

# Mid-term Outcomes of Laparoscopic Total Cystectomy Versus Open Surgery for Complicated Liver Hydatid Cysts

Abulaihaiti Maitiseyiti, PhD, Zhigang Ma, MS, Yuan Meng, MD,  
Guanglei Tian, PhD, Baheti Kalifu, MD, Shuang Lu, MS, and Xiong Chen, MD

**Background:** Total cystectomy is a challenging procedure in patients with complicated liver hydatid cysts (HCs). This study aimed to evaluate the feasibility and safety of laparoscopic total cystectomy in patients with complicated liver HCs.

**Methods:** Prospectively collected clinical data of 50 consecutive patients, who underwent laparoscopic procedures for complicated liver HCs between January 2017 and January 2019, were retrospectively analyzed. One hundred patients who underwent open procedures were compared with the laparoscopic group in terms of perioperative outcomes during the 1-year follow-up period.

**Results:** Conversion to open surgery occurred in 1 (2%) case. The number of single and multiple lesions and the size of HCs were similar between the 2 groups ( $P > 0.05$ ). Sixty-six percent of patients underwent total cystectomy, 10% subtotal cystectomy, and 24% hepatectomy in the laparoscopic group ( $P > 0.05$ ). Decompression and hepatic inflow occlusion were performed in high-risk cases. No differences were noted in average blood loss volume, and transfusion rate between the 2 groups. Postoperative recovery in the laparoscopic group was significantly shorter than that in the open group. There was no difference in the incidence of postoperative complications between the laparoscopic and open groups. No recurrence or death was observed in either group during this period.

**Conclusions:** Laparoscopic total cystectomy was a curative and safe surgical approach to the treatment of complicated HC with favorable mid-term outcomes. Subtotal cystectomy combined with decompression is the preferred option for patients with high surgical risk(s). However, long-term outcomes need to be validated in prospective studies with larger sample sizes and prolonged follow-up.

**Key Words:** laparoscopy, hydatid cyst, complicated, liver, cystectomy  
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Liver hydatid cyst (HC) is a chronic parasitic infection caused by the larvae of the cestode *Echinococcus granulosus*.<sup>1</sup> It is highly endemic in western China, Central Asia, South America, Mediterranean countries, and eastern Africa. The liver is the most commonly affected organ, and severe complications may occur if inadequate care and management is provided.<sup>2</sup>

Total cystectomy (also termed total pericystectomy) has been described by Peng et al,<sup>3</sup> and is regarded as a curative treatment option, which can achieve the goal of complete removal of the cyst, with the lowest recurrence rate, reduction in complications associated with residual cyst cavity, and avoiding a long period of postsurgical medication. Clinical evidence suggests that patients in whom the first operation fails may be at higher risk for recurrence of HC(s). On the one hand, the anatomic condition of liver HC becomes complicated due to the formation of severe abdominal adhesion(s). On the other hand, these patients may experience repeated open operations, which is not only associated with significant psychological burden, but also results in difficulties in subsequent surgical procedures.<sup>4,5</sup> Therefore, some complicated and recurrent patients do not undergo the traditional procedure.

The laparoscopic approach to the resection of hepatic lesions is becoming widely accepted due to advantages of decreased postoperative pain, quicker recovery times, and lower postoperative abdominal adhesion(s) compared with open surgery.<sup>6</sup> The laparoscopic approach to managing liver HCs was first documented in 1992.<sup>7</sup> However, technical challenges, including intraoperative spillage of cyst contents and potential bleeding, are more difficult to control laparoscopically than in previous years.<sup>8</sup> In recent years, the number of reports describing laparoscopic approaches to liver HCs have gradually increased.<sup>9–11</sup> Although laparoscopic surgery appears to be effective and safe for uncomplicated liver HCs occurring in accessible segments,<sup>12</sup> most early studies were case reports and did not involve radical surgical procedures, or initial attempts at laparoscopic procedures for cases with liver HCs located in favorable locations.<sup>13,14</sup> Relevant reports describing laparoscopic approaches to complicated HCs are rare, especially those addressing radical surgery for complicated HCs because laparoscopic procedures are technically challenging. As such, comparative outcomes of laparoscopic total cystectomy and traditional total cystectomy for the treatment of complicated liver HCs remain unclear. Accordingly, the present study aimed to compare the mid-term perioperative outcomes of laparoscopic and open approaches to complicated liver HC.

## METHODS

### Study Design

The present study prospectively analyzed 50 consecutive patients with complicated liver HC, who underwent a laparoscopic procedure in the department of HPB Surgery of the People's Hospital of Xinjiang Uygur Autonomous Region (Xinjiang, China) between January 2017 and January 2019; these individuals formed the laparoscopic group. One hundred patients who underwent traditional cystectomy for complicated liver HC in the same period formed the open group. Baseline characteristics, perioperative information, early morbidity, and

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From the Department of Hepatobiliary Surgery, People's Hospital of Xinjiang Uygur Autonomous Region, Urumqi, Xinjiang, China.  
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Reprints: Xiong Chen, MD, Department of Hepatobiliary Surgery, People's Hospital of Xinjiang Uygur Autonomous Region, Urumqi, Xinjiang 830001, China (e-mail: chenxiong2019@126.com).  
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postoperative complications were recorded. Postoperative morbidity was categorized according to the Dindo-Clavien classification.<sup>15</sup> Perioperative outcomes and postoperative recurrence were compared between the laparoscopic and open groups.

This study was performed prospectively, and was approved by the Ethics Committee of the People's Hospital of Xinjiang Uygur Autonomous Region. All enrolled patients provided written informed consent to voluntary participation. Patients and family members were fully informed by the surgeon of the advantages and disadvantages of 2 surgical approaches (ie, open and laparoscopic surgery), and made the final decision.

### Definitions, and Inclusion and Exclusion Criteria

Complicated liver HC was defined in the presence of at least one of the following criteria: solitary liver lesion(s)  $\geq 5$  cm in size or number of lesions  $\leq 3$ ; HCs located in high-risk segment(s) of the liver (right lobe and caudate lobe); liver HC lesions adjacent to major vessels or near the liver hilum; and recurrent liver HC.

The inclusion criteria were as follows. Complicated liver HC confirmed on abdominal ultrasound scan and liver contrast-enhanced computed tomography (CT) combined with *E. granulosus* serology. Some cases that were difficult to diagnose were confirmed by laparoscopic exploration to differentiate cyst content. All liver HCs were classified by the World Health Organization—Informal Working Group on Echinococcosis,<sup>16</sup> active HC (cystic lesion, CE-1, CE-2, CE-3), and CE-4 and CE-5 HC patients with high risk(s) were considered for surgery. All patients who undergo surgery are required to be in good general condition with main organ function, and the ability to tolerate general anesthesia and open as well as laparoscopic surgery. Individuals with ruptured liver HCs and lesions (CE3, CE4, CE5) that did not continue to grow, and patients who underwent a PAIR (puncture, aspiration, injection, re-aspiration) procedure were excluded.

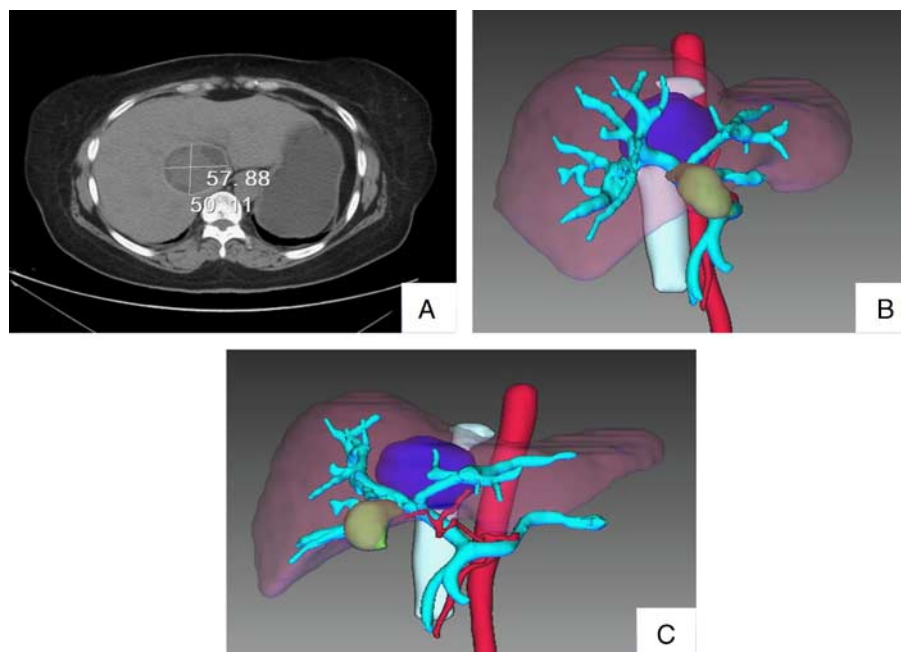
### Preoperative Preparation

All patients underwent contrast-enhanced liver CT and 3-dimensional reconstruction to visualize anatomic features of the liver HC (Fig. 1). According to patient physical condition and features of the HC lesion, including HC classification, size, amount, cyst wall thickness, relationship with intrahepatic vessels and bile duct, if space between external cyst wall and liver tissue was clear, evaluation of intraoperative risk, individualized surgical options were adopted for patients with complicated HC. Total cystectomy is the preferred choice for all HC patients. All patients receive oral treatment with albendazole 1 week before surgery.

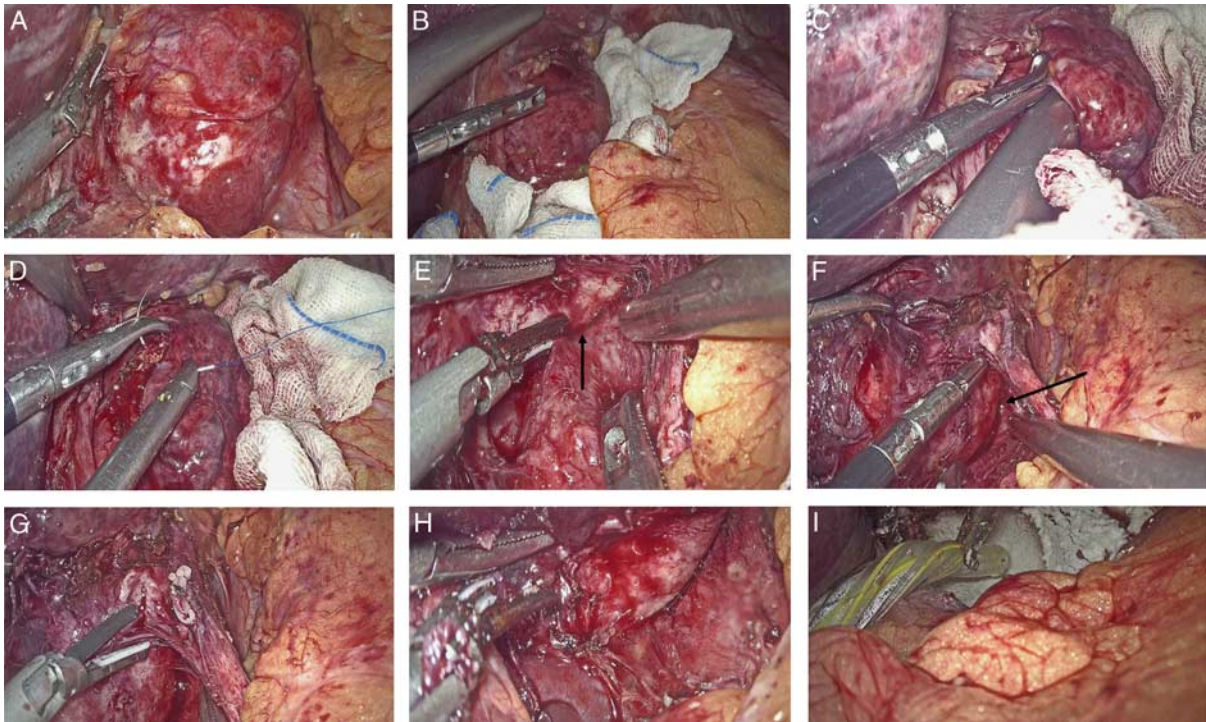
### Surgical Procedure for Total Cystectomy

Surgery is performed with the patients under general anesthesia and endotracheal intubation. The surgeon stands on the left or right side of the patient according to the location of the cyst. Patient position was adjusted according to the location of the cyst in the liver. In the laparoscopic procedure, patients were positioned with head-up tilt (30 degrees reverse Trendelenburg) and legs apart, with the surgeon standing between them, or on the patient's right side. Pneumoperitoneum to a pressure of 13 to 15 mm Hg was created using a Veress needle. The primary 10 mm port is inserted through an incision above the umbilicus, and a 30 degrees laparoscope is introduced to explore the abdominal cavity and confirm the exact location of the HC. If the liver HC is ruptured, the procedure is converted to open surgery. After locating the borderline of the HC, the relationship between the HC and intrahepatic vessels is evaluated using intraoperative laparoscopic ultrasonography (Toshiba, Hitachi, Tokyo, Japan).

After complete exposure of the liver HC, HC tissue is packed with hypertonic saline-soaked gauze (15% to 20%) to prevent the spillage of cyst contents into the abdominal cavity. For small size HCs, close total cystectomy is performed, and open total cystectomy or subtotal cystectomy are performed for



**FIGURE 1.** Surgical procedure planning using 3-dimensional liver reconstruction. A, Computed tomography scan showed hydatid cyst (HC) lesion located on caudate lobe (size: 57.88×50.11 mm). B and C, It showed the 3-dimensional reconstruction based on liver enhanced computed tomography scan for liver HC on caudate lobe. Liver HC is signed as blue color.



**FIGURE 2.** Surgical procedure of laparoscopic open total cystectomy for liver hydatid cyst (HC) in the caudate lobe. A, Exposure the liver HC in caudate lobe clearly. B, Protect abdominal cavity away from contamination by spillage of viable protoscolexes. Surrounding area were packed with hypertonic saline-soaked gauze. C, Decompression was performed by opening the HC using laparoscopic rotary cutter and aspirator. D, Suture the opened incision on the surface HC completely. E and F, Searching the potential space between the normal liver tissue and pericyst tissue of HC, as shown by the black arrow. G, Ligation of nonfunctional pipes. H, Stripping the HC along the potential space and complete removal of HC lesion. I, Observation the surgical area of hepatic parenchyma and placement of drainage tube.

large and high-risk HC lesions. To search for potential space between the hepatic tissue and pericyst tissue of the HC, the liver HC is dissociated using a harmonic scalpel (Ethicon Endo-Surgery, Cincinnati, OH). Hepatic blood inflow occlusion was prepositioned. Searching for an accurate potential space between the liver parenchyma and HC pericyst is a key step in successful dissection of the HC. In this space, the entire HC is resected from the hepatic tissue. Portal triad clamping is used when major bleeding occurs. Vessels and bile ducts across the space were ligated using a hem-o-lok clip (Weck Closure Systems, Research Triangle Park, NC). Small biliary communications are repaired using a prolene suture (detailed procedures shown in Fig. 2).

### Application of Laparoscopic Rotary Cutter and Aspirator

If giant HCs with higher pressure, or HCs close to major liver vessels are observed laparoscopically, open total pericystectomy is performed. First, the pericyst is opened, and a custom-made laparoscopic rotary cutter and aspirator (patent number: 2018215580554) are used for decompression of the HC under adequate protection of the area surrounding the HC (shown in Fig. 3). Cyst content is suctioned as soon as possible. According to cyst fluid content, final diagnosis is confirmed. Repeated instillation of 20% hypertonic sodium chloride solution is performed to inactivate protoscolexes, the opened site is then sutured using silk thread or ligated using a hem-o-Lok clip. The potential space between normal liver tissue and HC pericyst becomes more obvious and loose after total decompression, which facilitates



**FIGURE 3.** Custom-made laparoscopic rotary cutter and aspirator.

total cystectomy. If bile is present in the cyst content, the bile leakage site is sutured, and exploration of the common bile duct is performed. Total HC is extracted en bloc in a specimen bag via an extended incision in the upper abdominal area. The abdominal cavity is washed using warm saline. After excluding bleeding and bile leakage on the hepatic cross-section, a drainage tube is routinely placed in the surgical area. After total cystectomy, medication is not routinely required; however, a 3- to 6-month period of albendazole therapy is required after subtotal cystectomy. The specific laparoscopic procedures performed in the present study are shown in the flowchart presented in Figure 4.

In open surgery, laparotomy is performed through a midline or right subcostal incision. After abdominal exploration, the location, amount, and size of the HC(s) are identified. After dissecting the external wall of the HC, the space between the normal hepatic parenchyma and external wall is confirmed. Along the space, the HC is totally resected, and intrahepatic vessels and nonfunctional bile ducts across this space are ligated. The liver wound on the parenchyma is examined for bleeding and bile leakage. The specific procedure is the same as the laparoscopic procedure.

### Management of Postoperative Complications

Interventional procedures, including ultrasound-guided or radiology-based percutaneous catheter drainage, were used postoperatively in patients who developed massive volume(s) of pleural effusion, massive residual fluid collection in the cavity, residual cavity infection, or abdominal infection caused by bile leakage.

### Follow-up

All patients were followed up at 3, 6, and 12 months after surgery. Liver function tests and abdominal ultrasonography were performed according to routine protocol. Patients with suspected recurrence underwent contrast-enhanced upper abdominal CT to confirm the diagnosis. For patients who experienced recurrence, laparoscopic procedures combined with medication were preferred based on the size, location, and amount of HC, as well as the patient's condition. Postoperative

follow-up was performed by telephone and during outpatient visits to assess postoperative HC recurrence and survival status.

### Statistical Analysis

Data were analyzed using the SPSS version 26.0 (IBM Corporation, Armonk, NY). Normally distributed variables are expressed as mean  $\pm$  SD, and categorical variables are expressed as frequency. The Student *t* test was used to compare differences in continuous variables between the 2 groups. The  $\chi^2$  test was used to compare differences in categorical variables between the 2 groups. Differences with *P*-value  $<0.05$  were considered to be statistically significant.

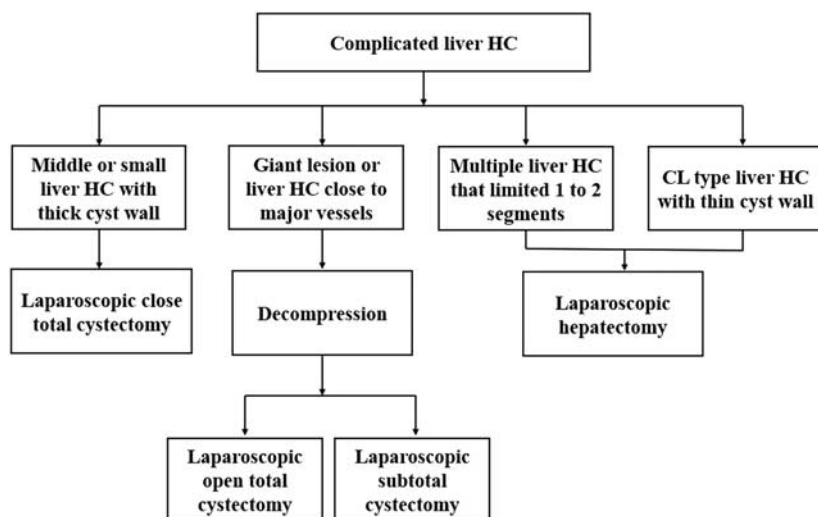
## RESULTS

### Intraoperative Demographic Characteristics

Detailed demographic data, comorbidities, history of abdominal operation(s), initial reasons for treatment, and American Society of Anesthesiologists (ASA) fitness grade of the 50 patients who underwent laparoscopic radical resection and 100 matched patients who underwent open surgery in the same period are summarized in Table 1. The mean ( $\pm$  SD) age of patients in the laparoscopic and open groups was  $46.74 \pm 1.37$  and  $45.33 \pm 1.25$  years, respectively, and 58% were male (both groups). Hypertension was the most frequent comorbidity among the patients, the majority of whom were diagnosed by health examination. The physical condition of the 2 groups was similar according to evaluation of ASA fitness grade ( $P > 0.05$ ).

### Characteristics of Liver HC

The number and maximum size of HCs, distribution of lesion(s), and HC type classification are shown in Table 2. Single HC lesions were slightly more common than multiple HC lesions in both groups ( $P > 0.05$ ). Thirty percent of patients in the laparoscopic group exhibited a maximum HC diameter  $> 10$  cm, while this figure was 35% in the open group; however, the difference was not statistically significant ( $P > 0.05$ ). The majority of HC lesions were located in the right liver lobe and caudate lobe, which carry higher surgical risks. The location and distribution of HCs was similar



**FIGURE 4.** Flowchart of managing strategies in patients with liver complicated hydatid cysts (HCs) via laparoscopic procedure. CL indicates cystic lesion.

**TABLE 1.** Shows the Demographic Characteristics of Complicated Liver HC Patients in Laparoscopic Group and Open Group

	Laparoscopic Group (n = 50)	Open Group (n = 100)	P
Age (mean ± SD) (y)	46.74 ± 1.37	45.33 ± 1.25	0.529
Sex (male) (%)	29,58	58,58	1.00
BMI (median)	28	28	0.742
Comorbidities			0.478
Diabetes	3	5	
Hypertension	12	13	
Low serum protein	5	4	
COPD	1	3	
Other organs HC	1	5	
Coronary heart disease	1	4	
Previous abdominal operation history	12	18	0.386
Initial reasons for treatment			0.943
Checkups	34	59	
Fever	1	1	
Abdominal pain	16	35	
Fatigue	1	3	
Jaundice	1	2	
ASA fitness grade			0.877
I-II	42	83	
III	8	17	
IV	0	0	

ASA indicates American Society of Anesthesiologists classification; BMI, body mass index; HC, hydatid cyst.

between the 2 groups ( $P > 0.05$ ). There were 42 (84%) and 86 (86%) active HC patients in the laparoscopic and open groups, respectively ( $P > 0.05$ ).

**Perioperative Results**

Of 33 (66%) patients who underwent total cystectomy in the laparoscopic group, 67% were in the open group,

**TABLE 2.** Shows the Location, Classification, Characteristics of Liver HC in Laparoscopic Group and Open Group

	Laparoscopic Group (n = 50)	Open Group (n = 100)	P
Amount of HC			0.483
Single lesion	27	60	
Multiple lesion	23	40	
Maximum diameter of HC (cm)			0.54
5-10	35	65	
> 10	15	35	
Segments involved			0.856
I	5	8	
II, III, IV	15	37	
V, VI	18	33	
VII, VIII	12	22	
Type of cyst			0.942
CL	17	30	
CE-1	11	21	
CE-2	12	30	
CE-3	2	5	
CE-4-CE-5	8	14	

CL indicates cystic lesion; HC, hydatid cyst.

**TABLE 3.** Shows the Perioperative Outcomes Between Laparoscopic Group and Open Group

	Laparoscopic Group (n = 50)	Open Group (n = 100)	P
Types of surgical procedure performed			0.541
Total pericystectomy	33	67	
Subtotal pericystectomy	5	15	
Hepatectomy	12	18	
Decompression			0.416
Yes	12	28	
No	38	64	
Hepatic inflow occlusion			0.641
Yes	27	58	
No	23	42	
Average operation time (median) (min)	200	180	0.015
Blood loss volume (mL)			0.35
< 500	43	91	
≥ 500	7	9	
Transfusion rate (%)	12	7	0.21
Postoperative hospital stays (d)	7.66 ± 3.0	9.16 ± 4.65	0.00
Postoperative time to first flatus (median) (d)	2	3	0.00
Average removal time of peritoneal drainage tube (median) (d)	5.5	7	0.00
Conversion to open surgery	1	0	
Overall mortality	0	0	
Postoperative recurrence	0	0	
Postoperative complications (Dindo-Clavien classification)	n = 8	n = 29	0.770
Grade I	3	10	
Grade II	2	11	
Grade III	3	8	
Type of complication			
Pneumonia	1	6	
Reactive pleural effusion	2	5	
Damage of liver function	2	4	
Residual cavity fluid collection	1	4	
Bile leakage	0	2	
Abdominal infection	0	1	
Intraperitoneal hemorrhage	0	1	
Pneumothorax	1	2	
Port site/incision infection	1	4	

Postoperative complications were assessed by the Dindo-Clavien classification (I to IV).

indicating that not all patients are suitable for total pericystectomy. Hepatic resection was the second major option for HC treatment in both groups (Table 3). Among these, 3 patients underwent left hepatectomy, 4 left lateral sectionectomy, and 5 segmentectomy in the laparoscopic group, while 15 underwent right hepatectomy, 1 left lateral sectionectomy, and 2 segmentectomy ( $P > 0.05$ ).

Subtotal cystectomy was performed in patients with higher surgical risk. Decompression was used in 12 patients with high-pressure cysts in the laparoscopic group and 28 in the open group. Hepatic inflow occlusion was used for hepatic resection or intraoperative bleeding in both groups ( $P = 0.641$ ). The average operation time was longer in the laparoscopic group than in the open group ( $P = 0.015$ ), with median values of 200 versus 180 minutes, respectively. Blood loss in the 2 groups was recorded as follows: laparoscopic group, <500 mL (n=43),

$\geq 500$  mL ( $n=7$ ); open group,  $<500$  mL ( $n=91$ ),  $\geq 500$  mL ( $n=9$ ) ( $P=0.350$ ). The transfusion rate was higher in the laparoscopic group than in the open group; however, the difference was not statistically significant ( $P=0.210$ ). The mean length of postoperative hospital stays for patients in the laparoscopic group was  $7.66 \pm 3.0$  versus  $9.16 \pm 4.65$  days in the open group. Mean postoperative time to first flatus was 2 days in the laparoscopic group versus 3 days in the open group, and median time to removal of the peritoneal drainage tube was 5.5 versus 7 days in the laparoscopic and open groups, respectively. Postoperative recovery was significantly shorter in the laparoscopic group than in the open group ( $P<0.05$ ).

### Mortality and Morbidity

No postoperative death was observed in either group, and no major complications were observed in the laparoscopic group. One patient was converted to open surgery because a large HC lesion was located in segment VIII, which carries a high surgical risk and could not be controlled laparoscopically. Eight (16%) patients experienced postoperative complications in the laparoscopic group and 29 (29%) in the open group. Dindo-Clavien grade I, grade II, grade III complications occurred in 3, 2, and 3 patients in laparoscopic group, and in 10, 11, and 8 in the open group, respectively. Although complication rates were higher in the open group than in the laparoscopic group, the difference was not statistically significant ( $P=0.770$ ), suggesting similar postoperative complication rates between the 2 groups. No patients experienced recurrence of liver HC during the follow-up period.

### DISCUSSION

Liver HC is a chronic condition characterized by its slow development and is asymptomatic in the early stages.<sup>17</sup> In most cases, patients seek medical treatment only when HC develops to an advanced stage(s) or significant clinical manifestations occur; however, complicated liver HC poses significant technical challenges to curative surgery.<sup>18</sup> Significant progress in PAIR,<sup>19</sup> albendazole-based medication,<sup>20</sup> and surgery<sup>21</sup> has been reported in the literature; however, radical surgery is still regarded to be gold standard for HC treatment. Radical surgery, such as total cystectomy, subtotal cystectomy and liver resection, can achieve curative outcome(s).

Laparoscopic procedures for liver HCs was previously regarded to be contraindicated due to the possibility of uncontrolled bleeding and cyst fluid spillage.<sup>22</sup> However, with ongoing advances in the concepts of minimally invasive surgery, and improvements in laparoscopic device technology and surgical approaches to hepatic surgery, the number of reports describing laparoscopic procedures for the treatment of liver HC have gradually increased.<sup>23,24</sup> The majority of previous studies were published as case reports or clinical trials with small sample sizes, and the surgical procedures did not appear to be radical in nature and, as such, are technically safe and generally easy to perform.<sup>25</sup> Although a few studies that compared open versus laparoscopic surgery with longer-term follow-up have been published,<sup>26</sup> radical laparoscopic surgery for liver HC is rare and restricted to selected patients.<sup>27,28</sup> Therefore, the feasibility and safety of laparoscopic total cystectomy for complicated liver HC with high technical risks remain unclear.

In the present study, 50 complicated liver HC patients who underwent laparoscopic radical surgery were compared with

100 matched patients who underwent open surgery, with a 1-year follow-up. One-half of the patients in the laparoscopic group had organic comorbidities and a history of abdominal surgery. There were 23 cases with multiple HC lesions and 15 with a maximum HC diameter  $>10$  cm. In addition, the majority of hepatic lesions were located in dangerous segments that were difficult to expose, which increased surgical risk(s) and morbidity. However, in our center, preoperative 3-dimensional liver reconstruction is routinely performed to comprehensively and precisely assess anatomic features. In addition, combined with intraoperative laparoscopic ultrasonography to confirm margins and local features of the lesion, it not only contributes to avoiding injury of intrahepatic vessels but also prevents missing the HC lesion. Such measures are helpful in accurately evaluating potential surgical risks and hardships to establish alternative management strategies and minimizing risks.

Of the 66% of patients who underwent total cystectomy, 10% underwent subtotal cystectomy in the laparoscopic group. These promising results, however, are contingent on several factors. Hepatic surgeons must not only be proficient in laparoscopic techniques, but also possess rich experience with open surgery for liver HC, which follows the basic principles of prevention of HC spillage, obliteration of the remaining cyst cavity, and prevention of postoperative complications. Skilled operators select the most reasonable surgical options if total cystectomy is difficult, and decisively perform subtotal pericystectomy, if needed, after decompression. Forced procedures for total pericystectomy may increase the risk for additional injury and surgical risk. Hepatectomy is more suitable for HCs with thin cystic wall(s), and will avoid rupture during continuous dissection.

In the present study, 24% of patients underwent decompression using a novel custom-made laparoscopic rotary cutter and aspirator, which is capable of suctioning cyst contents through a small incision on the surface of particularly large HCs, or those with high-pressure or inaccessible locations, thus making it easy to completely remove cyst fluid. Needle aspiration is not recommended for CE2 type HCs because needles can easily be clogged by daughter cyst(s) in the primary cyst. The open site of the HC was sutured immediately after decompression to respect cystic wall integrity. The potential space between the normal hepatic parenchyma and pericyst tissue becomes looser and clearer. It is helpful to identify the traffic branches of vessels from HC and remove the HC entirely along this space.

Hepatic inflow occlusion was used only for uncontrolled bleeding. A low-risk procedure was performed without the need for portal clamping. The average operation time in the laparoscopic group was longer than that in the open group, which may have at least 2 explanations. First, cooperation between the assistant and operator is often less than ideal due to the long learning curve of the procedure; however, such a problem is addressed quickly by intensive training and increased experience of the surgical team. Second, all patients enrolled in the present study had complicated HC, thus resulting in longer cystectomies. However, the volume of blood loss and transfusion rate were similar between the 2 groups. Intraoperative bleeding was well-controlled by proper portal clamping, a clearly enlarged operative field, and exquisite manipulation.

Postoperative hospital stays, postoperative time to first flatus, and average time to removal of the peritoneal drainage tube in the laparoscopic group were significantly shorter than those in the open group. Our results are in accordance with a report from Bayrak and Altintas.<sup>29</sup> Such early recovery is closely related to the advantages of laparoscopy, including less surgical trauma, little-to-no influence on organic immunity,

and homeostasis. No deaths or recurrences were observed during the follow-up period. Well-controlled intraoperative bleeding and bile leakage were observed in the laparoscopic group because laparoscopy provides better visual control of the cyst cavity under magnification, which enables better detection of the biliary fistula.

There was no significant difference in postoperative complications between the 2 groups. This indicated that laparoscopic surgery could yield satisfactory postoperative outcomes similar to open surgery; however, laparoscopic surgery has the merit of earlier recovery, less negative influence on the body, and better esthetic outcomes. The general physical condition of the patient, features of the HC, experience of the hepatic surgeon with HC treatment, and high-quality laparoscopic liver instruments are critical factors for successful laparoscopic cystectomy. We believe that continuous accumulation of experience with laparoscopic liver surgery could complement and overcome some of the limitations of open surgery. Longer-term, prospectively designed, larger-scale cohort studies are needed to confirm long-term outcomes.

### CONCLUSIONS

Laparoscopic close total cystectomy demonstrated improved mid-term outcomes compared with open surgery for the majority of patients with complicated HC. Regarding particularly large liver HCs with high surgical risk, satisfactory outcomes could be achieved by laparoscopic open total cystectomy or subtotal cystectomy based on decompression. With the accumulation of experience, the laparoscopic approach appears to be a viable alternative option for liver HC treatment.

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