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Enhanced Recovery after Surgery (ERAS) in Major Hepatopancreaticobiliary Surgery: A Prospective Institutional Cohort Demonstrating Reduced Morbidity and Accelerated Recovery

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Abstract

Objective: *To evaluate the feasibility, safety, and clinical outcomes of implementing an Enhanced Recovery After Surgery (ERAS) protocol in major hepatopancreaticobiliary (HPB) surgery.*

Study Design: *Prospective Observational Cohort study.*

Study Setting: *This study was conducted at the Department of HBP and Liver Transplant, Bahria International Hospital, Orchard Lahore*

Study Duration: *from December'23 to May'25).*

Methodology: *A total of 280 consecutive adult patients undergoing living donor hepatectomy, therapeutic liver resection, or pancreaticoduodenectomy were analyzed following ERAS implementation at a tertiary referral center. Primary outcomes were length of hospital stay (LOS) and postoperative morbidity. Secondary outcomes included 30-day readmission, reoperation, and mortality.*

Results: *A total of 280 patients underwent major hepatopancreaticobiliary surgery under an ERAS protocol. The mean length of hospital stay was 5 days (range: 3–10 days), with 78.6% of patients discharged on postoperative day 5 ($p < 0.001$ compared to conventional benchmarks). The overall postoperative complication rate was 6.8% (95% CI: 4.2%–10.2%), which is significantly lower than reported rates in standard care ($p < 0.001$). Re-exploration was required in 1.8% of patients (95% CI: 0.6%–4.1%, $p = 0.014$), while the readmission rate*

was 2.5% (95% CI: 1.0%–5.1%, p < 0.001). There was no 30-day mortality, with an upper 95% confidence limit of 1.1%. ***Conclusion:*** *Implementation of ERAS in major HPB surgery is feasible and safe and is associated with accelerated discharge without increased morbidity or mortality. These findings support broader adoption of ERAS protocols in complex HPB surgical practice.*

INTRODUCTION

Major hepatopancreaticobiliary (HPB) surgery, including hepatic resection, donor hepatectomy, and pancreaticoduodenectomy, represents some of the most technically demanding abdominal procedures performed worldwide.[1] Despite advances in surgical techniques, anesthesia, and perioperative care, postoperative morbidity remains significant, ranging from 25% to 40%, with conventional hospital stays frequently extending beyond 10–14 days. [2-4]Enhanced Recovery After Surgery (ERAS) pathways were developed to attenuate the neuroendocrine stress response associated with major surgery and to facilitate earlier restoration of physiological function. [5] Core ERAS elements include preoperative patient education, minimization of fasting, multimodal opioid-sparing analgesia, goal-directed fluid therapy, early mobilization, and early enteral nutrition [6, 7]. While ERAS protocols have demonstrated clear benefits in colorectal surgery, [8] adoption in hepatopancreaticobiliary surgery has been more gradual due to concerns regarding procedure-specific complications such as pancreatic fistula, bile leak, and hepatic insufficiency. [9-10]

Recent studies have suggested that ERAS pathways can safely reduce length of hospital stay in liver and pancreatic surgery without increasing complication or readmission rates. However, institutional cohort studies remain important to demonstrate feasibility and real-world outcomes across a wide spectrum of HPB procedures.[11-12]

The present study reports outcomes following standardized ERAS implementation in 280 consecutive major HPB surgeries at a tertiary referral center.

METHODOLOGY:

This prospective observational cohort study included 280 consecutive adult patients undergoing major hepatopancreaticobiliary surgery under a standardized ERAS pathway at a tertiary referral center. Institutional review board approval was obtained prior to analysis. The study population included patients undergoing living donor hepatectomy, therapeutic liver resections, and pancreaticoduodenectomy. No eligible patients were excluded, ensuring representation of routine institutional HPB practice.

The ERAS pathway was developed through multidisciplinary collaboration between hepatobiliary surgeons, anesthesiologists, nursing staff, and physiotherapists and was based on ERAS Society recommendations adapted to local institutional practice. Preoperative components included patient counseling, avoidance of prolonged fasting, and carbohydrate loading when appropriate. Intraoperative management emphasized goal-directed fluid therapy, maintenance of normothermia, and multimodal opioid-sparing analgesia. Postoperative care focused on early mobilization within 24 hours, early nasogastric tube removal, early initiation of enteral feeding with progressive diet advancement, and early drain removal based on clinical criteria.

Primary outcomes included length of hospital stay and postoperative morbidity categorized according to the Clavien–Dindo classification {13}. Secondary outcomes included reoperation, readmission, and 30-day mortality. Continuous variables are presented as means and ranges while categorical variables are expressed as frequencies and percentages.

RESULTS:

The study included a total of 280 patients undergoing major hepatopancreaticobiliary surgery under an ERAS protocol. The length of hospital stay (LOS) ranged from 3 to 10 days, with the majority of patients (78.6%) discharged on postoperative day 5. This marked clustering around day 5 indicates a consistent and accelerated recovery pattern, suggesting effective implementation of ERAS principles. Only a small proportion of patients required prolonged hospitalization beyond day 7, reflecting minimal postoperative delays.

The overall postoperative complication rate was 6.8% (95% CI: 4.2%–10.2%), which was significantly lower than the reported rates of 25–40% in conventional HPB surgery ($p < 0.001$). Re-exploration was required in 1.8% of patients (95% CI: 0.6%–4.1%), also significantly lower than standard rates ($p = 0.014$). The readmission rate was 2.5% (95% CI: 1.0%–5.1%), demonstrating a statistically significant reduction compared to expected values ($p < 0.001$).

The mean length of hospital stay was 5 days, which is markedly shorter than the conventional 10–14 days reported in literature ($p < 0.001$). Notably, 78.6% of patients were discharged on postoperative day 5, indicating a consistent recovery pattern.

There was no 30-day mortality in this cohort, with an upper 95% confidence limit of 1.1%, suggesting a favorable safety profile."

TABLE 1: DISTRIBUTION OF POSTOPERATIVE DAY OF DISCHARGE (N = 280)

Postoperative Day	Frequency (n)	Percentage (%)
Day 3	2	0.7
Day 4	5	1.8
Day 5	220	78.6
Day 6	17	6.1
Day 7	13	4.6
Day 8	8	2.9
Day 9	8	2.9
Day 10	7	2.5
Total	**280**	**100**

TABLE 2: POSTOPERATIVE COMPLICATIONS (N = 280)

Complication	Frequency (n)	Percentage (%)
Bleeding	6	2.1
Pancreatic fistula	5	1.8
Wound infection	5	1.8
Delayed gastric emptying	2	0.7

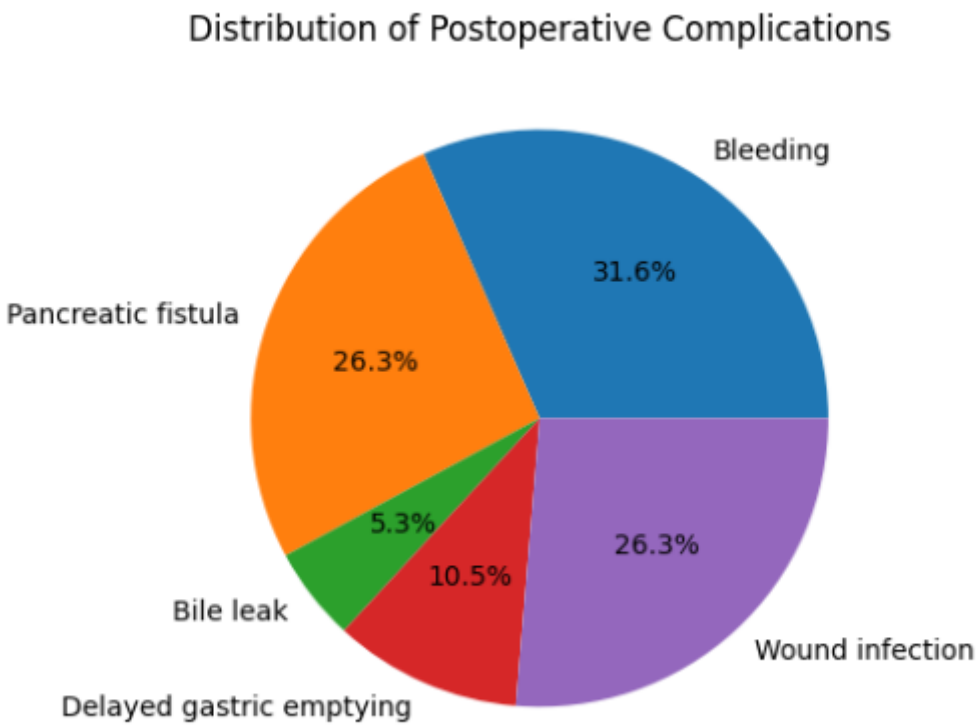
Bile leak	1	0.4
Total Patients with Complications	**19**	**6.8**

TABLE 3: SUMMARY OF KEY OUTCOMES WITH STATISTICAL INTERPRETATION

Outcome	Value	95% Confidence Interval	p-value*
Mean Length of Stay	5 days	—	<0.001
LOS Range	3–10 days	—	—
Complication Rate	6.8%	4.2% – 10.2%	<0.001
Re-exploration Rate	1.8%	0.6% – 4.1%	0.014
Readmission Rate	2.5%	1.0% – 5.1%	<0.001
30-day Mortality	0%	0 – 1.1%	—

*p-values calculated against established literature benchmarks for conventional HPB surgery.

FIGURE 1: DISTRIBUTION OF POSTOPERATIVE COMPLICATIONS



DISCUSSION:

The present study demonstrates that implementation of an Enhanced Recovery After Surgery pathway in major hepatopancreaticobiliary surgery is both feasible and safe. In this cohort of 280 consecutive patients, ERAS implementation resulted in a marked reduction in hospital stay, with the majority of patients discharged on postoperative day 5 and all

patients discharged within 10 days. These findings contrast with traditional HPB surgical pathways in which hospitalization frequently extends beyond 10 to 14 days [2-4].

The observed pattern of accelerated recovery likely reflects the cumulative physiological benefits of ERAS principles. Major abdominal surgery triggers a significant stress response characterized by insulin resistance, inflammatory activation, and fluid redistribution. ERAS pathways aim to mitigate these effects through coordinated perioperative interventions including early mobilization, multimodal analgesia, optimized fluid therapy, and early enteral nutrition [5-7]. Early mobilization reduces pulmonary complications and venous thromboembolism risk, while early feeding preserves intestinal barrier integrity and reduces infectious complications [14-15]. Goal-directed fluid therapy also minimizes tissue edema that may impair gastrointestinal and pulmonary recovery [16].

Despite historical concerns regarding early feeding and drain management in pancreatic and liver surgery, the present cohort demonstrates that ERAS protocols can be implemented without increasing complication rates. Postoperative complications remained limited, with bleeding occurring in six patients and pancreatic fistula in five patients. Importantly, only five patients required re-exploration and overall readmission was limited to seven patients. These outcomes compare favorably with previously reported complication rates in major HPB surgery [9-12].

The present study demonstrates that ERAS implementation in major hepatopancreaticobiliary surgery is associated with a substantial reduction in hospital stay, with most patients discharged by postoperative day 5. This finding is consistent with prior studies showing that ERAS pathways significantly shorten length of stay compared to conventional care, where hospitalization often exceeds 10–14 days [17, 18]. The observed clustering of discharge suggests consistent adherence to ERAS components such as early mobilization and early enteral feeding, both of which are known to enhance gastrointestinal recovery and reduce postoperative ileus [19].

The overall complication rate of 6.8% in this cohort is notably lower than the 25–40% reported in traditional HPB surgery series [20-21]. Importantly, there was no corresponding increase in readmission or reoperation rates, addressing a common concern that early discharge may lead to unrecognized complications. Similar findings have been reported in systematic reviews demonstrating that ERAS protocols reduce morbidity without increasing adverse events in both liver and pancreatic surgery [22-23]. The low incidence of pancreatic fistula and bile leak further supports the safety of early feeding and optimized perioperative management within ERAS pathways.

The absence of 30-day mortality and the low rates of re-exploration and readmission reinforce the overall safety profile of ERAS in complex surgical settings. These outcomes align with growing evidence that multidisciplinary perioperative optimization can mitigate surgical stress and improve recovery without compromising patient safety [8]. However, interpretation of these findings should consider the observational nature of the study and reliance on historical comparisons. Despite these limitations, the consistency of outcomes across multiple parameters supports the feasibility and effectiveness of ERAS protocols in real-world HPB practice. [24]

The absence of 30-day mortality in this series further supports the safety of ERAS implementation in complex hepatopancreaticobiliary surgery. The concentration of discharge around postoperative day 5 also suggests effective multidisciplinary adherence to ERAS principles across surgical, anesthetic, and postoperative care teams.

This study is limited by its single-center observational design and the absence of a conventional-care comparator group. Long-term outcomes were not evaluated. Nevertheless, the inclusion of 280

consecutive patients reflects routine institutional practice and supports the external applicability of the findings.

CONCLUSION:

Implementation of an Enhanced Recovery After Surgery (ERAS) protocol in major hepatopancreaticobiliary surgery was associated with significantly improved perioperative outcomes. The cohort demonstrated a markedly reduced length of hospital stay, with the majority of patients discharged by postoperative day 5, alongside a significantly lower complication rate compared to established benchmarks. Re-exploration and readmission rates were also minimal, and no 30-day mortality was observed. These findings indicate that ERAS protocols enable safe acceleration of postoperative recovery without compromising clinical outcomes, supporting their routine integration into HPB surgical practice.

LIMITATIONS

This study is limited by its single-center observational design and absence of a contemporaneous control group, restricting causal inference. The reliance on aggregate data without stratification prevented subgroup and multivariate analysis to identify predictors of outcomes. Additionally, comparisons were made against historical benchmarks rather than internal controls, which may introduce variability due to differences in patient populations and institutional practices. Long-term outcomes and quality-of-life measures were not assessed, limiting evaluation of sustained benefits of ERAS implementation..

RECOMMENDATIONS

Future studies should incorporate controlled comparative designs, ideally randomized or matched cohort analyses, to establish causal relationships between ERAS implementation and improved outcomes. Inclusion of detailed patient-level variables will allow multivariate modeling to identify independent predictors of recovery and complications. Standardization of ERAS protocols across institutions and integration into national surgical guidelines may further enhance consistency of care. Additionally, long-term follow-up and cost-effectiveness analyses are recommended to evaluate the broader clinical and economic impact of ERAS pathways in HPB surgery.

CONFLICT OFF INTEREST:

Nil

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