Is Laparoscopic Hepatectomy a Safe, Feasible Procedure in Patients with a Previous Upper Abdominal Surgery?

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Abstract

Background: Laparoscopic liver resection has become an accepted treatment for liver tumors or intrahepatic bile duct stones, but its application in patients with previous upper abdominal surgery is controversial. The aim of this study was to evaluate the feasibility and safety of laparoscopic hepatectomy in these patients.

Methods: Three hundred and thirty-six patients who underwent laparoscopic hepatectomy at our hospital from March 2012 to June 2015 were enrolled in the retrospective study. They were divided into two groups: Those with previous upper abdominal surgery (PS group, $n = 42$) and a control group with no previous upper abdominal surgery (NS group, $n = 294$). Short-term outcomes including operating time, blood loss, hospital stay, morbidity, and mortality were compared among the groups.

Results: There was no significant difference in median operative duration between the PS group and the NS group (180 min vs. 160 min, $P = 0.869$). Median intraoperative blood loss was same between the PS group and the control group (200 ml vs. 200 ml, $P = 0.907$). The overall complication rate was significantly lower in the NS group than in the PS group (17.0% vs. 31.0%, $P = 0.030$). Mortality and other short-term outcomes did not differ significantly between groups.

Conclusions: Our study showed no significant difference between the PS group and NS group in term of short-term outcomes. Laparoscopic hepatectomy is a feasible and safe procedure for patients with previous upper abdominal surgery.

Key words: Hepatectomy; Laparoscopy; Reoperation

Introduction

The liver can be easily invaded by tumors. Conventional open surgery is the preferred treatment for tumor resection, as is for intrahepatic bile duct stones, especially in patients who have undergone previous upper abdominal surgery. In recent decades, continuous innovation and improvement of laparoscopic equipment and technology have led to the evolution of laparoscopic hepatectomy from a challenging procedure performed by highly skilled surgeons in handful medical centers to one that is widely performed. However, few laparoscopic hepatectomy procedures have been reported for patients with previous upper abdominal surgery. Because severe adhesions secondary to previous surgery can lead to higher rates of complication and conversion to open surgery,[1] laparoscopic surgery has not been recommended for patients with previous abdominal surgery. The aim of this study was to evaluate the feasibility and safety of laparoscopic hepatectomy in these patients.

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Methods

Patient selection

Prior to data collection, the study protocol was evaluated and approved by the Ethical Committees for Human Subjects at Sir Run Run Shaw Hospital Affiliated to Medical College of Zhejiang University. Three hundred and thirty-six patients who had undergone laparoscopic hepatectomy at our hospital from March 2012 to June 2015 were included in this retrospective study. We divided these patients into two groups: An experimental group of those who had undergone previous upper abdominal surgery (PS

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group, n = 42) and a control group of those who had not (NS group, n = 294). Previous upper abdominal surgery was defined as surgery performed above the umbilical region, including hepatobiliary and pancreatic surgery, splenectomy and gastrectomy, and surgery involving the small intestine, colon, kidney, and upper abdominal retroperitoneum.

In this study, laparoscopic hepatectomy included malignant or benign primary hepatic tumors, metastatic hepatic carcinoma, and intrahepatic duct stones. Inclusion criteria were: (1) primary hepatic malignant tumors with no extrahepatic metastasis; metastatic hepatic tumors that metastatic focuses were limited to one lobe of liver; benign hepatic tumors that were obviously symptomatic, at high risk for rupture with life-threatening consequences, or with unclear diagnosis; intrahepatic duct stones with obvious stricture or dilation of the bile duct and liver atrophy; (2) Child-Pugh score A or B; (3) well-preserved general condition. Patients with severe portal hypertension or American Standards Association (American Society of Anesthesiologists) ≥ grade III or future liver remnant insufficiency (<30% in the nonsclerotic liver or <40% in the liver with cirrhosis) were excluded.

Surgical technique

The operative details have been reported previously.[2] Briefly, a 10 mm camera trocar was inserted subumbilically in the NS group and in where adhesions were expected to be minimal in the PS group. Pneumoperitoneum was established with carbon dioxide to a pressure of 12–15 mmHg (1 mmHg = 0.133 kPa). Under laparoscopic guidance, three more ports were established: A 10 mm main port in the xiphoid for surgical manipulation and two 5 mm accessory ports on the right side of the abdomen. For major liver resection, the hepatic hilum was dissected, and liver parenchymal transection was carried out using a Peng's multifunctional operative dissector (Hangzhou Shuyou Medical Instrument Co., Ltd., Hangzhou, Zhejiang, China) along with ischemia line. Vascular clips or polypropylene sutures were used to control the divided vascular and biliary structures. A Pringle maneuver was carried out if necessary. The specimen of the liver was retrieved and placed in a plastic bag after enlargement of one of the port sites. Drainage tubes were left in place if bleeding or bile leakage was suspected.

Perioperative care and follow-up

All patients received prophylactic antibiotics immediately prior to the operation and had the same postoperative care by a professional nursing team. Postdischarge transhepatic arterial chemoembolization and other adjuvant therapies were recommended for patients diagnosed with hepatocellular carcinoma or other malignant tumors. Follow-up included physical examination, laboratory tests, tumor markers, and imaging examination every 3 months.

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 19.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as median (range) while categorical variables were expressed as number (percentage). Continuous variables were compared using Mann–Whitney U-test while categorical variables were compared using the Chi-square test or Fisher's exact test. A P value of <0.05 was considered statistically significant.

Results

The cohort consisted of 336 patients divided into PS (n = 42) and NS (n = 294) groups. Patients' demographic and clinical/laboratory data are presented in Table 1. The PS group was significantly older than the NS group (65 years [38–80 years] vs. 54 years [16–85 years], $P < 0.001$). Moreover, the alkaline phosphatase of patients in PS group was significantly higher than that in NS group (111 U/L [46–551 U/L] vs. 88 U/L [33–515 U/L], $P = 0.021$). There were no significant between-group differences in other demographic variables, including sex, presence of cirrhosis or hepatitis-B, and liver function.

Perioperative outcomes are summarized in Tables 2-4. There was no significant difference in median operative duration between the PS group and the NS group (180 min [50–400 min] vs. 160 min [25–500 min], $P = 0.869$). Median intraoperative blood loss was same between the PS group and the control group (200 ml [20–1500 ml] vs. 200 ml [5–2000 ml], $P = 0.907$). In the PS group (n = 42), six cases were converted to open surgery because of the presence of severe adhesions. Of 37 conversions to open procedure in the NS group (n = 294), 25 were because of severe adhesions, six because of bleeding, four because of inadequate margins, and two because of severe gas embolism. The rate of intraoperative transfusion was identical between the two groups (14.3% vs. 14.3%, $P = 1.000$). With regard to the Pringle maneuver, the NS group tended to have a shorter clamping time, but the difference was not significant (13 min [5–25 min] vs. 15 min [12–48 min], $P = 0.294$). The overall complication rate was significantly lower in the NS group than in the PS group (17.0% vs. 31.0%, $P = 0.030$), but no between-group difference was observed in Clavien-Dindo grade.[3] One patient in each group died during hospitalization. The duration of postoperative hospital stay, the rate of unplanned re-admission within 3 months, and the postoperative liver function were similar between groups [Table 3].

The extent of liver resection did not differ significantly between the two groups [Table 5]. Both hemihepatectomy and larger liver resections were defined as a major liver resection. Less than a hemihepatectomy was regarded as minor liver resection. The extension of liver resection of two groups had no differences significantly (χ^2 = 2.636, P = 0.104). In the PS group, 13 left hemihepatectomies,

Table 1: Characteristics and preoperative liver function of patients with laparoscopic hepatectomy

Item	PS group (n = 42)	NS group (n = 294)	Statistical value	P
Age* (years)	65 (38–80)	54 (16–85)	−3.781	<0.001
Gender†: Male	20 (47.6)	150 (51.0)	0.170	0.680
Hepatitis-B†	13 (31.0)	99 (33.7)	0.122	0.726
Cirrhosis†	7 (16.7)	62 (22.4)	0.440	0.507
ALT* (U/L)	26 (8–194)	24 (2–380)	−1.087	0.277
AST* (U/L)	26 (12–176)	25 (11–571)	−0.627	0.531
AKP* (U/L)	111 (46–551)	88 (33–515)	−2.315	0.021
γ-GT* (U/L)	47 (9–989)	37 (3–115)	−1.192	0.233
ALB* (g/L)	40.8 (28.2–49.3)	40.0 (27.7–51.3)	−0.144	0.885
TB* (μmol/L)	14.7 (7.2–77.6)	14.0 (3.5–137.4)	−0.523	0.245
PT* (s)	12.9 (11.4–16.8)	13.0 (10.9–16.9)	−1.162	0.581
Child-Pugh (A)†	40 (95.2)	284 (96.6)	0.198	0.657

*Continuous data are presented as median (range), Mann–Whitney U-test; †Categorical data are presented as n (%), Chi-square test. AKP: Alkaline phosphatase; ALT: Alanine aminotransferase; AST: Aspartate aminotransferase; γ-GT: Gamma-glutamyltransferase; PT: Prothrombin time; TB: Total bilirubin; PS: Previous upper abdominal surgery; NS: Nonprevious upper abdominal surgery; ALB: Albumin.

Table 2: Perioperative outcomes of patients with laparoscopic hepatectomy

Items	PS group (n = 42)	NS group (n = 294)	Statistical value	P
Operation time* (min)	180 (50–400)	160 (25–500)	−0.165	0.869
Blood loss* (ml)	200 (20–1500)	200 (5–2000)	−0.360	0.907
Transfusion rate†	6 (14.3)	42 (14.3)	0	1.000
Time of Pm* (min)	15 (12–48)	13 (5–25)	−1.049	0.294
Pm‡	4 (9.5)	25 (8.5)	NA	0.771
Conversion†	6 (14.3)	37 (12.6)	0.295	0.587
Overall complications†	13 (31.0)	50 (17.0)	4.691	0.030
Hospital stay* (day)	8 (4–45)	8 (1–49)	−1.236	0.217
Hospital death‡	1 (2.4)	1 (0.3)	NA	0.235
3-month readmissions‡	1 (2.4)	4 (1.2)	NA	0.489

*Continuous data are presented as median (range), Mann–Whitney U-test; †Categorical data are presented as n (%), Chi-square test; ‡Categorical data are presented as n (%), Fisher's test. NA: Not available; 3-month re-admisssions: Unplanned re-admission within 3 months; Pm: Pringle maneuver; PS: Previous upper abdominal surgery; NS: Nonprevious upper abdominal surgery.

Table 3: Liver function of patients with laparoscopic hepatectomy on postoperative day 1

Item	PS group (n = 42)	NS group (n = 294)	Statistical value	P
ALT (U/L)	173 (35–1656)	163 (25–1713)	−0.400	0.689
AST (U/L)	199 (29–916)	177 (23–2232)	−0.332	0.740
AKP (U/L)	80 (6–405)	72 (26–375)	−1.193	0.056
γ-GT (U/L)	45 (9–465)	31 (5–725)	−1.172	0.087
ALB (g/L)	31.2 (21.6–43.5)	31.8 (18.5–49.4)	−1.275	0.202
TB (μmol/L)	23.2 (3.8–97.1)	24.9 (6.3–155.2)	−0.289	0.918
PT (s)	15.0 (12.7–23.3)	15.1 (12.2–27.3)	−0.103	0.773

Data are presented as median (range), Mann–Whitney U-test. AKP: Alkaline phosphatase; ALT: Alanine aminotransferase; AST: Aspartate aminotransferase; γ-GT: Gamma-glutamyltransferase; PT: Prothrombin time; TB: Total bilirubin; PS: Previous upper abdominal surgery; NS: Nonprevious upper abdominal surgery; ALB: Albumin.

and 4 right hemihepatectomies were performed. In the control group, there were 56 left hemihepatectomies and 27 right hemihepatectomies, respectively. Of the 56 patients who underwent left hemihepatectomy, three underwent concomitant caudate lobe resection.

Of the 336 patients in both groups, 111 (101 in the NS group and 10 in the PS group) had pathologically confirmed hepatocellular carcinoma. Although the preoperative alpha-fetoprotein level was significantly higher in the NS group, the median maximum tumor diameters (2.7 cm [1.3–7.5 cm] in the PS group and 4.0 cm [0.8–16.2 cm] in the control group, P = 0.188) did not differ significantly between groups. R0 resection was achieved in all patients except one, in the NS group, whose resection was R1 [Table 6].

Subgroup analysis of clinical outcomes of patients in PS group

The PS group patients (n = 42) were divided into two subgroups by type of previous surgery, laparoscopic (n = 13)

Table 4: Liver function of patients with laparoscopic hepatectomy on postoperative day 3

Item	PS group (n = 42)	NS group (n = 294)	Statistical value	P
ALT (U/L)	98 (29–942)	107 (11–2230)	−1.089	0.276
AST (U/L)	51 (3–531)	54 (10–918)	−0.584	0.587
AKP (U/L)	83 (46–287)	75 (31–948)	−1.390	0.164
γ-GT (U/L)	40 (11–322)	38 (4–438)	−0.846	0.398
ALB (g/L)	31.0 (26.4–58.6)	32.0 (24.5–54.7)	−0.268	0.788
TB (µmol/L)	24.3 (13.6–40.6)	20.8 (6.8–217.8)	−1.962	0.050
PT (s)	14.6 (8.8–116.9)	15.3 (12.4–24.6)	−0.270	0.787

Data are presented as median (range), Mann-Whitney U-test. AKP: Alkaline phosphatase; ALT: Alanine aminotransferase; AST: Aspartate aminotransferase; γ-GT: Gamma-glutamyltransferase; PT: Prothrombin time; TB: Total bilirubin; PS: Previous upper abdominal surgery; NS: Nonprevious upper abdominal surgery; ALB: Albumin.

Table 5: Extent of liver resection of patients with laparoscopic hepatectomy

Item	PS group (n = 42)	NS group (n = 294)
Surgical type (major), n (%)	17 (40.5)	83 (28.2)
Left hemihepatectomy	13 (31.0)	53 (18.0)
Left hemihepatectomy associated with caudate lobe resection	0 (0)	3 (1.0)
Right hemihepatectomy	4 (9.5)	27 (9.2)
Surgical type (minor), n (%)	25 (59.5)	211 (71.8)
Segment	6 (14.3)	34 (11.6)
Associated segments	2 (4.8)	7 (2.4)
Left lateral lobe	8 (19.0)	79 (26.9)
Local resection	8 (19.0)	89 (30.3)
Solitary caudate lobe	1 (2.4)	2 (0.7)

Hemi (or greater) hepatectomy was defined as major liver resection; less than hemihepatectomy was defined as minor. PS: Previous upper abdominal surgery; NS: Nonprevious upper abdominal surgery.

or open (n = 29). The types of previous surgery are listed in Table 7. There were no significant between-group differences in any perioperative outcome, including operative duration, intraoperative blood loss, and rates of transfusion and overall complications [Table 8].

Discussion

In the past, repeat surgery was considered as a contraindication for a laparoscopic procedure. We believe there is an even greater challenge associated with any type of laparoscopic hepatobiliary surgery after previous upper abdominal surgery. Bleeding of vascular-rich adhesions can lead to poor visualization, and disruptions in the hilar structure and immobility of liver result in a prolonged operation and greater blood loss. Furthermore, postoperative adhesions are associated with a high risk of bowel injury.[4-6] Several groups have reported that the morbidity and mortality rates of open repeat liver resections vary from 22% to 28% and 0% to 5%, respectively.[7-9] As the innovation of laparoscopic technique, laparoscopic hepatectomy has the advantages of inducing less surgical trauma and resulting in a shorter recovery time and hospital stay.[4,5,10,11] In theory, a laparoscopic procedure decreases the stress response and protects postoperative immunity, which are also benefits of a minimal incision[12] and which correspond to the popular concept of rapid rehabilitation.

Although, there have been some concerns about the ability of laparoscopic hepatectomy to cure malignancy. However, Cherqui *et al.* reported 93% 3-year survival in patients with peripheral hepatocellular carcinoma undergoing laparoscopic resection, with an acceptable 30% overall recurrence rate,[1,13] and similar results were reported by Sarpel *et al.*[14] Moreover, many literature reviews have demonstrated no difference in the treatment of malignant tumors in terms of surgical margin between laparoscopic and open hepatectomy,[15-20] and some experts even have suggested that laparoscopic left lateral lobe resection is now a standard procedure.[1,5-7,21-25] Therefore, laparoscopic hepatectomy can be a good alternative even for recurrent hepatocellular carcinoma.[23]

In this study, although the age of PS group was significantly older than that of NS group, there were no other significant between-group differences in short-term outcomes. Only overall complications were significantly higher in the PS group than in the NS group. Severe complications unique to laparoscopy, such as gas embolism, rarely occurred. Only two cases with gas embolism were reported in NS group. In the subgroup analysis, the type of previous surgery (laparoscopy vs. laparotomy) had no effect on short-term postoperative outcomes. Therefore, previous upper abdominal surgery is not the contraindication for a laparoscopic procedure as before, though many patients are still undergoing follow-up, and data on long-term outcomes of oncologic integrity are collected sequentially.

In conclusion, laparoscopic hepatectomy in patients with previous upper abdominal surgery is controversial, and the ethical issues that would be associated with a randomized controlled trial prevent resolution of the issue in this manner. However, it is gaining greater acceptance, and a number of retrospective studies support laparoscopic hepatectomy as a feasible and safe procedure for patients who have undergone previous upper abdominal surgery and regardless of whether the previous surgery was laparoscopic or open. However, further long-term follow-up is needed.

Table 6: HCC-related outcomes of patients with laparoscopic hepatectomy

Item	PS group (n = 10)	NS group (n = 101)	Statistical value	P
Maximum diameter of tumor* (cm)	2.7 (1.3–7.5)	4.0 (0.8–16.2)	−1.315	0.188
AFP* (μg/L)	48.3 (2.3–2695.2)	43.5 (1.5–50237.4)	−0.489	0.582
R0 resection rate†	10 (100)	100 (99)	NA	1.000
Adjuvant therapy†	9 (90)	67 (66.3)	NA	0.166
TACE	9	63		
Chemotherapy	0	2		
Radiotherapy	0	1		
RFA	0	1		

*Continuous data are presented as median (range), Mann–Whitney U-test; †Categorical data are presented as n (%), Fisher's test. NA: Not available; RFA: Radiofrequency ablation; TACE: Transhepatic arterial chemoembolization. One patient received TACE and targeted radiotherapy; HCC: Hepatocellular carcinoma; PS: Previous upper abdominal surgery; NS: Nonprevious upper abdominal surgery; AFP: Alpha-fetoprotein.

Table 7: Subgroup analysis of patients of previous upper abdominal surgery group by type of previous surgery

Item	Laparoscopy (n = 13)	Laparotomy (n = 29)
Kidney	1	2
Liver	5	1
Bile duct	5	14
Pancreas	0	0
Spleen	0	4
Stomach	0	3
Small intestine	0	1
Colon	2	3
Retroperitoneum	0	1

Table 8: Subgroup analysis of patients with previous upper abdominal surgery

Item	Laparoscopy (n = 13)	Laparotomy (n = 29)	Statistical value	P
Operation time* (min)	180 (60–280)	180 (50–400)	−0.120	0.904
Blood loss* (ml)	225 (20–500)	200 (20–1500)	−0.168	0.866
Transfusion rate†	1 (7.7)	5 (17.2)	NA	1.000
Pm†	0 (0)	4 (13.8)	NA	0.293
Conversion†	2 (15.4)	4 (13.8)	NA	1.000
Overall complications†	3 (23.1)	10 (34.5)	NA	0.719
Hospital stay* (day)	9 (4–45)	8 (4–28)	−0.670	0.503
Hospital death†	1 (7.7)	0 (0)	NA	0.528
3-month readmissions†	0 (0)	1 (3.4)	NA	1.000

*Continuous data are presented as median (range), Mann–Whitney U-test; †Categorical data are presented as n (%), Fisher's test. NA: Not available; 3-month readmissions: Unplanned re-admission within 3 months; Pm: Pringle maneuver.

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Conflicts of interest

There are no conflicts of interest.

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