Improving the Surgical Outcomes after Liver Resection with ERAS Program

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Background: *Enhanced recovery after surgery (ERAS) has been accepted as the program to improve the surgical outcomes. This program has been increasingly utilized in liver resection.*
Objective: *To evaluate the outcomes of patients underwent liver resection by applying ERAS program.*
Material and Method: *All patients underwent liver resection between January 2007 and April 2011 at King Chulalongkorn Memorial Hospital were included into the present study. Patients' characteristics, preoperative factors, operative data, postoperative care that correlated to ERAS components, and postoperative outcomes were recorded. Outcomes including postoperative length of stay (LOS), intensive care unit (ICU) stay, complications, rate of reoperation, interventional treatment, and mortality were compared between patients in ERAS group (applied ERAS components >4) and conventional group (applied ERAS components <4).*
Results: *Three hundred forty seven patients were enrolled in present the study. There were 165 and 182 patients in ERAS and conventional groups, respectively. When compared between these two groups, ERAS group had better postoperative LOS (7 days vs. 10 days; p = 0.0001), ICU stay (0 days vs. 1 days; p = 0.0001), reoperation rate (1.2% vs. 4.9%; p = 0.047) and reintervention rate (15% vs. 27%; p = 0.005). There were no significant differences in complication rate (31% vs. 40%; p = 0.096) and mortality rate (0.6% vs. 1.1%; p = 0.62).*
Conclusion: *ERAS program improves the surgical outcomes in patients who underwent liver resection.*

Keywords: *Enhanced recovery after surgery, Fast-track surgery, Liver resection*

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In USA, there are over 30 million operations per year, using resources in the health care system at a great cost. Some recent studies focus on enhanced recovery for the surgical patients to reduce the costs. In these studies, parameters such as the length of hospital stay, duration to return to normal activity, morbidity, and mortality have been used to study the recovery of the patients. The process or protocol that enhanced recovery was called "fast-track surgery" or "enhanced recovery after surgery (ERAS)"[1].

ERAS is a multimodal pathway. ERAS components are divided into three parts and follow the sequence of surgical procedure in term of preoperative, intraoperative, and postoperative components.

Several reports confirmed that the process of ERAS improved the surgical outcome, especially in colorectal surgery[2-8]. However, in liver resection, there are few studies using ERAS protocol[9-11]. The main objective of the present study was to evaluate the outcomes of patients that underwent liver resection by applying ERAS program.

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Material and Method

All patients that underwent liver resection between January 2007 and April 2011 at King Chulalongkorn Memorial Hospital were enrolled into the present study. A retrospective medical chart review was undertaken to examine patient characteristic, preoperative factor, operative data, and postoperative care, which correlated to ERAS components and outcomes. The protocol was approved by the Institutional Review Board of the Faculty of Medicine, Chulalongkorn University.

Ten components of ERAS were recorded in this study as shown in Table 1. The patients were divided into two groups. The ERAS group was defined

Table 1. Enhanced Recovery After Surgery (ERAS) components[1]

Preoperative component	No mechanical bowel preparation (MBP)
Intraoperative components	Laparoscopic technique
	Intraoperative epidural blockade
	No intraoperative hypothermia (BT <36°C)
	No drain
	No nasogastric tube
Postoperative components	Postoperative epidural blockade
	Postoperative patient-controlled analgesia (PCA)
	Off urinary catheter in 48 hours
	Early enteral feeding (calorie intake in 24 hour)

as patients who were applied four or more of ERAS components. Meanwhile, conventional group obtained less than four components of ERAS. The operative outcomes were compared between two groups in the aspect of postoperative length of stay (LOS), intensive care unit (ICU) stay, complication, reoperation rate, reintervention rate, and mortality rate.

Statistical analysis

Continuous data were presented as median and interquartile range (IQR). Postoperative LOS, ICU stay were analyzed by using the Mann-Whitney U test. Reoperation rate, reintervention rate, complication rate and mortality rate were analyzed by using Chi-square test. A p-value <0.05 was considered to be statistically significant. Data were analyzed using SPSS® version 16.0 for Windows®.

Results

Three hundred forty seven patients were enrolled in the present study (n = 347). Mean ages was 57 years (±11.59). The patients were divided into male 229 (66%) and female 118 (34%). Most patients did not have any underlying disease. One hundred nineteen patients (34.3%) had diabetes mellitus, hypertension, or dyslipidemia as co-morbidity. Hepatocellular carcinoma (146 patients, 42.1%), colorectal liver metastasis (83 patients, 23.9%), and cholangiocarcinoma (81 patients, 23.3%) were the most common diagnosis required for liver resection. The demographic data in ERAS group and conventional group is shown in Table 2. There were no significant differences in demographic data between groups. Liver resection was divided into two groups, minor resection (≤2 segments resection in Couinaud's classification), which was performed in 160 patients (46.1%), and major resection (>2 segments resection in Couinaud's classification), which was performed in 187 patients (53.9%).

In the preoperative phase, most patients (64%) obtained the mechanical bowel preparation. All patients received antibiotic prophylaxis before the operation, Cefazolin was used in 60% of patients. The operative data were shown in Table 3.

In the postoperative care, in term of pain management, 138 patients (39.8%) were controlled by epidural blockade, 244 patients (70.3%) by patient-controlled analgesia, and 110 patients (31.7%) got intravenous opioid (some patients received more than one method of analgesia). One hundred fifty six patients (45%) had no nasogastric tube after operation. Removal of urinary catheter within 48 hours after operation was performed in 153 patients (44%). One hundred fifty five patients (45%) received early enteral feeding (postoperative calorie intake within 24 hours).

Median (IQR) postoperative LOS and ICU stay were 9 (6 to 14) and 1 (0 to 1) days, respectively. Reoperation and reintervention rate were 3.2% and 21.6%. Postoperative complications occurred in 125 patients (36%). The most common complication after liver resection was intraabdominal collection (42 patients, 12.1%).

There were 165 and 182 patients in ERAS and conventional groups, respectively. Surgical outcomes were summarized in Table 4, 5, and 6. The postoperative LOS was 7 days in ERAS group, which was significantly shorter than 10 days in conventional group. Interestingly, postoperative LOS in patients who received major hepatic resection was 9 and 11 days in ERAS and conventional group, respectively (p = 0.0001). In minor liver resection patients, LOS was shorter in ERAS group (7 vs. 8 days, p = 0.003). Similarly, the length of ICU stay was shorter in ERAS group (0 vs. 1 day, p = 0.0001). In patients who received major

Table 2. Demographic data of ERAS group and conventional group

Demographic data	ERAS group (n = 165)	Conventional group (n = 182)	*p*-value
Age (years): mean (±SD)	55.71 (±11.32)	58.33 (±11.73)	0.526
Gender (male: female)	106:59	123:59	0.512
ASA grade (%)			0.967
I	46 (27.9)	51 (28.0)	
II	106 (64.2)	118 (64.8)	
III	13 (7.9)	13 (7.1)	
Co-morbidity (%)			0.109
None	61 (37.0)	79 (43.4)	
Myocardial infarction	0 (0)	1 (0.5)	
COPD	4 (2.4)	5 (2.7)	
DM, HT, DLP	68 (41.2)	51 (28.0)	
Others	32 (19.4)	46 (25.3)	
Diagnosis (%)			0.05
Benign liver tumor	11 (6.7)	5 (2.7)	
Hepatocellular carcinoma	79 (47.9)	67 (36.8)	
Colorectal liver metastasis	39 (23.6)	44 (24.2)	
Cholangiocarcinoma	25 (15.2)	56 (30.8)	
Others	11 (6.7)	10 (5.5)	

ASA = American Society of Anesthesiologist; COPD = Chronic Obstructive Pulmonary Disease; DM = Diabetes mellitus; HT = Hypertension; DLP = Dyslipidemia

Table 3. Operative data

Intraoperative components	n (%)
Minimally invasive surgery	
Open	324 (93.4)
Laparoscopic	23 (6.6)
Epidural blockade	
None	207 (59.7)
Used	140 (40.3)
Drain	
None	25 (7.2)
Used	322 (92.8)
Intraoperative hypothermia (BT <36°C)	
Yes	157 (45.2)
No	190 (54.8)

BT = Body temperature

liver resection, the duration of ICU stay was shorter in ERAS group (0 vs. 1 days, $p = 0.0001$). Similarly in minor resection, length of ICU stay was shorter in ERAS group (0 vs. 1 day, $p = 0.009$). Furthermore, reoperation (1.2% vs. 4.9%; $p = 0.047$) and reintervention rate (15% vs. 27%; $p = 0.005$) were significantly less in ERAS group. Complication rate had tendency to decline in ERAS group but not significantly (31% vs. 40%; $p = 0.096$). One (0.6%) patient died in ERAS group from postoperative liver failure, and two (1.1%) patients in conventional group from sepsis with multiorgan failure in one patient and massive gastrointestinal hemorrhage in the other one. Overall mortality rate was 0.86%.

Discussion

In general, the outcome that use to indicate the recovery of the surgical patients was length of hospital stay. The present study showed that the use of ERAS program significantly decreased postoperative LOS. Besides, ICU stay was significantly shorter in ERAS group. In the safety issue, the use of ERAS protocol in the present study was not increased the reintervention, reoperation, complication, or mortality rate. This study showed that re-operation rate and re-intervention rate were significantly less in the ERAS group, and complication rate had tendency to decline in ERAS group but was not statistically significant. Mortality rate was similar in both groups. Morbidity and mortality rate were similar with other published studies (38 to 45% and 2.7 to 3.1%, respectively)[12-14].

After applying ERAS protocol, postoperative LOS and ICU stay were significantly shorter in both major and minor liver resection. Although minor liver resection produced less stress and metabolic response

Table 4. Surgical outcomes of all patients

Surgical outcomes	ERAS group (n = 165)	Conventional group (n = 182)	*p*-value
Postoperative LOS (days) (IQR)	7 (6 to 11)	10 (7 to 17)	0.0001
ICU stay (days) (IQR)	0 (0 to 1)	1 (0 to 1)	0.0001
Reoperation rate	2 (1.2%)	9 (4.9%)	0.047
Reintervention rate	25 (15%)	50 (27%)	0.005
Complication rate	52 (31%)	73 (40%)	0.096
Mortality rate	1 (0.6%)	2 (1.1%)	0.62

Table 5. Surgical outcomes of patients underwent minor liver resection

Surgical outcomes	ERAS group (n = 94)	Conventional group (n = 66)	*p*-value
Postoperative LOS (days) (IQR)	7 (5 to 10)	8 (7 to 13)	0.003
ICU stay (days) (IQR)	0 (0 to 1)	1 (0 to 1)	0.009
Reoperation rate	1 (1.1%)	1 (1.5%)	0.8
Reintervention rate	13 (13.8%)	16 (24.2%)	0.92
Complication rate	29 (30.9%)	21 (31.8%)	0.897
Mortality rate	1 (1.1%)	0 (0%)	0.401

Table 6. Surgical outcomes of patients underwent major liver resection

Surgical outcomes	ERAS group (n = 71)	Conventional group (n = 116)	*p*-value
Postoperative LOS (days) (IQR)	9 (7 to 13)	11 (8 to 23)	0.001
ICU stay (days) (IQR)	0 (0 to 1)	1 (1 to 1)	0.0001
Reoperation rate	1 (1.4%)	7 (6.03%)	0.129
Reintervention rate	12 (16.9%)	35 (30.2%)	0.042
Complication rate	23 (32.4%)	52 (44.8%)	0.092
Mortality rate	0 (0%)	2 (1.7%)	0.266

than major liver resection.

There are some limitations to this study. First, it was designed as a retrospective review. Therefore, there were large amount of selection bias. Furthermore, there were no criteria for patient selection into ERAS or conventional group. Second, there were no discharge criteria to allow patient to leave the hospital, and no data of re-admission rate to prevent and detect early discharge problem.

Conclusion

ERAS program facilitated recovery outcomes in patients that underwent liver resection. It should be applied not only to colorectal surgery but to liver surgery.

What is already known on this topic?

Enhanced recovery after surgery protocol or fast-track surgery is well-known and has been applied for surgical patients for a long time, especially in Europe. Many publications reported the benefit of this program in the field of colorectal surgery. However, there are few studies of ERAS protocol in liver surgery.

What this study adds?

This study showed that ERAS program can

improve recovery outcomes in liver resection especially in the major liver resection. Moreover, safety remain the same while morbidity, and mortality were not increased after using ERAS program.

The findings support the use of ERAS protocol not only in colorectal surgery but also in liver surgery.

Potential conflicts of interest

None.

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การพัฒนาผลการผ่าตัดตับโดยใช้แนวทางการดูแลผู้ป่วยผ่าตัดให้ฟื้นตัวเร็วขึ้น (ERAS)

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ภูมิหลัง: แนวทางการดูแลผู้ป่วยผ่าตัดให้ฟื้นตัวเร็วขึ้นหรือ Enhanced Recovery After Surgery (ERAS) ได้รับการยอมรับว่าสามารถทำให้ผลการผ่าตัดดีขึ้นได้ ปัจจุบันได้ถูกนำมาใช้มากขึ้นในการผ่าตัดตับ

วัตถุประสงค์: เพื่อประเมินผลของการผ่าตัดตับ หลังจากที่นำแนวทาง ERAS มาใช้กับผู้ป่วยกลุ่มนี้

วัสดุและวิธีการ: ทำการศึกษาย้อนหลังในผู้ป่วยที่เข้ารับการผ่าตัดตับที่โรงพยาบาลจุฬาลงกรณ์ระหว่างเดือนมกราคม พ.ศ. 2550 ถึงเดือนเมษายน พ.ศ. 2554 โดยเก็บรวบรวมข้อมูลเกี่ยวกับลักษณะของผู้ป่วย ปัจจัยก่อนการผ่าตัด ข้อมูลระหว่างการผ่าตัด การดูแลหลังการผ่าตัด และผลการรักษาหลังการผ่าตัด ได้แก่ ระยะเวลาการนอนโรงพยาบาล ระยะเวลาการนอนในหน่วยพยาบาลผู้ป่วยหนัก ภาวะแทรกซ้อน อัตราการผ่าตัดซ้ำ อัตราการทำหัตถการซ้ำหลังการผ่าตัด และอัตราการเสียชีวิต โดยนำข้อมูลเหล่านี้เปรียบเทียบกันในกลุ่มที่ได้รับการดูแลตามแนวทาง ERAS (ได้รับการดูแลตามแนวทาง ERAS ≥4 ข้อ) และกลุ่มที่ได้รับการดูแลตามปกติ (ได้รับการดูแลตามแนวทาง ERAS <4 ข้อ)

ผลการศึกษา: ผู้ป่วยทั้งหมด 347 คน ถูกนำเข้ามาในการศึกษานี้ แบ่งเป็นกลุ่มที่ได้รับการดูแลตามแนวทาง ERAS 165 คน และ 182 คน อยู่ในกลุ่มที่ได้รับการดูแลตามปกติ เมื่อเปรียบเทียบผลการรักษาพบว่าในกลุ่มที่ได้รับการดูแลตามแนวทาง ERAS มี ระยะเวลาการนอนโรงพยาบาลหลังผ่าตัดที่น้อยกว่า (7 เทียบกับ 10 วัน; p = 0.0001) ระยะเวลาการนอนในหน่วยพยาบาลผู้ป่วยหนักที่น้อยกว่า (0 เทียบกับ 1 วัน; p = 0.0001) อัตราการผ่าตัดซ้ำน้อยกว่า (1.2% เทียบกับ 4.9%; p = 0.047) และอัตราการทำหัตถการซ้ำหลังการผ่าตัดน้อยกว่า (15% เทียบกับ 27%; p = 0.005) ในกลุ่มที่ได้รับการดูแลตามปกติอย่างมีนัยสำคัญทางสถิติ โดยที่ไม่มีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติของภาวะแทรกซ้อน (31% เทียบกับ 40%; p = 0.096) และอัตราการเสียชีวิต (0.6% เทียบกับ 1.1%; p = 0.62) ในทั้งสองกลุ่ม

สรุป: การดูแลผู้ป่วยตามแนวทาง ERAS สามารถทำให้ผลการรักษาดีขึ้นได้ในผู้ป่วยที่ได้รับการผ่าตัดตับ