Original Article

Compliance to enhanced recovery program in liver resection surgery: A retrospective cohort study

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Abstract

Background and Aims: Liver resection is a complex surgery, and optimizing recovery is critical to ensure that patients can promptly regain their health and quality of life. The authors present a retrospective cohort study on Enhanced Recovery After Surgery (ERAS) in liver resection aimed at correlating compliance with ERAS elements to length of stay (LOS) and the incidence of complications in a tertiary-level cancer hospital in Eastern India.

Material and Methods: In total, 44 hepatectomy patients were assessed retrospectively from June 2022 to May 2023. Data were collected from electronic medical records and patient charts.

Results: The overall compliance was 77.7%. Individual component compliance varied. Lower compliance rates were seen with some aspects such as fasting and carbohydrate loading, minimally invasive surgical techniques used, and avoidance or early removal of the drain. The cohort was divided into two groups. Group 1 had compliance to ≥75% of 21 elements of ERAS, and group 2 had compliance to <75%. Statistical analysis showed higher ERAS compliance and reduced complications, although LOS differences were not statistically significant (group 1 and group 2 with an LOS difference of 1 day). Severe complications such as re-exploration and death were noted in the group of patients with compliance to less than 75% of the components.

Conclusion: With increased ERAS compliance, the patients benefited clinically and financially.

Keywords: Compliance, enhanced recovery after surgery, liver surgery

Background and Aims

Major abdominal surgery is associated with a significant stress response, resulting in considerable physiological, metabolic, and immune derangement. Enhanced Recovery After Surgery (ERAS), as conceptualized by Prof. Henrik Kehlet,[1] emphasizes evidence-based practices that reduce the stress of surgery on the patient's body, leading to faster recovery times, shorter hospital stays, and improved surgical outcomes. The concept of ERAS has gained considerable momentum worldwide and has been applied to surgical specialties other than colorectal surgeries.

Liver resection is a complex surgery with inherent risks that make it challenging for both the anesthesiologist and the surgeon. Optimizing recovery in hepatectomy patients is critical to ensure that they can regain their health and quality of life promptly. Since the publication of the first ERAS guideline for liver surgery in 2016[2] and its recent update in 2022,[3] this concept has been applied with evidence of favorable postoperative outcomes;[4] however, literature on ERAS after hepatectomy in the Indian population is scarce. We aimed to investigate the compliance to 21 out of 25 ERAS recommendations for liver surgery and its association with length of stay (LOS) and development of complications.

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Material and Methods

All adult patients with liver and gallbladder cancer who underwent elective hepatic resection in our institution between June 2022 and May 2023 were included in this study. This included single-segment resection, multiple-segment resection, and major hepatectomies. All the patients included in the study underwent a standard anesthesia protocol and were operated by the same surgical unit.

Data for the study were retrieved from the electronic medical records and physical patient charts. The institutional review board (IRB) granted a waiver of informed consent and approved the sharing of the research resource (IRB waiver number: EC/WV/TMC/15/23, dated 28th July 2023) to the scientific community. This manuscript adheres to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.[5]

The primary outcome was overall compliance and adherence to the ERAS society recommendations for liver surgery.[3] It was calculated by dividing the total compliance score across all patients by the maximum possible score (if all recommendations were fully complied with):

$$\text{Overall compliance} = \frac{\text{Total compliance score}}{\text{Maximum possible score}} \times 100$$

Secondary outcomes included differences in LOS and development of complications between patients who were compliant and non-compliant to ERAS protocol. Twenty-one components of ERAS society recommendations for liver surgery[3] were included [Table 1], and compliance to individual items was assessed. Prehabilitation and preoperative nutrition were integrated as a single element. Epidural, postoperative intravenous, and per oral analgesia were also combined with a wound catheter and transversus abdominis plane (TAP) block and were collectively referred to as multimodal analgesia intra and postoperatively. Complications were reported within 30 days after surgery and classified according to Clavien-Dindo *et al.*[6] Major complications were defined as those requiring invasive procedures, surgery, or admission to the intensive care unit. Any incidence of mortality was also recorded. LOS was defined as the number of days spent in the hospital after surgery.

Data were extracted retrospectively from the electronic medical records and patient charts. Patient characteristics, such as age, weight, primary diagnosis, American Society of Anesthesiologists Physical Status (ASA-PS), and presence of comorbidities were collected. Preoperative assessments of the anesthesia and surgical team, including details of prehabilitation, fasting, and carbohydrate drink advice, were collected. Intraoperative details such as the duration of surgery and anesthesia, mode of analgesia, fluid balance, and the amount of crystalloids, colloids, and blood products transfused were noted. Resting and dynamic pain scores of the first three postoperative days with specifications of analgesics used, day of ambulation, day of resumption of enteral feeding, day of removal of nasogastric tube, and abdominal drains were also noted. Postoperative complications classified as Clavien-Dindo scores were also collected.

Table 1: ERAS Components for liver surgery

Components	Assessed in our study (Yes/No)
Preoperative counseling	Yes
Prehabilitation	Yes
Preoperative biliary drainage	Yes
Preoperative smoking and alcohol cessation	Yes
Preoperative nutrition	Yes
Avoidance of perioperative oral immunonutrition	No
Preoperative fasting and preoperative carbohydrate load	Yes
Avoidance of long acting anxiolytics, other premedications preoperatively	Yes
Anti-thromboprophylaxis	Yes
Preoperative steroids administrations	No
Antimicrobial prophylaxis and skin preparation	Yes
Minimally invasive surgery	Yes
Epidural, postoperative intravenous, and postoperative per oral analgesia	Yes
Wound catheter and Transversus abdominis plane (TAP) block	Yes
Early removal of nasogastric tubes	Yes
Prophylactic abdominal drainage	Yes
Preventing intraoperative hypothermia	Yes
Postoperative artificial nutrition and early oral intake	Yes
Postoperative glycemic control	Yes
Prevention of delayed gastric emptying	No
Avoidance of stimulation of bowel movement	Yes
Early and scheduled mobilization	Yes
Postoperative Nausea and Vomiting Prophylaxis	Yes
Fluid management	Yes
Monitoring/Audit	No

Statistical analysis

As a retrospective analysis, there was no *a priori* statistical analysis plan. No statistical power calculation was performed, and the sample size was based on the available data from the database. The study cohort was divided into two groups according to the degree of compliance with ERAS components (group 1: more than 75% compliant; group 2: less than 75% compliant). Continuous variables are reported as mean (standard deviation [sd]) or median (interquartile range [IQR]) depending on the normality of the distribution

and analyzed using either the Student *t*-test for independent samples or the Mann–Whitney *U*-test. Categorical variables are presented as numbers and percentages and analyzed using χ^2 or Fisher's exact test. A *P* value of < 0.05 was considered statistically significant. Statistical analysis was performed using the SPSS version 16 for Windows (IBM SPSS Statistics for Windows, Version 16.0. Armonk, NY: IBM Corp.).

Results

A total of 44 patients were included in the cohort [Table 2], mostly American Society of Anesthesiologists (ASA) grade I and II. None of the patients were excluded.

The median age in the cohort was 58 years, with the maximum number of patients belonging to ASA-PS II. The overall compliance to ERAS recommendations for liver surgery was 77%. The percentage of compliance of each ERAS element have been described in Figure 1. The mean LOS was 9 ± 4.7 days.

The patients were divided into two groups [Table 2]. Group 1 had patients with compliance ≥75%, and group 2 had compliance <75%. In total, 35 patients were in group 1, and nine patients were in group 2. The median LOS in group 2 was 9 days compared to 8 days in group 1 ($P = 0.179$). Clavien-Dindo score >2 was seen in group 2 ($P = 0.04$). Furthermore, 44.4% of the patients in group 2 had PONV compared to 22.8%. In addition, 33.5% of the cohort had NG reinsertion in group 2, whereas in group 1, only 5.7% needed the reinsertion. A retrospective power analysis was performed using the occurrence rate of postoperative complications (classified as Clavien-Dindo score >2), set at 68.9%.

Discussion

The results of the present study reveal that overall compliance to ERAS recommendations for liver surgery was 77%. Three previous studies reported compliance to ERAS components

Table 2: Characteristics of total Cohort

Parameters	Values		
Age	58*(50, 67)§		
Sex			
Male	19† (43.18)‖		
Female	25† (56.81)‖		
ASA-PS			
I	11† (25)‖		
II	29† (65.9)‖		
III	4† (9.09)‖		
Comorbidities			
Diabetes	15† (34.09)‖		
Hypertension	24† (54.5)‖		
Hypothyroidism	7† (15.9)‖		
Surgical approach			
Open	43† (97.7)‖		
Laparoscopic	1† (2.27)‖		
Surgical procedure			
Hepatectomy	18† (40.9)‖		
Major	13† (29.54)‖		
Minor	31† (70.45)‖		
Radical cholecystectomy	26† (59.09)‖		
Without biliary reconstruction	31† (70.45)‖		
With biliary reconstruction	13† (29.54)‖		
Duration of surgery (in minutes)	347.5*(285, 472.5)§		
Length of Stay (LOS) (in days)	9‡ ± 4.7¶		
Clavien dindo classification			
Grade I	15† (34.1)‖		
Grade II	27† (61.3)‖		
Grade IIIb	1† (2.3)‖		
Grade V	1†(2.3)‖		
	Group 1 (*n*=35)	**Group 2 (*n*=9)**	***P***
Length of stay (days)	8 *(7, 10)§	9 *(7, 15.5)§	0.179
Clavien Dindo grade >2	0†	2† (22.2)‖	0.04
Dynamic Pain score on Postoperative Day 1	5* (4, 6)§	5*(4, 6)§	0.90 (0.13)**
PONV	8† (22.8)‖	4† (44.4)‖	0.23
Abdominal distension	2† (5.7)‖	3† (33.5)‖	0.05

**Median, †Number of cohort, ‡Mean, §Interquartile range, ‖Percentage, ¶Confidence Interval, ASA-PS: American Society of Anesthesiologists Physical Status, n: Number of cases, **z-value*

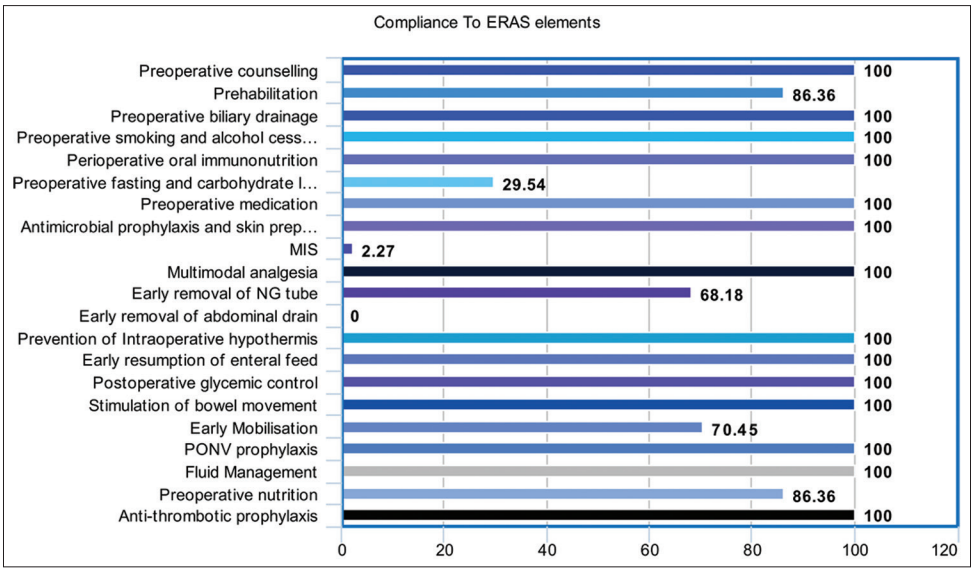

Figure 1: Percentage of compliance of each ERAS element

ranging between 65% and 73%[7–9]. Jones *et al.*[10] reported 100% compliance in 18 out of the 19 ERAS elements in the ERAS group. In the present study, compliance to 21 out of 25 elements of ERAS recommendations was evaluated. There was variability in individual compliance rates. Components such as preoperative counseling, prehabilitation with nutritional survey, cessation of smoking and alcohol consumption, avoidance of preoperative sedative medications, preoperative biliary drainage, antimicrobial prophylaxis, antithrombotic prophylaxis, multimodal analgesia, goal directed fluid management with balanced crystalloids, postoperative glycemic control, prevention of intraoperative hypothermia, and early mobilization had good compliance rates, ranging between 70% and 100% [Figure 1]. Compliance rates were low with components such as fasting and carbohydrate loading, use of minimally invasive surgical techniques, and no abdominal drain or early drain removal. The ERAS society recommends against routine placement of abdominal drains in patients undergoing hepatectomy without biliary reconstruction, but there have been notable disagreements on when to remove abdominal drains among individual studies evaluated in a previous systematic review and meta-analysis.[11] Abdominal drains were placed in all our patients and removed by postoperative day 3. These decisions were mainly related to surgeon preference rather than patients' specific requirements.

ERAS, as conceptualized by Prof. Henrik Kehlet,[1] emphasizes evidence-based practices that reduce the stress of surgery on the patient's body, leading to faster recovery times, shorter hospital stays, and improved surgical outcomes. These protocols are safe and feasible in hepatectomies, without increasing mortality and readmission rates, while reducing LOS and risk of complications, and with significant hospital cost savings.[11]

The mean LOS in our study population was 9 days; one patient was re-explored, and one death was reported. Our study also highlights the fact that with greater compliance to ERAS recommendations, there was a morbidity and mortality difference. Hence, better outcomes were not only due to a single element but multiple components in the perioperative period, leading to lesser morbidity and mortality. The difference in LOS by 1 day between the groups did not achieve statistical significance but may be clinically relevant in terms of reduction of hospital cost and resource allocation.

The current study has some limitations. First, its retrospective design increases the risk of bias. Second, our sample was relatively small. Hence, larger, preferably prospective, and randomized studies can be conducted in the future to substantiate our observations. Third, we considered differences in LOS as an outcome measure between the two groups as per their degree of compliance. The LOS is not an ideal index to judge the success of an ERAS program as several factors make the patients able to or keen to stay in the hospital[12]. Fitness to discharge criteria would have been more appropriate.

Though the causality of poor ERAS implementation with poorer postoperative outcomes cannot be established, an association of poor outcomes was seen in patients where ERAS components were not implemented.

Conclusions

Implementation of ERAS protocols in liver surgery is achievable through the formulation of institutional protocols and a multidisciplinary approach. The overall effectiveness of

the protocol is well supported, and healthcare practitioners are encouraged to follow it as closely as possible to benefit patients.

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Conflicts of interest

There are no conflicts of interest.

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