

## Feasibility of Enhanced Recovery After Surgery (ERAS) Protocol in Perioperative Management of Pancreaticoduodenectomy: Postprint

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### Abstract

**Objective:** To investigate the safety and efficacy of the Enhanced Recovery After Surgery (ERAS) protocol in perioperative management of pancreaticoduodenectomy. **Methods:** Patients undergoing pancreaticoduodenectomy in the Department of General Surgery at Peking Union Medical College Hospital between April 2016 and April 2018 were retrospectively analyzed. Sixty-three patients who met the inclusion and exclusion criteria were enrolled in the ERAS group, while 60 patients who underwent conventional pancreaticoduodenectomy during the same period served as the control group. Intraoperative and postoperative parameters, complication rates, and clinical outcomes were compared between the two groups. **Results:** Baseline characteristics were comparable between the ERAS and control groups with no statistically significant differences. The ERAS group predominantly underwent laparoscopic surgery, whereas the control group had a higher proportion of open procedures ( $P < 0.01$ ). Although operative time was longer in the ERAS group ( $P < 0.01$ ), intraoperative blood loss was significantly reduced ( $P < 0.01$ ). The ERAS group demonstrated earlier nasogastric tube removal ( $P = 0.012$ ) and earlier resumption of liquid diet ( $P = 0.015$ ), shorter hospital stay ( $P = 0.024$ ), and lower hospitalization costs ( $P = 0.018$ ). The incidence of delayed gastric emptying was significantly lower in the ERAS group (3.2%) compared with the control group (13.3%) ( $P = 0.039$ ). No statistically significant differences were observed between the groups in total complication rate, pancreatic fistula, biliary fistula, postoperative hemorrhage, infection, readmission, reoperation rates, or mortality. Within the ERAS group, the laparoscopic subgroup exhibited significantly lower intraoperative blood loss ( $P < 0.01$ ), shorter postoperative hospital stay ( $P = 0.016$ ), and reduced hospitalization costs ( $P = 0.021$ ) compared with the open surgery subgroup. **Conclusion:** Pancreaticoduodenectomy performed under the ERAS protocol is safe and effective, accelerates patient recovery, and does not increase the risk of complications.

## Full Text

### Feasibility of Enhanced Recovery After Surgery in the Perioperative Management of Pancreaticoduodenectomy

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#### Abstract

**Objective:** To explore the safety and effectiveness of Enhanced Recovery After Surgery (ERAS) protocols in the perioperative management of pancreaticoduodenectomy.

**Methods:** A retrospective cohort study was conducted analyzing patients who underwent pancreaticoduodenectomy at the Department of General Surgery, Peking Union Medical College Hospital between April 2016 and April 2018. Sixty-three patients meeting inclusion and exclusion criteria were enrolled in the ERAS group, while 60 patients who underwent conventional pancreaticoduodenectomy during the same period served as the control group. Perioperative parameters, postoperative complications, and clinical outcomes were compared between the two groups.

**Results:** Baseline characteristics were comparable between the ERAS and control groups. The ERAS group predominantly underwent laparoscopic surgery, whereas the control group mainly had open surgery ( $P < 0.01$ ). The ERAS group had longer operation times ( $P < 0.01$ ) but significantly reduced intraoperative blood loss ( $P < 0.01$ ). Compared with the control group, the ERAS group demonstrated earlier nasogastric tube removal, earlier postoperative fluid intake, shorter postoperative hospital stays, and significantly lower hospitalization expenses (all  $P < 0.05$ ). The incidence of delayed gastric emptying in the ERAS group was significantly lower than in the control group (3.2% vs. 13.3%,  $P < 0.05$ ). There were no significant differences between groups in the incidence of total complications, pancreatic fistula, biliary fistula, postoperative hemorrhage, secondary hospital admission, secondary surgery, or mortality. Within the ERAS group, the laparoscopic subgroup had significantly lower intraoperative blood loss ( $P < 0.01$ ), shorter postoperative hospital stays ( $P < 0.05$ ), and lower hospitalization expenses ( $P < 0.05$ ) compared with the open surgery subgroup.

**Conclusion:** ERAS protocols are safe and effective for the perioperative management of pancreaticoduodenectomy, significantly accelerating patient recovery

without increasing the risk of complications.

**Keywords:** Enhanced Recovery After Surgery; pancreaticoduodenectomy

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## 1. Subjects and Methods

### 1.1 Study Subjects and Grouping

A retrospective cohort study was performed analyzing clinical data from patients who were admitted to the Department of General Surgery, Peking Union Medical College Hospital between April 2016 and April 2018 for pancreaticoduodenectomy and were discharged successfully. Patients meeting the following inclusion and exclusion criteria were included: (1) aged 18-75 years; (2) preoperative contrast-enhanced CT indicating resectable or potentially resectable disease without distant metastasis; (3) requirement for pancreaticoduodenectomy due to benign or malignant pancreatic head tumors, duodenal tumors, or malignant bile duct/ampullary tumors. Exclusion criteria included: (1) severe liver disease, respiratory disease, or uncontrolled diabetes; (2) cases where pancreaticoduodenectomy was not performed (exploratory surgery only or total pancreatectomy). All procedures were performed by the same group of senior pancreatic surgeons. Sixty-three patients meeting the criteria were enrolled in the ERAS group, while 60 patients who underwent conventional clinical management pathways during the same period served as the control group. The ERAS group predominantly utilized minimally invasive techniques, including totally laparoscopic, laparoscopic-assisted, or laparoscopic-converted-to-open approaches when technically difficult. The ERAS group was further divided into laparoscopic and open surgery subgroups for comparison.

### 1.2 Research Methods

This study was based on a multidisciplinary collaboration model, drawing on domestic and international ERAS development experience and employing minimally invasive surgical techniques to explore the feasibility of ERAS protocols in pancreatic surgery perioperative management. All patients and their families were fully informed about treatment options and provided informed consent. The study was approved by the Ethics Committee of Peking Union Medical College Hospital, Chinese Academy of Medical Sciences (approval number: ZS-1089). The ERAS group received perioperative rapid recovery management guided by ERAS principles, including preoperative nutritional assessment, postoperative functional exercise, and early ambulation, tailored to individual patient differences and clinical experience. The control group followed conventional management protocols strictly implemented by the Department of General Surgery, Peking Union Medical College Hospital, including perioperative nutritional support and fluid management.

Comparison of perioperative clinical management pathways for pancreaticoduodenectomy between ERAS and control groups

### 1.3 Observation Indicators

The following indicators were compared and analyzed between the ERAS and control groups: (1) surgical-related indicators including operation time, intraoperative blood loss, and transfusion; (2) postoperative general conditions including gastrointestinal function recovery, nasogastric tube removal time, first postoperative ambulation time, resumption of fluid intake time, postoperative hospital stay, and hospitalization expenses; (3) postoperative complications including incidence and severity grading; and (4) readmission and mortality rates. Pancreaticoduodenectomy has numerous and complex complications, including pancreatic fistula, biliary fistula, postoperative hemorrhage, delayed gastric emptying, wound infection, urinary tract infection, deep vein thrombosis, wound dehiscence, liver abscess, and chylous fistula.

### 1.4 Statistical Analysis

SPSS 20.0 software was used for all statistical analyses. Measurement data were expressed as mean  $\pm$  standard deviation. Normality distribution was tested using variance analysis. Normally distributed measurement data were analyzed using t-tests, while count data were analyzed using Fisher's exact test.  $P < 0.05$  was considered statistically significant.

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## 2. Results

### 2.1 General Clinical Data of ERAS and Control Groups

Statistical analysis showed no significant differences between the ERAS and control groups in age, sex, body mass index (BMI), smoking history, diabetes history, jaundice history, neoadjuvant therapy, or pathological diagnosis ( $P > 0.05$ ), indicating good baseline comparability.

### 2.2 Comparison of Intraoperative and Postoperative Conditions

There were significant differences in surgical approaches between the ERAS and control groups. The ERAS group predominantly underwent laparoscopic surgery, while the control group mainly had open surgery. The ERAS group had longer operation times than the control group ( $P < 0.01$ ) but significantly less intraoperative blood loss ( $P < 0.01$ ). Postoperative nasogastric tube removal time and resumption of fluid intake time were earlier in the ERAS group ( $P < 0.05$ ), and postoperative hospital stay was significantly shorter ( $P < 0.05$ ). Hospitalization expenses were also lower in the ERAS group ( $P < 0.01$ ).

### 2.3 Comparison of Postoperative Complications

The incidence of delayed gastric emptying in the ERAS group was significantly lower than in the control group (3.2% vs. 13.3%,  $P=0.039$ ). There were no significant differences between groups in the incidence of total complications, pancreatic fistula, biliary fistula, postoperative hemorrhage, secondary surgery, or readmission. The total postoperative complication rate was 41.3% (26/63) in the ERAS group and 48.3% (29/60) in the control group, with no statistical difference. No deaths occurred in either group .

### 2.4 Comparison of Laparoscopic and Open Surgery Subgroups Within the ERAS Group

ERAS group patients were divided into laparoscopic surgery ( $n=36$ ) and open surgery ( $n=27$ ) subgroups. Baseline characteristics were comparable between subgroups. The laparoscopic surgery group had significantly longer operation times than the open surgery group ( $P<0.010$ ), but there was no significant difference in overall postoperative complication rates. The laparoscopic group demonstrated significantly better outcomes in intraoperative blood loss, postoperative hospital stay, and hospitalization expenses ( $P<0.05$ ) .

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## 3. Discussion

The core of the ERAS concept lies in adopting perioperative optimization measures supported by evidence-based medicine. This concept overturns perioperative management principles established for nearly a century, reducing surgical trauma and stress responses, and shortening postoperative hospital stays. In recent years, numerous large-scale pancreatic centers domestically and internationally have begun exploring ERAS protocols for pancreaticoduodenectomy. Balzano et al. [11] analyzed postoperative recovery indicators in 2014 under traditional management models, showing that ERAS protocols significantly reduced gastric emptying dysfunction ( $P=0.004$ ). Williamson et al. [12] reported in 2015 that ERAS programs reduced delayed gastric emptying after pancreaticoduodenectomy (13.9% vs. 24.6%,  $P=0.004$ ) and shortened hospital stays (13.9 days vs. 24.6 days,  $P=0.004$ ). The Second Affiliated Hospital of Zhejiang University conducted similar research, as did Shanghai Huashan Hospital and Ruijin Hospital, all demonstrating that ERAS groups had superior outcomes in nasogastric tube removal time, gastric emptying dysfunction, and hospital stay compared with conventional groups [14-15]. Our results align with these reports, showing ERAS group had earlier nasogastric tube removal, earlier fluid intake resumption, and lower hospitalization expenses than the control group, with delayed gastric emptying incidence also lower than the control group.

The causes of postoperative delayed gastric emptying remain controversial, possibly related to duodenal ischemia or gastrointestinal reconstruction [16]. Fasting

status impairs gastric motility, while fed states produce stronger gastrointestinal contractions [17]. Early postoperative oral feeding can improve gastrointestinal motility [18], and ERAS protocols advocate early nasogastric tube removal and resumption of oral intake. Our study did not observe increased postoperative pancreatic fistula due to early fluid intake, indicating that ERAS management does not increase postoperative complication risk and may help reduce delayed gastric emptying.

Compared with traditional surgery, minimally invasive surgery is an important measure to reduce trauma and stress, significantly decreasing postoperative stress responses, reducing intestinal paralysis and pulmonary dysfunction, lowering cardiac burden, reducing postoperative complication rates, and shortening hospital stays [19-20]. This study introduced the minimally invasive concept into pancreatic surgery, with more laparoscopic cases in the ERAS group than in the control group. Although the laparoscopic group had longer operation times than the open group, there was no significant difference in overall postoperative complication rates, while postoperative hospital stay and hospitalization expenses were superior in the laparoscopic group, demonstrating the advantages of laparoscopic minimally invasive techniques.

The core of ERAS management protocols in pancreatic surgery has gained some recognition for safety, but many specific implementation details remain questionable. The ERAS guidelines [6] should be applied according to local conditions and tailored to individual patients. There are significant disparities in medical resources across regions in China, and different hospitals may have varying surgical volumes and experience. Blindly pursuing rapid recovery may lead to substantial medical risks and violate the original concept. ERAS protocols should be implemented progressively under conditions where technical capabilities and overall medical strength permit, ensuring patients benefit fully.

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## References

- [1] Kehlet H. Multimodal approach to control postoperative pathophysiology and rehabilitation [J]. *Br J Anaesth*, 1997, 78: 606-617.
- [2] Kehlet H, Wilmore DW. Multimodal strategies to improve surgical outcome [J]. *Am J Surg*, 2002, 183: 630-641.
- [3] Varadhan KK, Neal KR, Dejong CH, et al. The enhanced recovery after surgery (ERAS) pathway for patients undergoing major elective open colorectal surgery: a meta-analysis of randomized controlled trials [J]. *Clin Nutr*, 2010, 29: 434-440.
- [4] Chinese Expert Consensus on Enhanced Recovery After Surgery for Colorectal Surgery (2015) [J]. *Chinese Journal of Practical Surgery*, 2015, 8: 841-843.
- [5] Karra A, Wheat J, Chan D, et al. Propensity score analysis of an enhanced

recovery programme in upper gastrointestinal cancer surgery [J]. *World J Surg*, 2016, 40: 1645-1654.

[6] Lassen K, Coolson MM, Slim K, et al. Guidelines for perioperative care for pancreaticoduodenectomy: Enhanced Recovery After Surgery (ERAS) Society recommendations [J]. *Clin Nutr*, 2012, 31: 817-830.

[7] Mezhir JJ. Management of complications following pancreatic resection: an evidence-based approach [J]. *J Surg Oncol*, 2013, 107: 58-66.

[8] Balcom JH, Rattner DW, Warshaw AL, et al. Ten-year experience with 733 pancreatic resections: changing indications, older patients, and decreasing length of hospitalization [J]. *Arch Surg*, 2001, 136: 391-398.

[9] Kennedy EP, Rosato EL, Sauter PK, et al. Initiation of a critical pathway for pancreaticoduodenectomy at an academic institution—the first step in multidisciplinary team building [J]. *J Am Coll Surg*, 2007, 204: 917-924.

[10] Luckkey A, Livingstone E, Tache Y. Mechanisms and treatment of postoperative ileus [J]. *Arch Surg*, 2003, 138: 206-214.

[11] Balzano G, Zerbi A, Braga M, et al. Fast-track recovery programme for pancreaticoduodenectomy reduces delayed gastric emptying [J]. *Br J Surg*, 2008, 95: 1387-1393.

[12] Williamson C, Karlsson N, Stureson C, et al. Impact of a fast-track surgery programme for pancreaticoduodenectomy reduces delayed gastric emptying [J]. *Br J Surg*, 2015, 102: 1133-1141.

[13] Bai X, Zhang X, Lu F, et al. The implementation of an enhanced recovery after surgery (ERAS) program following pancreaticoduodenectomy [J]. *Pancreatology*, 2016, 16: 665-670.

[14] Dai J, Jiang Y, Fu D. Reducing postoperative complications and improving clinical outcome: Enhanced Recovery After Surgery (ERAS) in pancreaticoduodenectomy—a retrospective cohort study [J]. *Int J Surg*, 2017, 39: 176-181.

[15] Deng X, Cheng X, Huo Z, et al. Modified protocol for enhanced recovery after surgery is beneficial for Chinese cancer patients undergoing pancreaticoduodenectomy [J]. *Oncotarget*, 2017, 8: 47841-47848.

[16] Hu HL, Zhou XD, Zhang Q, et al. Factors influencing delayed gastric emptying after pancreaticoduodenectomy—a meta-analysis [J]. *Hepatogastroenterology*, 2014, 61: 1539-1545.

[17] Gerritsen A, Besselink MG, Gouma DJ, et al. Systematic review of five feeding routes after pancreaticoduodenectomy [J]. *Br J Surg*, 2013, 100: 589-599.

[18] Marquez ME, Baz FC, Suarez JP, et al. Nutrition management in enhanced recovery after abdominal pancreatic surgery [J]. *Cir Esp*, 2017, 95: 361-368.

[19] Delitto D, Luckhurst CM, Black BS, et al. Oncologic and perioperative outcomes following selective application of laparoscopic pancreaticoduodenectomy for periamullary malignancies [J]. J Gastrointest Surg, 2016, 20: 1343-1349.

[20] (2018, 2018) [J]. 1: 1-20.

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