Enhanced Recovery Program Versus Traditional Care in Laparoscopic Hepatectomy

Xiao Liang, MD, Hanning Ying, MM, Hongwei Wang, MD, Hongxia Xu, BN, Hong Yu, MD, Liuxin Cai, MD, Yifan Wang, PhD, Yifan Tong, MM, Lin Ji, MM, Raojun Luo, MM, and Xiu-Jun Cai, MD, PhD

Abstract: Enhanced recovery after surgery (ERAS) has shown effectiveness in terms of reducing the hospital stay and cost associated with open liver resection. However, the benefit of ERAS in patients undergoing laparoscopic liver resection is still unclear, and clinical studies on this topic are limited.

The ERAS program for laparoscopic liver resection was used in a group of 80 patients (ERAS group). The results were compared with those in a control group of 107 patients. All patients underwent laparoscopic liver resection. The primary endpoints were the postoperative hospital stay, defined as the number of days from surgery to discharge, and the hospitalization expense. The secondary endpoints were resumption of oral intake, readmissions, and complications.

The median postoperative hospital stay was 6.2 ± 2.6 days in the ERAS group, which was significantly shorter than that in the control group (9.9 ± 5.9 d; P < 0.001). The hospitalization cost was $6871 ± 2571 in the ERAS group and $7948 ± 3630 in the control group (P = 0.020). The morbidity rate was 22.5% (18 of 80 patients) in the ERAS group and 43.9% (47 of 107 patients) in the control group (P = 0.002). There were no significant differences in the rate of readmission between the 2 groups.

Enhanced recovery after surgery for laparoscopic liver resection is safe and effective. Patients in the ERPS group had a shorter hospital stay, fewer complications, and lower hospital costs.

(Medicine 95(8):e2835)

Abbreviations: ASA = American Society of Anesthesiologists, DVT = deep vein thrombosis, ERAS = enhanced recovery after surgery, LPMOD = laparoscopic Peng multifunctional operative dissector, PCIA = patient-controlled intravenous analgesia, VAS = visual analog scale.

INTRODUCTION

Laparoscopic liver resection was first introduced in the 1990s. During the past 20 years, many studies have shown that laparoscopic hepatectomy has become a safe and feasible surgical procedure for liver disease. Numerous studies comparing laparoscopic hepatectomy and open hepatectomy have revealed no differences in the width of the resection margins for malignant lesions or overall survival, and outcomes after resection for hepatocellular cancer or colorectal cancer liver metastases.1,2 However, liver surgery is associated with a high rate of complications (15%–48%),3,4 and in 1 study, the postoperative hospital stay after liver resection was 8 days.5

Enhanced recovery after surgery (ERAS) was first introduced by Kehlet6 in 1997, and was shown to reduce the complication rate and hospital stay duration after colorectal surgery.7 During the past 2 decades, ERAS has rapidly evolved with the application of various effective methods, including perioperative education, improved anesthetic and analgesic methods, and early oral intake and mobilization. Using these procedures, ERAS can relieve patients’ pain, promote patients’ recovery, and reduce complications and cost.8

All studies to date on the application of ERAS in liver resection show that ERAS is safe and feasible.9,10 However, the evidence for the use of ERAS in laparoscopic hepatectomy remains insufficient. Therefore, we performed the present study to determine the application of ERAS in laparoscopic hepatectomy at Sir Run Run Shaw Hospital, Medical College of Zhejiang University.

METHODS

Patients

From June 2014 to July 2015, 187 patients aged 14 to 80 years, who presented for laparoscopic liver resection at the Second Department of General Surgery, The Sir Run Run Shaw Hospital, Medical College of Zhejiang University, were considered for inclusion in the study. Our surgery department has 2 medical teams, both of which can perform high-volume laparoscopic liver surgery. One team followed the ERAS protocol and the other administered conventional perioperative care (Table 1). The patients were randomized to one of the 2 medical teams and were blinded to the intervention. The ERAS group comprised 80 patients, and the control group (conventional perioperative care) comprised 107 patients. With respect to patient characteristics, the 2 groups were similar in age, sex, Child–Pugh classification, and American Society of Anesthesiologists (ASA) physical status (Table 2).

The inclusion criteria were as follows: partial hepatectomy or half liver resection, body mass index of 18 to 35 kg/m², tumor (if present) in either the right or left lobe, Child–Pugh class A or
B liver functional status, and ASA physical status of I to III. The exclusion criteria were as follows: pregnant or lactating women, unwillingness to participate, inability to give written informed consent, Child–Pugh class C liver functional status, ASA physical status of IV or V, tumor invasion of the inferior vena cava or confluence of the hepatic vein, and decompensated liver cirrhosis.

Laparoscopic Hepatectomy

All operations were performed under general anesthesia. The laparoscopic Peng multifunctional operative dissector (LPMOD) was used in each operation to transect the liver parenchyma by curettage and aspiration. The patient was placed in the supine position. A Veress needle was inserted directly under the umbilicus to allow for the flow of carbon dioxide into the peritoneal cavity. With the pneumoperitoneum inflated to 12 to 14 mm Hg CO₂, the large vessels and bile ducts were ligated with clips via laparoscopic instruments. Regional hepatic vascular exclusion was used in these cases.

Clinical Pathway

Preoperative

Patients in the control group underwent routine care, such as nothing by mouth for 8 hours before surgery, bowel preparation, and no oral nutritional supplements. The doctors and nurses were familiar with the medical records of the patients and provided them with conventional preoperative and psychological education. Patients in the ERAS group received a more detailed explanation of the perioperative care and ERAS program when they made the decision to undergo surgery. The nurses provided the patients a checklist showing the rehabilitation plan, and daily mobilization and nutritional goals. Patients received 250 mL of an oral carbohydrate solution 2 hours before surgery.

Intraoperative and Anesthesia

The same conventional anesthetic protocol (combined intravenous and inhalation anesthesia) was used in both groups.

TABLE 1. Summary of Enhanced Recovery After Surgery Program

| Day before surgery | ERAS Group | Control Group |
|--------------------|------------|---------------|
| Perioperative education, including mobilization and dietary goals | No | Normal bowel preparation |
| No routine bowel preparation | No | Normal bowel preparation |
| Normal oral nutrition | No | Normal bowel preparation |

| Day of surgery | ERAS Group | Control Group |
|----------------|------------|---------------|
| Carbohydrate drinks until 2 h before surgery (250 mL) | No | Combined tracheal intubation and general anesthesia |
| Combined tracheal intubation and general anesthesia local anesthesia (0.2% ropivacaine) | No | Routine nasogastric tube drainage |
| No nasogastric tube or removed as early as possible | No | Standard use of abdominal drains |
| Less abdominal drain used | No | Standard use of abdominal drains |

| Postoperative day 0 | ERAS Group | Control Group |
|--------------------|------------|---------------|
| Drink water 6 h after surgery | Fast | Only PCIA or ParecoxibNa (Dynastat) |
| Restricted intravenous fluid 2000 to 2500 mL | No | Normal oral nutrition |
| Pain control: PCIA + 40 mg ParecoxibNa (Dynastat) i.v. per 12 h | No | No |

| Postoperative day 1 | ERAS Group | Control Group |
|--------------------|------------|---------------|
| Oral nutritional supplements (liquid) | No diet plan | No diet plan |
| Mobilization twice daily | Bed rest | Bed rest |
| Urinary catheter removed | No | No |
| Reduce intravenous fluid | No | No |

| Postoperative day 2 | ERAS Group | Control Group |
|--------------------|------------|---------------|
| Stop intravenous anesthetics and use oral Tramadol or Celecoxib | PCIA or ParecoxibNa (Dynastat) | Liquid |
| Oral semiliquid diet | No | No |
| Stop maintenance intravenous fluid | Mobilization on bed | Mobilization on bed |
| Mobilization 4 times daily | No | No |
| Remove CVC | No | No |
| Remove abdominal drainage tube if volume of drainage < 30 mL | No | No |

| Postoperative day 3 | ERAS Group | Control Group |
|--------------------|------------|---------------|
| Stop anesthetics if pain controlled well | Stop PCIA | Stop PCIA |
| Normal mobilization | Encourage to mobilization out of bed | Encourage to mobilization out of bed |
| Normal diet | Liquid or semiliquid diet | Liquid or semiliquid diet |
| Check the discharge criteria | Remove urinary catheter | Remove urinary catheter |

| Postoperative day 4: home | ERAS Group | Control Group |
|---------------------------|------------|---------------|
| Continue the events as day 3 | Continue the events as day 3 | Continue the events as day 3 |
| Check the discharge criteria | Remove abdominal drainage tube if volume of drainage < 30 mL | Remove abdominal drainage tube if volume of drainage < 30 mL |
| Education for discharge and recovery plan at home | Encourage to more mobilization | Encourage to more mobilization |
| Check the discharge criteria | Check the discharge criteria | Check the discharge criteria |

CVC = Central Venous Catheter, ERAS = enhanced recovery after surgery, PCIA = patient-controlled intravenous analgesia.
In the ERAS group, the temperature of the operation room was maintained at >23°C, and a warm air blower and heated peritoneal washing liquid were used to keep the patients warm. Additionally, the use of nasogastric tubes and abdominal cavity drainage tubes was minimized. Fluid administration was strictly restricted (crystalloid + colloid < 2000 mL). Routine antibiotic prophylaxis was administered.

**Postoperative**

Patients in the ERAS group were given water or liquids 6 hours after surgery. If gastrointestinal tract peristalsis, flatus, and defecation were restored, the patients were given liquid food on postoperative day 1, then a semiliquid diet on postoperative day 2. Fluid infusion was managed by clinical parameters such as the CVP, urine output, and heart rate (maintenance fluids were controlled at 200–2500 mL/d). The patients received patient-controlled intravenous analgesia and 40 mg of parecoxib sodium (Dynastat) intravenously every 12 hours. If pain persisted, 50 mg of oral tramadol was added 3 times daily. The patients were encouraged to do mobilization and walk around the ward on postoperative day 1 to avoid deep venous thrombosis (DVT). The urinary catheter was removed 1 day after surgery, and the abdominal drainage tube was removed as soon as possible. Details of the ERAS program are shown in Table 1.

The discharge criteria were as follows: normal temperature, good pain control with oral analgesia only, tolerance of food, no intravenous fluids, and willingness to be discharged.

The primary endpoint of the study was the postoperative hospital stay, defined as the number of days from surgery to discharge, and the hospitalization cost. The secondary endpoints were resumption of oral intake, the pain score, readmissions, and complications (evaluation by Clavien–Dindo classification). The pain score was evaluated by a visual analogue scale (VAS) that ranged from 0 to 10 cm (0 cm, no pain; and 10 cm, worst pain). All of the patients were asked to state the severity of their pain during and immediately after the procedure using the VAS. A detailed explanation about the VAS and its application was given personally to each patient before the procedure. A VAS score of >4 was accepted as severe pain.

All data were collected during hospitalization and at the 30-day follow-up. This study was a retrospective study with effective and safe measures; therefore, ethical approval was not necessary.

### Statistical Analysis

Data on patient characteristics, intraoperative parameters, and postoperative courses were collected. Continuous data with a normal distribution were statistically tested for group differences using a 2-sample Student t test. Data without a normal distribution were analyzed using the Mann–Whitney U test. Readmission, complication, and mortality rates were analyzed using the chi-square test or Fisher exact test. A P value of <0.050 was considered to be statistically significant. Statistical analyses were performed with SPSS (version 19 (IBM Corp., Armonk, NY).

### RESULTS

In total, 187 patients were included in the 2 groups. The 107 patients in the control group received standard care, and the 80 patients in the ERAS group underwent the ERAS program. The patient characteristics of the 2 groups were similar in age, sex, Child–Pugh classification, and ASA physical status. All patients in both groups underwent laparoscopic hepatectomy. The types of liver resection performed are shown in Table 2. There were also no significant differences in the pathological findings between the 2 groups (Table 2).

The operative details and outcomes are shown in Table 3. The operative time was 172.6 ± 86.0 minutes in the ERAS group and 190.8 ± 90.1 minutes in the control group (P = 0.260). The intraoperative blood loss volume was 268.2 ± 416.0 mL in the ERAS group and 328.0 ± 426.2 mL in the control group (P = 0.380), and blood transfusion was needed during the operation in 8 patients in the ERAS group and 13 in the control group (P = 0.650). A nasogastric decompression tube was used in 19 of 80 patients in the ERAS group and in 40 of 107 patients in the control group (P = 0.047). The duration of nasogastric tube placement was 0.9 days in the ERAS group and 1.6 days in the control group (P < 0.001). In the ERAS group, abdominal drainage tubes were used for 0.9 ± 0.6 days and removed 2.7 ± 2.1 days postoperatively. This was significantly less frequent than in the control group (1.5 ± 0.5 and 8.0 ± 3.9 days, respectively; P < 0.001 for both). Urinary catheters were removed 1.0 ± 0.3 days postoperatively in the ERAS group and 2.0 ± 1.2 days postoperatively in the control group (P < 0.001). Oral intake was usually resumed within

### TABLE 2. Patient Demographics

|                      | ERAS Group | Control Group | P   |
|----------------------|------------|---------------|-----|
| Age, y               | 53.4 ± 13.5| 55.5 ± 12.8   | 0.290*|
| Sex (male/female)    | 37/43      | 50/57         | 0.950 |
| Primary disease      |            |               |      |
| Cirrhosis            | 13         | 29            | 0.070 |
| Hypertension         | 8          | 20            |      |
| Diabetes mellitus    | 3          | 12            |      |
| Cardiovascular disease| 4        | 11            |      |
| Others               | 15         | 20            |      |
| Child–Pugh class (A/B)| 78/2      | 103/4         | 0.630 |
| ASA physical status (I/II) | 35/45  | 49/58         | 0.780 |
| Type of hepatectomy  |            |               |      |
| Right hepatectomy    | 5          | 12            | 0.240 |
| Left hepatectomy     | 12         | 17            | 0.870 |
| Segmentectomy        | 22         | 27            | 0.730 |
| Local resection      | 41         | 51            | 0.630 |
| Liver pathology      |            |               |      |
| Hepatocellular carcinoma| 38      | 46            | 0.540 |
| Metastatic hepatic carcinoma| 9  | 6           |      |
| Cholangiocellular carcinoma| 4    | 3            |      |
| Hepatolithiasis       | 10         | 16            |      |
| Hepatic hemangioma    | 14         | 30            |      |
| Others               | 5          | 6             |      |

Values are presented as mean (standard deviation) or n. ASA = American Society of Anesthesiologists, ERAS = early recovery after surgery. *P* value of <0.050 was considered to be statistically significant. Statistical analyses were performed with SPSS, version 19 (IBM Corp., Armonk, NY).
6 hours after surgery in the ERAS group. The median time until semiliquid diet resumption was 1.7 ± 0.7 days in the ERAS group and 4.5 ± 2.9 days in the control group (P < 0.001). The readmission rates (<30 d) were similar in the ERAS and control groups (3 vs 5 patients, respectively; P = 0.600).

Complications are shown in Table 4. There was no perioperative mortality in the 2 groups. The complications were evaluated using the Clavien–Dindo classification. The morbidity rate was 22.5% (18 of 80 patients) in the ERAS group and 43.9% (47 of 107 patients) in the control group (P = 0.002). No patient in the ERAS group developed DVT, but 6 patients did in the control group (P = 0.030). Grade II to V complications occurred in 16.3% of patients in the ERAS group, which was significantly lower than the rate in the control group (30.8%; P = 0.020). One patient in the ERAS group underwent a reoperation because of hemorrhage. Two patients in the control group underwent reoperations; 1 had liver failure, and the other was diagnosed with multiple organ dysfunction and stayed in the intensive care unit for 2 weeks.

The pain scores were used to evaluate the effect of analgesia (Table 3). On days 1, 3, and 5, the mean pain score in the ERAS group was significantly lower than that in the control group (all P < 0.001) (Table 3, Figure 1). The serum C-reactive protein concentrations on days 1, 3, and 5 are shown in Table 3. The C-reactive protein concentration in the control group was significantly higher than that in the ERAS group, but not significantly so (all P > 0.050). The median postoperative hospital stay was 6.2 ± 2.6 days in the ERAS group, which was significantly shorter than that in the control group (9.9 ± 5.9; P < 0.001) (Figure 2). The cost of hospitalization was $6871 ± 2571 in the ERAS group and $7948 ± 3630 in the control group (P = 0.020).

**DISCUSSION**

Recent studies have shown that ERAS is widely used in the perioperative period and leads to significantly shorter hospital stays after surgery and lower hospitalization costs. We searched the PubMed database and found 3 studies about the ERAS program in laparoscopic hepatectomy. He et al reported a study including 86 patients, in which the postoperative hospital stay after laparoscopic hepatectomy was 6 (range 4–8) days among patients who underwent ERAS, which was 2 days shorter than that in the control group; the hospitalization

---

**TABLE 3. Operative Details and Outcomes**

|                    | ERAS Group | Control Group | P   |
|--------------------|------------|---------------|-----|
| Operative time, min| 172.6 ± 86.0 | 190.8 ± 90.1  | 0.260 |
| Intraoperative blood loss, mL | 268.2 ± 416.0 | 328.0 ± 426.2 | 0.380 |
| Blood transfusion  | 8          | 13            | 0.650 |
| Pain score         |             |               |     |
| Postoperative day 1| 1.9 ± 0.5   | 2.6 ± 1.0     | <0.001 |
| Postoperative day 3| 1.3 ± 0.6   | 2.4 ± 1.0     | <0.001 |
| Postoperative day 5| 0.8 ± 0.6   | 1.8 ± 0.7     | <0.001 |
| Duration of urinary catheters, d | 1.0 ± 0.3 | 2.0 ± 1.2 | <0.001 |
| Duration nasogastric tube | 0.9 | 1.6 | <0.001 |
| Duration of abdominal drainage tube | 0.9 ± 0.6 | 1.5 ± 0.5 | <0.001 |
| Abdominal drainage tube removal (postoperative day) | 2.7 ± 2.1 | 8.0 ± 3.9 | <0.001 |
| Semiliquid diet after surgery, d | 1.7 ± 0.7 | 4.5 ± 2.9 | <0.001 |
| C-reactive protein concentration |             |               |     |
| Postoperative day 1 | 41.9 ± 32.7 | 44.0 ± 35.2 | 0.790 |
| Postoperative day 3 | 88.3 ± 51.4 | 88.2 ± 44.7 | 0.960 |
| Postoperative day 5 | 37.4 ± 22.9 | 55.3 ± 54.9 | 0.100 |
| Postoperative hospital stay, d | 6.2 ± 2.6 | 9.9 ± 5.9 | <0.001 |
| Time to function recovery, d | 5.0 ± 2.3 | 8.5 ± 4.4 | <0.001 |
| Readmission (<30 d) | 3          | 5             | 0.600 |
| Cost (US dollar)    | $6871 ± 2571 | $7948 ± 3630  | 0.020 |

Values are presented as mean ± standard deviation or n unless otherwise indicated.

ERAS = enhanced recovery after surgery.

---

**TABLE 4. Surgical Complications by Clavien–Dindo Classification**

|                  | ERAS Group (n = 80) | Control Group (n = 107) | P   |
|------------------|---------------------|-------------------------|-----|
| No complications | 62 (77.5)           | 60 (56.1)               | 0.002 |
| Grade I          |                      |                         |     |
| Nausea/vomiting  | 3 (3.75)            | 5 (4.7)                 | 0.760 |
| Wound infection  | 2 (2.5)             | 3 (2.8)                 | 0.900 |
| Deep vein thrombosis | 0 (0.0)   | 6 (5.6)                 | 0.030 |
| Grade II         |                      |                         |     |
| Postoperative liver failure | 8 (10)   | 10 (9.3)                | 0.880 |
| Grade IIa        |                      |                         |     |
| Pleural effusion  | 1 (1.25)            | 6 (5.6)                 | 0.120 |
| Bile leakage     | 2 (2.5)             | 6 (5.6)                 | 0.300 |
| Intraabdominal inflammation | 1 (1.25) | 7 (6.5)                | 0.080 |
| Grade IIb        |                      |                         |     |
| Hemorrhage >1000 mL and reoperation | 1 (1.25) | 2 (1.9)            | 0.740 |
| Grade Iva        | 0 (0.0)             | 1 (0.9)                 | 0.390 |
| Grade IVb        | 0 (0.0)             | 1 (0.9)                 | 0.390 |
| Grade V          | 0 (0.0)             | 0 (0.0)                 | N/A  |

Values are presented as n (%). All P values were measured by the chi-square test.

ERAS = enhanced recovery after surgery.
et al showed that 80.8% of patients who underwent ERAS (26/c6 hepatectomy and reported similar conclusions. Sa´nchez-Pe´rez a study of 26 patients who underwent ERAS after laparoscopic/c6 surgery. Good pain control was achieved. Moreover, we used a
and used 40 mg of parecoxib sodium (Dynastat) intravenously
for local anesthesia around the trocar incision intraoperatively
complications. In our study, we gave patients 0.2% ropivacaine
after surgery.17–20 However, these methods increase the risk of
of epidural analgesia was an effective solution to control pain
many studies of the application of ERAS reported that the use
liver cancer, hepatolithiasis, benign tumors, and others. Our
study involved 187 patients with different liver diseases, such as
patients) left the hospital within the first 3 days after surgery
(5.9 days in the control group (58.8% in the control group including 17 patients).
Our study has some differences from these studies. Our study involved 187 patients with different liver diseases, such as liver cancer, hepatolithiasis, benign tumors, and others. Our sample size and diseases are more convincing. Additionally, many studies of the application of ERAS reported that the use of epidural analgesia was an effective solution to control pain after surgery.17–20 However, these methods increase the risk of complications. In our study, we gave patients 0.2% ropivacaine for local anesthesia around the trocar incision intraoperatively and used 40 mg of parecoxib sodium (Dynastat) intravenously every 12 hours with patient-controlled intravenous analgesia after surgery. Good pain control was achieved. Moreover, we used a
visual analog scale for assessment of pain. Finally, our study shows that our ERAS protocol is suitable and useful for laparo-
scopic hepatectomy. Therefore, we applied for a randomized controlled trial (NCT02533193), and it is currently underway.
In our study, patients in the ERAS group left the hospital at
6.2 ± 2.6 days, and the hospitalization cost was $6871 ± 2571. Both of these parameters were significantly lower than those in the control group (9.9 ± 5.9 d and $7948 ± 3630, respectively; both P < 0.050). In the ERAS protocol of this study, periopera-
tive patient education, early postoperative mobilization, less use of drainage tubes, enhanced pain control, intravenous fluid restriction, and oral nutrition played important roles in reducing patients’ stress and promoting rapid recovery.21
Perioperative patient education is an important factor throughout the ERAS program. Before the operation, it is neces-
ary for patients to understand the ERAS program and follow the doctors’ or nurses’ advice. With good cooperation of patients, implementation of the ERAS program can relieve patients’ anxiety, fear, and stress, all of which may increase the hospital stay and cost. After the operation, patient education reinforces the daily goals of the ERAS procedures and improves patients’ physical and psychological recovery. Additionally, an efficient, professional, and united team comprising doctors, anesthetists, nurses, and pharmacists is a powerful tool with which to maintain the ERAS program and provide patients with the best care.22,23
In the ERAS program, patients are able to drink fluids (250 mL of a glucose–sodium solution) within 2 hours of surgery and have liquid food 6 hours after surgery. Some authors have reported that 2 hours of fasting can avoid aspiration pneumonia during surgery. Drinking 250 mL of a glucose–sodium solution 2 h before surgery helps patients to improve tolerance to surgery and reduce anxiety, hunger, and insulin resistance.24 Use of no gastric tube or early gastric tube removal allows patients to drink water within 6 hours after surgery, and have a liquid diet on postoperative day 1 and a semiliquid diet on postoperative day 2. Routine bowel preparation and intake of an early normal oral diet help to promote the resumption of gastrointestinal function, reducing catabolism, stress, and complica-
tions such as vomiting, nausea, and distension.

Pain control is crucial in patients undergoing ERAS. Good pain control can reduce the hospital cost and duration of stay, and patients are much more comfortable. Many studies on the application of ERAS have reported that the use of epidural analgesia is an effective solution to control pain after surgery. In the present study, however, patients in the ERAS group received a local anesthetic during surgery. Patient-controlled intravenous anesthesia and intravenous parecoxib sodium (Dynastat) every 12 hours were used after surgery, and oral analgesics replaced intravenous analgesia if good pain control was achieved. The pain scores were significantly lower in the ERAS than in the control group on days 1, 3, and 5 (1.9 vs 2.6, 1.3 vs 2.4, and 0.8 vs 1.8, respectively; all P < 0.001). Epidural analgesia may improve the risk of complications such as bleeding, infection, and an extended operation time.
In this study, patients were required to perform movements in bed on the operation day. On postoperative day 1, the patients were encouraged to get up from their bed and walk around the wards twice daily with the help of others. Less drainage tube use, good pain control, and early removal of the urethral catheter are important for early mobilization. Early mobilization can reduce complications such as DVT and intestinal obstruction. In the present study, DVT occurred in no patients in the ERAS group and in 6 patients in the control group. Patients who are able to ingest a normal diet, are mobile postoperatively,
and have no nausea/vomiting or other complications feel more comfortable and are willing to go home. This results in a shorter hospital stay and decreases the economic burden on patients.21

Reducing complications may also influence recovery because complications reduce patients’ comfort and even survival.22,23 Some studies showed that the ERAS program can improve short and long-term outcomes by reducing stress. In the present study, the ERAS group had a significantly lower rate of complications. The readmission rate (<30 d) was similar in the ERAS and control groups.

Laparoscopic hepatectomy has become widely used for treatment of both benign and malignant liver diseases.24,25 Many studies have shown that laparoscopic hepatectomy is safe and feasible with low morbidity and mortality. Meanwhile, laparoscopic hepatectomy is a minimally invasive surgery that causes less stress and trauma. It can improve patients’ recovery and shorten their hospital stay and cost. Therefore, laparoscopic liver resection is an important part of the ERAS program in patients undergoing liver resection.

CONCLUSIONS

Laparoscopic hepatectomy, as a safe and feasible surgery for patients, can promote recovery after liver resection. The ERAS program is also considered to be more effective and safer than conventional care for liver resection. However, more studies on the use of ERAS in laparoscopic hepatectomy are needed, especially randomized prospective studies.

REFERENCES

1. Baker TB, Jay CL, Ladner DP, et al. Laparoscopy-assisted and open living donor right hepatectomy: a comparative study of outcomes. Surgery. 2009;146:817–823.
2. Castaing D, Vibert E, Ricca L, et al. Oncologic results of laparoscopic versus open hepatectomy for colorectal liver metastases in two specialized centers. Ann Surg. 2009;250:849–855.
3. Benzon E, Molaro R, Cedolini C, et al. Liver resection for HCC: analysis of causes and risk factors linked to postoperative complications. Hepatogastroenterology. 2007;54:186–189.
4. Karanjia ND, Lordan JT, Fawcett WJ, et al. Survival and recurrence after neo-adjunctive chemotherapy and liver resection for colorectal metastases: a ten year study. Eur J Surg Oncol. 2009;35:838–843.
5. National Health Service (NHS) Enhanced Recovery Partnership. Fulfilling the Potential: a Better Journey for Patients and a Better Deal for the NHS; 2012. Available at: http://www.improvement.nhs.uk/documents/er_better_journey.pdf. Accessed April 12, 2013.
6. Kehlet H. Multimodal approach to control postoperative pathophysiology and rehabilitation. Br J Anaesth. 1997;78:606–617.
7. Varadhhan 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. Clin Nutr. 2010;29:434–440.
8. Yang D, He W, Zhang S, et al. Fast-track surgery improves postoperative clinical recovery and immunity after elective surgery for colorectal carcinoma: randomized controlled clinical trial. World J Surg. 2012;36:1874–1880.
9. Pag AJ, Ejaz A, Spolverato G. Enhanced recovery after surgery protocols for open hepatectomy: physiology, immunomodulation, and implementation. J Gastrointest Surg. 2015;19:387–399.
10. Michael J, Hughes, Stephen McNally, et al. Wigmore. Enhanced recovery following liver surgery: a systematic review and meta-analysis. HPB. 2014;16:699–706.
11. Cai XJ, Yang J, Yu H, et al. Clinical study of laparoscopic versus open hepatectomy for malignant liver tumors. Surg Endosc. 2008;22:2350–2356.
12. Dindo D, Demartines N, Clavien PA. Classification of surgical complications - a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg. 2004;240:205–213.
13. Jesen MP, McFarland CA. Increasing the reliability and validity of pain intensity measurement in chronic pain patients. Pain. 1993;55:195–203.
14. Veenhof AA, Vlug MS, van der Pas MH, et al. Surgical stress response and postoperative immune function after laparoscopy or open surgery with fast track or standard perioperative care: a randomized trial. Ann Surg. 2012;255:216–221.
15. Kim JW, Kim WS, Cheong JH, et al. Safety and efficacy of fast-track surgery in laparoscopic distal gastrectomy for gastric cancer: a randomized clinical trial. World J Surg. 2012;36:2879–2887.
16. Muehling B, Schelzig H, Steffen P, et al. A prospective randomized trial comparing traditional and fast-track patient care in elective open infrarenal aneurysm repair. World J Surg. 2009;33:577–585.
17. He F, Lin X, Xie F, et al. The effect of enhanced recovery program for patients undergoing partial laparoscopic hepatectomy of liver cancer. Clin Transl Oncol. 2015;17:694–701.
18. Stoot JH, van Dam RM, Busch OR, et al. Enhanced Recovery After Surgery (ERAS) Group. The effect of a multimodal fast-track programme on outcomes in laparoscopic liver surgery: a multicentre pilot study. HPB (Oxford). 2009;11:140–144.
19. Sánchez-Pérez B, Aranda-Narváez JM, Suárez-Muñoz MA, et al. Fast-track program in laparoscopic liver surgery: theory or fact? World J Gastrointest Surg. 2012;4:246–250.
20. Lin DX, Li X, Ye QW, et al. Implementation of a fast-track clinical pathway decreases postoperative length of stay and hospital charges for liver resection. Cell Biochem Biophys. 2011;61:413–419.
21. Shao Y, Zou LL, Zhou QH, et al. Fast-track surgery for gastroenteric neoplasms: a meta-analysis. Tumori. 2014;100:e197–e203.
22. Darrab AA, Fan J, Fernandes CM, et al. How does fast track affect quality of care in the emergency department? Eur J Emerg Med. 2006;13:32–35.
23. Ward C, Wright M. Fast-track palliative care training to bridge the theory and practice gap. Nurs Times. 2004;100:38–40.
24. Gustafsson UO, Hausel J, Thorell A, et al. Adherence to the enhanced recovery after surgery protocol and outcomes after colorectal cancer surgery. Arch Surg. 2011;146:571–577.
25. Farid SG, Aldouri A, Morris-Stiff G, et al. Correlation between postoperative infective complications and long-term outcomes after hepatic resection for colorectal liver metastasis. Ann Surg. 2010;251:91–100.
26. Khuri SF, Henderson WG, DePalma RG, et al. Determinants of long-term survival after major surgery and the adverse effect of postoperative complications. Ann Surg. 2005;242:326–341.
27. Nguyen KT, Gamblin TC, Geller DA. World review of laparoscopic liver resection: 2,804 patients. Ann Surg. 2009;250:831–841.
28. Gigot JF, Glineur D, Santiago Azagra J, et al. Laparoscopic liver resection for malignant liver tumors: preliminary results of a multicenter European study. Ann Surg. 2002;236:90–97.