts and measures are widely used in minimally invasive surgery, but there are no unified standards or evaluations

for their application in ERCP surgery. Therefore, we retrospectively analyzed the data of patients where the ERAS concept for perioperative nursing during ERCP surgery was applied between January 2017 and December 2019, with the aim of exploring the effect of ERAS in perioperative nursing of patients with choledocholithiasis treated by ERCP for treating biliary calculus.

## 2. Materials and methods

### 2.1. General information

A total of 161 patients who underwent ERCP surgery in our hospital between January 2017 and December 2019 and met the inclusion criteria were included in the study. Seventy eight patients were treated with the ERAS concept in perioperative nursing (experimental group), and 83 were treated with traditional methods (control group). Inclusion criteria:

- (1) diagnosis of common bile duct stones confirmed by CT, MRI, or other imaging techniques;
- (2) no serious cardiopulmonary complications;
- (3) no previous history of upper abdominal surgery;
- (4) complete clinical data;
- (5) signed informed consent.

Exclusion criteria:

- (1) choledocholithiasis with diameter greater than 2.5 cm;
- (2) biliary tract stenosis or deformity;
- (3) malignant tumor disease and coagulation dysfunction;
- (4) mental disorders that interfered with cooperating with surgery.

The study was approved by the ethics committee of Wuhan Union Medical College Hospital (No. 2019S084) and carried out in accordance with the Helsinki Declaration.

### 2.2. Method

Patients in the control group were given routine perioperative nursing, including condition monitoring and medication guidance. Patients in the experimental group received nursing intervention for ERAS in the perioperative period. The specific intervention measures were as follows:

1. Preoperative nursing: Psychological nursing: patients have different degrees of anxiety and depression resulting from negative cognitions of the disease and lack of relevant knowledge; hence, psychological counseling is needed. In accordance with the concept of ERAS in the perioperative period, health education was provided to improve patients' cooperation.
2. Preoperative preparation: patients were given 1000 ml glucose solution (10%) on the night before the operation and 500 ml glucose solution (10%) on the morning of the operation. Patients were instructed to fast and drink no water for 4 to 6 hours before the operation, and that bowel preparation should be performed at the same time to prevent intraoperative intraperitoneal infection.
3. Intraoperative nursing: assisting patients to adjust their body position, setting appropriate temperature and humidity before and during surgery, keeping patients warm during surgery, and strengthening nursing intervention on the nasobiliary duct and catheter to prevent infection and abdominal distension.

4. Postoperative care: patients were encouraged to get out of bed 6 hours after surgery, and medication was adjusted according to patients' pain scores. Antibiotics were administered 30 minutes before surgery and stopped 24 hours after surgery, if the patient had no obvious biliary tract infection; cholangiography was performed 24 hours after surgery, and the nasobiliary tube was removed the next day. The amount of fluid was controlled within 2000 ml of the physiological requirement, with a drip rate of 250 ml/hour. Diet and rehabilitation training were provided.<sup>[6,7]</sup>

### 2.3. Observation indicators

Intraoperative blood loss, time to first postoperative ambulation, first exhausting time, time to defecation and eating, duration of nasobiliary tube indwelling, length of stay, and hospitalization costs were observed and recorded for the two groups of patients.

WBC and ASM as well as the occurrence of postoperative complications such as cholangitis, pancreatitis, and bleeding were observed and recorded 24 hours after operation in the 2 groups.

### 2.4. Data analysis

Continuous variables were presented as mean  $\pm$  standard deviation, and categorical variables were expressed as percentage. Student *t* test was performed to compare the difference in continuous variables between the experimental group and control group. Chi-Squared test or Fisher exact test was used to compare categorical variables between the 2 groups. All statistical analyses were performed using SPSS version 24 (Chicago, IL) with two-sided  $P < .05$  considered statistically significant.

## 3. Results

### 3.1. Patient characteristics

Patients' demographic data are presented in Table 1. There were no statistically significant differences between the 2 groups for age, sex, BMI, ASA score, and comorbidity ( $P > .05$ ).

### 3.2. Between-group comparisons of related clinical indexes

The time to first ambulation ( $8.74 \pm 4.85$  hours vs  $16.35 \pm 5.34$  hours,  $P = .023$ ), exhausting time ( $31.23 \pm 5.20$  hours vs  $51.30 \pm 5.36$  hours,  $P < .001$ ), defecation ( $48.31 \pm 8.79$  hours vs  $59.46 \pm 7.54$  hours,  $P < .001$ ) and eating ( $32.00 \pm 18.33$  hours vs  $45.60 \pm 30.34$  hours,  $P = .001$ ) of the experimental group was shorter than that of the control group, and the difference was statistically significant. Compared with the control group, duration of nasobiliary drainage ( $26.53 \pm 7.43$  hours vs  $37.56 \pm 9.91$  hours,  $P < .001$ ), length of hospital stay ( $8.32 \pm 1.55$  days vs  $4.56 \pm 1.38$  days,  $P < .001$ ), and hospitalization expenses ( $36800 \pm 11900$  Yuan vs  $28900 \pm 6500$  Yuan,  $P = .016$ ) were all lower in the experimental group (Table 2).

### 3.3. Between-group comparisons of intraoperative blood loss and postoperative complications

There were no significant differences in intraoperative blood loss and WBC count 24 hours postoperative ( $P > .05$ ), but the experimental group's AMS values 24 hours postoperative were

**Table 1****Demographic characteristics of patients.**

Characteristics	ERAS group (n = 78) n (%) / mean $\pm$ sd	Control group (n = 83) n (%) / mean $\pm$ sd	P
Age (year)	60.74 $\pm$ 17.85	63.49 $\pm$ 15.40	.359
Sex			.295
Male	37 (47.4)	41 (49.4)	
Female	41 (52.6)	42 (50.6)	
BMI*	22.5 $\pm$ 3.06	22.5 $\pm$ 2.77	.697
ASA*			.917
II	48 (61.5)	56 (67.5)	
III	27 (34.6)	25 (30.1)	
IV	3 (3.9)	2 (2.4)	
Comorbidity	11 (14.1)	13 (15.7)	0.797
Hypertension	5 (6.4)	8 (9.6)	
Diabetes	2 (2.6)	2 (2.4)	
Coronary heart disease	2 (2.6)	4 (4.8)	
Cerebral infarction	0 (0)	1 (1.2)	
Schistosomiasis	0 (0)	2 (2.4)	
Cirrhosis	0 (0)	1 (1.2)	
Hypoalbuminemia	2 (2.6)	0 (0)	

ASA = American Society of Anesthesiologists, BMI = body mass index.

3-D XB\* represent 3-dimension x-ray beams, and EB\* represent electron beams.

**Table 2****The comparison of related clinical indexes between the 2 groups.**

Characteristics	ERAS group (n = 78) n (%) / mean $\pm$ sd	Control group (n = 83) n (%) / mean $\pm$ sd	P
The time to first ambulation (h)	8.74 $\pm$ 4.85	16.35 $\pm$ 5.34	.023
Exhausting time (h)	31.23 $\pm$ 5.20	51.30 $\pm$ 5.36	<.001
The time to first of defecation (h)	48.31 $\pm$ 8.79	59.46 $\pm$ 7.54	<.001
The time to first of eating (h)	32.00 $\pm$ 18.33	45.60 $\pm$ 30.34	.001
duration of nasobiliary drainage (h)	26.53 $\pm$ 7.43	37.56 $\pm$ 9.91	<.001
Hospital stay (day)	4.56 $\pm$ 1.38	8.32 $\pm$ 1.55	<.001
Hospitalization expenses (yuan)	28900 $\pm$ 6500	36800 $\pm$ 11900	.016

significantly lower than that of the control group (154.93  $\pm$  190.01 U/L vs. 241.97  $\pm$  482.64 U/L,  $P = .031$ ). Postoperative complication incidence was 9.1% in the experimental group, which was significantly lower than in the control group, whereas 20.4% (17 of 83 patients) experienced postoperative complications; this difference was statistically significant ( $P = .039$ ) (Table 3).

**4. Discussion**

ERAS is a concept of perioperative treatment proposed in 1997 by Kehlet, who aimed to optimize perioperative treatment

measures through a series of evidence-based medical interventions. ERAS can reduce the adverse physiological and psychological stress caused by surgery and medical treatment, reduce the negative effect on patients, and accelerate patients' recovery after surgery.<sup>[8–11]</sup> In 2001, Danish surgeons Wilmore et al reintroduced this concept and began to widely implement it in clinical practice.<sup>[12,13]</sup> Currently, the ERAS concept is widely used in colorectal, orthopedic, gynecological, gastric cancer, and thoracic surgeries, and relevant studies have shown its significant clinical effect.<sup>[14–21]</sup>

Although open surgery and laparoscopy are also suitable treatments, ERCP has become the first choice for many patients

**Table 3****The comparison of intraoperative bleeding loss and postoperative complications between the 2 groups.**

Characteristics	ERAS group (n = 78) n (%) / mean $\pm$ sd	Control group (n = 83) n (%) / mean $\pm$ sd	P
Intraoperative blood loss (ml)	4.65 $\pm$ 1.631	5.27 $\pm$ 2.553	.359
WBC	6.47 $\pm$ 3.02	6.78 $\pm$ 4.23	.511
AMS	154.93 $\pm$ 190.01	241.97 $\pm$ 482.64	.031
Total complications	7 (9.1)	17 (20.4)	.039
Cholangitis	1 (1.3)	4 (4.8)	
Pancreatitis	3 (3.9)	7 (8.4)	
Postoperative hemorrhage	0 (0)	1 (1.2)	
Other	3 (3.9)	5 (6.0)	

WBC = white blood cell values 24 hours postoperative ( $4\text{--}10 \times 10^9/\text{L}$ ), AMS = Serum amylase postoperative values 24 hours postoperative (U/L).

with biliary and pancreatic diseases because it has many advantages.<sup>[22]</sup> For example, it is minimally invasive, effective, requires a short hospital stay, and has a low incidence of complications, especially for elderly patients who are poor candidates for open surgery. With the development of medical technology, the therapeutic effect of ERCP has occupied an important medical position alongside the development of minimally invasive technology. ERCP has become the first choice for many patients with biliary and pancreatic diseases because it is minimally invasive, effective, requires only a short hospital stay, and has a low incidence of complications, and has irreplaceable advantages.<sup>[23]</sup>

Kehlet et al believe that reducing the stress response is the ERAS concept core principle and the basis for accelerating patients' postoperative rehabilitation.<sup>[24]</sup> During the ERCP perioperative period, there are multiple stress responses stemming from psychological and physiological aspects. In our study, the main purpose of preoperative psychological nursing was to help patients understand the process and effect of ERCP surgery, which helped facilitate their cooperation during surgery, when they are typically sedated. Preoperative preparation helps to eliminate patients' hunger state and relieve their anxiety. Preoperative prophylactic rectal indomethacin administration could replace pancreatic stent placement (PSP) in patients undergoing high-risk ERCP, potentially improving clinical outcomes and reducing healthcare costs.<sup>[25]</sup> During the operation, after successful ERCP catheterization, we made a small incision in the papillary sphincter, about 0.3 to 0.5 cm, and then expanded the balloon to 1.0 to 1.5 cm for stone extraction. The small incision helps to retain as much of the papillary sphincter as possible, and reduces the incidence of bleeding and intestinal perforation, which also follows the ERAS concept.

Nelson et al found that median postoperative hospitalization days decreased from 9.4. to 7.4 after applying accelerated rehabilitation surgery measures, and there were no significant changes in reoperation rates, readmission rates, or mortality within 30 days, which confirmed the safety and effectiveness of accelerated rehabilitation surgery.<sup>[26]</sup> Our results showed that the time to first postoperative ambulation was reduced when ERAS nursing was applied. Initial oral feeding was also significantly earlier in the experimental group than in the control group, and the length and cost of hospitalization were also significantly reduced ( $P < .05$ ). These results are consistent with previous studies.

Pancreatitis is the most common complication following ERCP, and is diagnosed by AMS levels.<sup>[27–28]</sup> Previous studies have shown that AMS was present in approximately 73% of patients after ERCP, which may be associated with a sudden increase in intrapancreatic pressure during angiography; however, less than 7% of patients were diagnosed with clinical pancreatitis.<sup>[29–32]</sup> Therefore, we focused on observing the changes in patients' abdominal signs and routine blood work. If the patients had no obvious abdominal pain and the AMS was within 3 to 5 times of the normal value 24 hours later, they started drinking water and underwent nasobiliary drainage angiography. If there were no residual stones, the nasobiliary drainage tube could be extracted.

Early papillary edema after EST can lead to increased intraduct pressure, and a small amount of bile can flow down the common channel into the pancreatic duct, increasing the incidence of pancreatitis. Therefore, nasobiliary drainage also effectively reduces the incidence of pancreatitis.<sup>[33–34]</sup> The timing

of nasal biliary drainage tube removal remains controversial. We believe that if the intraoperative operation is successful and the guidewire is not repeatedly inserted into the patient's pancreatic duct, the catheter can be extubated in advance without residual stones showing on postoperative angiography, which not only alleviates patients' discomfort, but is an important link in the ERAS concept. In our study, for patients in the experimental group, nasobiliary extubation was performed after nasobiliary cholangiography when the blood amylase was within 3 times the normal value and there were no obvious symptoms of abdominal pain 24 hours after surgery. By contrast, in control group patients, extubation was performed after nasobiliary cholangiography when AMS levels were within normal limits, with no obvious symptoms of abdominal pain. Our clinical results showed that early extubation did not increase the incidence of adverse events in the experimental group.

Postoperative complication incidence was 9.1% in the experimental group and 20.4% (17/83) in the control group. Complications included pancreatitis, cholangitis, and hemorrhage. No serious complications (e.g., acute severe pancreatitis) occurred in either group. There were no significant between-group differences in postoperative complication severity, but complication incidence was significantly lower in the experimental group. From our clinical practice and data analysis, we concluded that applying the ERAS concept for perioperative nursing can significantly reduce the time to the first postoperative ambulation, exhausting time, and time to defecation and eating. In addition, intraoperative blood loss, postoperative complications, hospital stay, and hospitalization expenses were also significantly reduced in patients receiving ERAS, suggesting that the concept is safe and economical in perioperative nursing of ERCP and EST for treatment of biliary calculus, and therefore has important clinical value.

This study has several limitations. First, it was a retrospective study conducted on data from a patient database, so our results must be interpreted with caution. Given the lack of randomization, different perioperative nursing methods may have affected patients' postoperative recovery. Second, although patients experienced both routine nursing methods and ERAS nursing methods, the nurses differed in their individual approaches; this lack of uniform criteria for treatment decisions may have biased the results. Third, given the limitation of follow-up time, we could not evaluate the impact of different perioperative nursing approaches on patients' long-term survival. Despite these limitations, this study provides meaningful data on safety and enhanced recovery effectiveness following surgical treatment of choledocholithiasis by ERCP.

## 5. Conclusion

Enhanced recovery after surgery methods are safe and effective in perioperative nursing after ERCP for the treatment of choledocholithiasis, and they may accelerate patients' recovery and reduce the incidence of complications. ERAS methods should be effectively applied and promoted in clinical nursing.

## Author contributions

**Conceptualization:** Yue Zhang, Zuhua Gong.

**Data curation:** Yue Zhang.

**Formal analysis:** Zuhua Gong, Sisi Chen.

**Investigation:** Yue Zhang.

**Methodology:** Sisi Chen.

**Project administration:** Yue Zhang.

**Resources:** Yue Zhang.

**Software:** Yue Zhang, Zuhua Gong.

**Validation:** Sisi Chen.

**Writing – original draft:** Yue Zhang, Zuhua Gong, Sisi Chen.

**Writing – review & editing:** Zuhua Gong, Sisi Chen.

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