World J Surg (2019) 43:3120–3127
https://doi.org/10.1007/s00268-019-05154-0

ORIGINAL SCIENTIFIC REPORT WITH VIDEO

Laparoscopic Central Bisectionectomy and Right Anterior Sectionectomy Using Two Retraction Methods: Technical Aspects with Video

Il Han Jeung[1] · Sung Hoon Choi[1] · Seungki Kim[1] · Sung Won Kwon[1]

Published online: 6 September 2019

Abstract

Background Laparoscopic central bisectionectomy and right anterior sectionectomy for centrally located tumors are technically demanding surgeries. Here, we introduce our laparoscopic technique and present the associated perioperative outcomes relative to an open approach.
Methods From April 2014 to November 2017, 26 patients underwent central bisectionectomy or right anterior sectionectomy. A total of 17 patients underwent the laparoscopic approach and nine underwent an open approach. We used a perihilar Glissonian approach to determine each anatomical resection plane and employed a rubber band self-retraction technique to ensure proper exposure of the two resection planes. Detailed descriptions, illustrations, video, and perioperative outcomes of the approach are presented.
Results Among patients who underwent the laparoscopic approach, there were no cases of conversion to open surgery. The mean operative times for the laparoscopic and open groups were similar (333 ± 76 vs. 305 ± 62 min, respectively, $p = 0.345$). Intraoperative blood loss (535 ± 443 vs. 966 ± 650, $p = 0.056$) and postoperative complications (1 vs. 3, $p = 0.065$) were slightly less in the laparoscopic group, but the difference was not statistically significant. Surgical margins of both approaches were comparable (0.8 ± 0.6 vs. 0.7 ± 0.2 cm, $p = 0.671$). The length of hospital stay after surgery was significantly shorter in the laparoscopic group (8.8 ± 2.6 vs. 17.1 ± 12.7 days, $p = 0.015$).
Conclusion The laparoscopic approach for central bisectionectomy and right anterior sectionectomy described in this study is feasible and safe with respect to short-term perioperative outcomes and may provide several benefits commonly attributed to minimally invasive surgery in selected patients.

Introduction

Although the indications for laparoscopic liver resection (LLR) have been gradually expanding due to an accumulation of experience and development of new instruments, it remains a developing field [1, 2]. Consistent with other types of laparoscopic surgeries, many case series have demonstrated that LLR offer several advantages over open procedures [3, 4]. However, the difficulty of each LLR procedure depends largely on tumor location, status of liver disease, extent of liver resection, and the proximity to major vessels, among other factors [5]. In particular,

This paper was presented as an oral presentation at EAES 2018 (26th international Congress of the European Association for Endoscopic Surgery) London, England.

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s00268-019-05154-0) contains supplementary material, which is available to authorized users.

✉ Sung Hoon Choi
feel415@cha.ac.kr

[1] Department of Surgery, CHA Bundang Medical Center, CHA University, Cancer Research Building #524, 59 Yatap-dong, Bundang-gu, Seongnam-si, Gyeonggi-do 463-712, Korea

laparoscopic central bisectionectomy (CBS) and right anterior sectionectomy (RAS) for centrally located tumors (CLTs) are both classified as advanced and complex surgical procedures due to high postoperative morbidity as well as poor intraoperative outcomes [6]. Therefore, only a few case series of laparoscopic anatomical hepatectomy for centrally located tumors (CLTs) have been reported; thus, safety and feasibility have not been established yet [7–10]. The purpose of this study was to evaluate the feasibility and safety of CBS and RAS conducted laparoscopically compared with open surgery and to share our technical expertise.

Methods

Patients information and method

Medical records of all patients who underwent hepatectomy in a prospectively collected database were retrospectively reviewed. A total of 26 patients underwent central bisectionectomy (CBS) or right anterior sectionectomy (RAS) by a single surgeon at a single institution between March 2014 and January 2018. CBS refers to anatomical resection of segments 4, 5, and 8, while RAS refers to resection of segments 5 and 8. A total of 17 patients underwent laparoscopic surgery and nine underwent open surgery. The covariates of the two groups were unequal, and the number of cases was too small to allow for matching of variables between groups. Therefore, we simply compared perioperative outcomes to assess the feasibility and safety of laparoscopic approach for CBS and RAS for CLTs.

Preoperative evaluations of patient were discussed at a multidisciplinary team meeting. Surgical indications included patients with an American anesthesiologists performance score class less than 2 and preserved liver function (Child–Turcotte–Pugh class A) [11]. The decision for open or laparoscopic approach was made by the surgeon based on consideration of history of previous upper abdominal surgery, proximity of the tumor to major vascular or biliary structures, and severity of liver cirrhosis.

Central venous pressure (CVP) was maintained at or below 5 mm H_2O during parenchymal transection.

Postoperative complications were graded according to the Dindo–Clavien–Strasberg classification system [12]. Postoperative mortality was defined as death within 90 days of surgery [13]. Postoperative bile leakage [14], ascites [15], and liver failure [16] were graded according to the International Study Group of Liver Surgery guidelines.

Statistical analysis

Continuous variables were reported as the mean and compared using Student's *t* test. Categorical variables were compared using the Chi-square test. Data were considered statistically significant at $p < 0.005$. Statistical analyses were conducted using the Statistical Package for Social Science for Windows™ release 21.0 (SPSS Inc., Chicago, IL, USA).

Surgical procedures (supplemental video)

1. Patient position and trocar placement (Fig. 1)

The patient is placed in the reverse Trendelenburg position with right side tilted up on the operating table after general anesthesia. The surgeon and scopist stand at the left side of the patient and an assistant at the right side of the patient. Proper exposure of two different resection plane guarantees the success of these operations. Particularly, the second resection plane, coincident with the right hepatic vein, is located deep in the posterior. Therefore, the laparoscopic camera trocar is inserted into the right abdomen about 3 to 4 cm apart from the umbilicus for proper visualization of the second resection plane (Fig. 1). The abdominal cavity is explored by laparoscope through the trocar. First, a virtual line is drawn assuming that the second resection plane is aligned in a straight line with laparoscopic camera view after liver mobilization and retraction. A 12-mm and a 5-mm trocars are inserted at about 45° on bilateral sides of the virtual line. The 12-mm trocar is used for the laparoscopic Cavitron Ultrasonic Surgical Aspirator (CUSA®; Valleylab, Boulder, CO, USA), and as the shaft of the instrument is relatively short the 12-mm trocar is

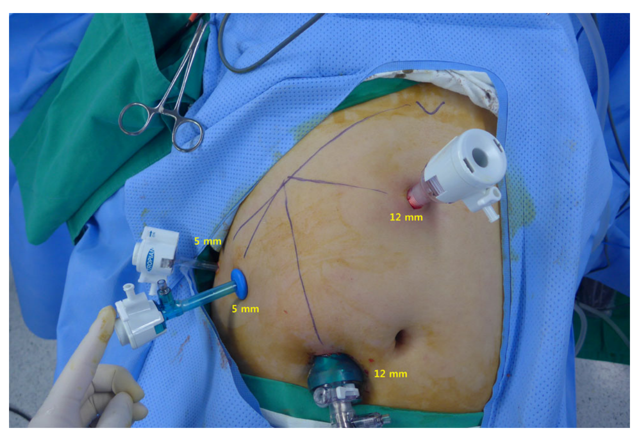

Fig. 1 Trocar placement. The laparoscopic camera trocar is inserted at the right abdomen about 3 to 4 cm apart from the umbilicus for proper visualization of the second resection plane. Two working trocars are positioned at 45° left and right around the imaginary line of the resection plane. An additional 5-mm trocar located on the right flank

placed at the subxiphoid area high enough so that the laparoscopic CUSA is able to reach all the resection planes. An additional 5-mm trocar is added at right flank to help with retraction.

2. Liver mobilization (Fig. 2)

The falciform ligament and the right side of liver are fully mobilized up to the right side of vena cava for the retraction of the liver. Sufficient mobilization helped to lift up the right lobe, and by moving it medially by retraction methods allowed adequate access to the deep lateral surgical plane. During the liver mobilization, progressive force and gentle traction are important, so the operator directly controls the snake retractor with his right hand to perform medial traction (Fig. 2a). Dissection is performed through the right flank 5-mm trocar using monopolar hook coagulator with his left hand (Fig. 2b).

3. Isolation of the right main Glissonian pedicle (Fig. 3)

Isolation of the Glissonian pedicle is essential for determining the resection plane. To achieve access to the Glissonian pedicle, we first performed cholecystectomy. Next, we isolated the Glissonian pedicle. In CBS, it is important to not be overly aggressive during the resection because laparoscopic isolation of the anterior Glissonian pedicle is sometimes difficult due to variables during the division and limited range of motion of the laparoscopic instruments. Therefore, we considered it easiest and safest to isolate the right anterior Glissonian pedicle after division of the first parenchymal resection plane exposing the right main Glissonian pedicle. On the other hand, with respect to RAS, the right main Glissonian pedicle should be isolated to delineate the first resection plane. A small incision is made on the liver serosa just above and below the hilar plate using an electrocautery. The serosal openings and intrahepatic parenchyma surrounding the Glissonian pedicles are gently widened using 10-mm 60° dissecting forceps. A Goldfinger™ (Ethicon, Endo-surgery, Cincinnati, OH, USA) with nylon tape is then passed through the opening heading to the other side (Fig. 3). The right Glissonian pedicle is then looped with the nylon tape.

4. Preparation of Pringle's maneuver (Fig. 4)

We designed a homemade laparoscopic tourniquet using an 11 French nelaton catheter with a 5-cm-long metal bar at one end and a bend at other end to create an ear that could pass through the metal bar (Fig. 4). The metal bar made it easier to encircle the hepatoduodenal ligament. When Pringle's maneuver is needed, the tourniquet can be tightened and fixed with a bulldog clamp (Fig. 5a). However, there are several methods of Pringle's maneuver both intracorporeally and extracorporeally, which could be personalized by their preference.

5. Rubber band self-retraction method

CBS and RAS both have two extensive transection areas. However, the two operations differ with respect to the first resection plane, located at the right side of the umbilical fissure and Cantlie's line, but, respectively, share the same second resection plane along the right hepatic vein. In CBS, the first resection line is simply along the right side of the umbilical fissure. However, in RAS, the first resection line is along the ischemic zone on Cantlie's line created by the occlusion of the previously looped right Glissonian pedicle using a bulldog clamp. When the resection line is demarcated on the liver surface, both edges of the demarcation line are sutured with elastic rubber bands, which are pulled out bilaterally using a 2-mm laparoscopic forcep called BJ needle® (NITI-ON Co., Ltd., Chiba, Japan) or Berci fascial closure® (Karl Storz, Tuttlingen, Germany) through mini-skin incisions on lateral side of the 2 main working trocars [17].

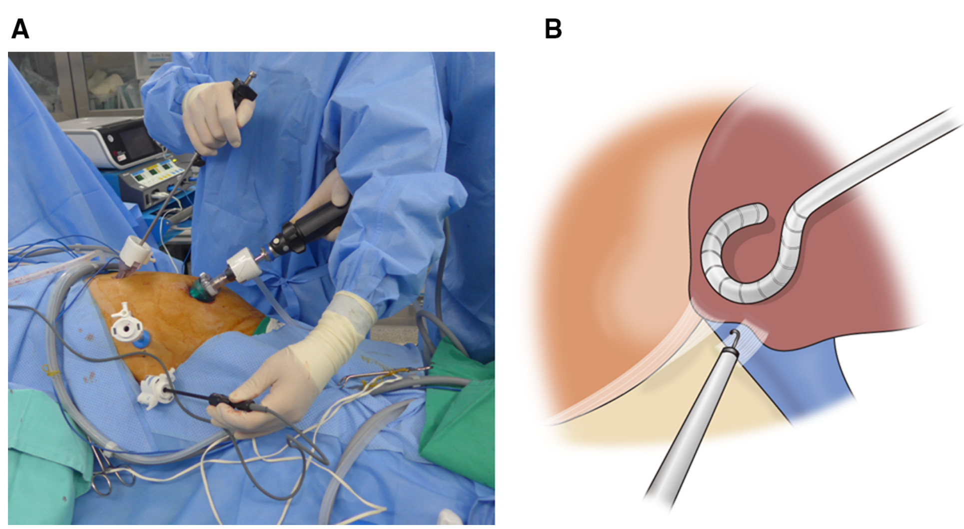

Fig. 2 Liver mobilization. Medial traction of liver is achieved by having the operator directly control the snake retractor with his right hand (**a**). Dissection proceeds through the right flank 5-mm trocar using a monopolar hook coagulator held in the operators left hand (**b**)

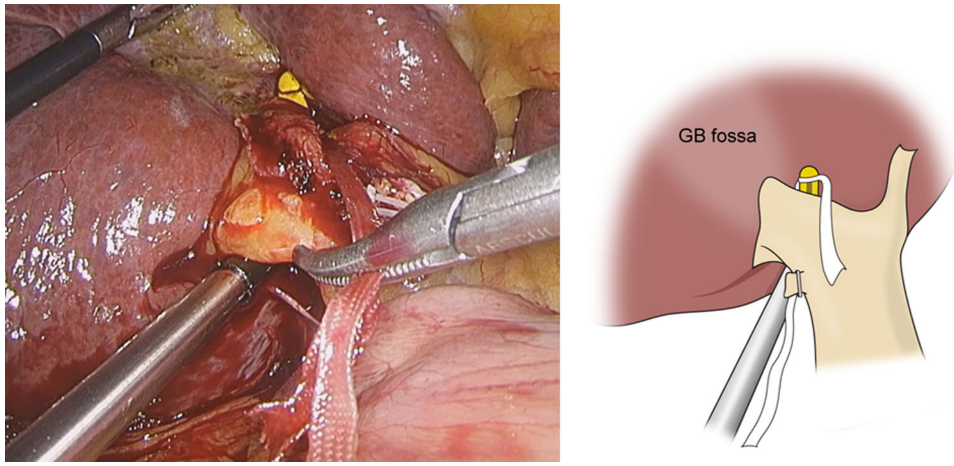

Fig. 3 Isolation of the right main Glissonian pedicle. A small incision is made on the liver serosa just above and below the hilar plate using an electrocautery. The serosal openings and intrahepatic parenchyma surrounding the Glissonian pedicles are gently widened using 10-mm 60° dissecting forceps. A Goldfinger™ with nylon tape is then passed through the opening heading to the other. *GB fossa* gallbladder fossa

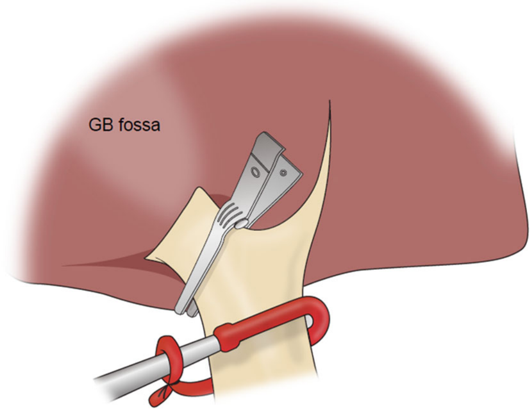

Fig. 4 Homemade laparoscopic tourniquet for Pringle's maneuver. A homemade laparoscopic tourniquet is designed using an 11 French nelaton catheter with a 5-cm-long metal bar at one end and a bend at other end to create an ear that could pass through the metal bar. The tourniquet can be tightened and fixed with a bulldog clamp

6. Parenchymal transection of the first resection plane

Superficial serosal and parenchymal division is carried out with Thunderbeat® (Olympus Medical System Corp. Tokyo, Japan) ultrasonic vibration power. Deep parenchymal transection is performed using a laparoscopic CUSA and laparoscopic bipolar coagulator (FineBlade™, LAGIS®, Taiwan). As the parenchymal division progresses deeper, the elastic power of the rubber band retraction automatically and gradually expands the resection planes. The first parenchymal transection is continued up to the junction of the middle hepatic vein and left hepatic vein in CBS, and the vena cava between the middle hepatic vein (MHV) and right hepatic vein (RHV) in RAS.

7. Isolation of the right anterior Glissonian pedicle (Fig. 6)

The hilar plate is fully exposed after complete transection of the first resection plane, subsequently allowing for safe and easy isolation of the right anterior Glissonian

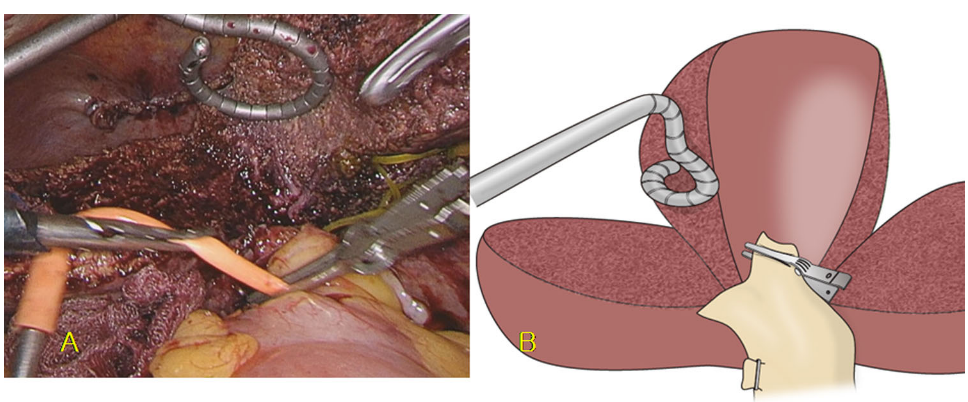

Fig. 5 Additional traction during the second parenchymal transection. As the liver parenchyma is divided, the specimen side becomes redundant and tilts forward. Therefore, the resection plane does not widen sideways and become poorly exposed. Then, the specimen side is pushed medially using a snake retractor. This traction helped to lift up and widen the right deep lateral surgical plane, moving it medially

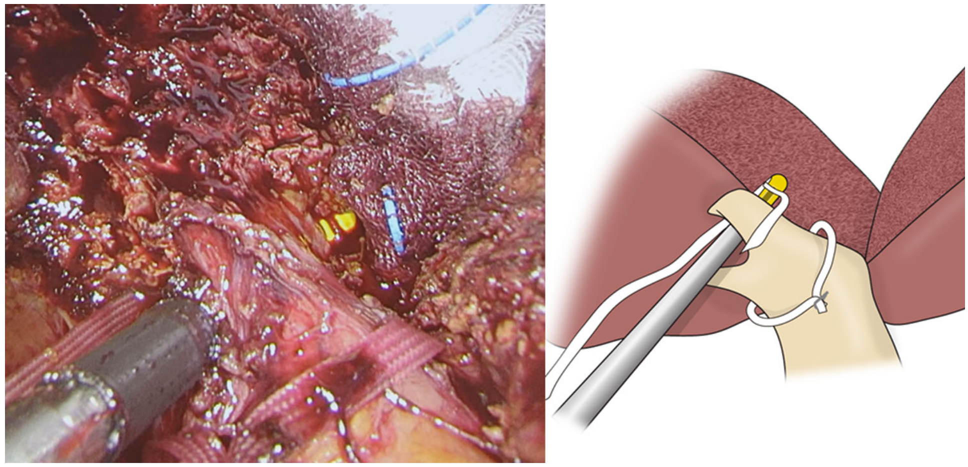

Fig. 6 Isolation of right anterior Glissonian pedicle. The hilar plate is fully exposed after complete transection of the first resection plane, subsequently allowing for safe and easy isolation of the right anterior Glissonian pedicle. A small serosal incision is made between the bifurcation of the right main Glissonian pedicle and the Goldfinger™ with a nylon tape is gently passed through the serosal opening to the exposed suprahilar area

pedicle. A small serosal incision is made between the bifurcations of the right main Glissonian pedicle. The Goldfinger with a nylon tape is gently passed through the serosal opening to the exposed suprahilar area. The right anterior Glissonian pedicle is looped and clamped using a laparoscopic bulldog clamp to verify the second resection plane, and the ischemic area of the right anterior sector is evaluated. The right anterior Glissonian pedicle is divided using a vascular endoscopic stapler (45-mm Tan cartilage, Endo GIA™, Covidien, Mansfield, MA, USA) after full exposure of the clamped pedicle during the second parenchymal transection.

8. Parenchymal transection of the second resection plane (Fig. 5)

Once the second resection line is established, another rubber band self-retraction method is applied at both edges of the resection line in the same manner, and the sutured rubber bands are pulled out using the two small skin incisions made previously and fixed on the operative drape with mosquito clamps. As the liver parenchyma is divided, the specimen side becomes redundant and the resection plane does not widen sideways, but rather tilts forward and becomes poorly exposed. Therefore, it is important to perform medial traction of the specimen at this time. To gain traction, we use a snake retractor to push the specimen side medially through the right flank 5-mm trocar (Fig. 5). In RAS, the specimen is removed by completing the parenchymal transection to the roots of the MHV and RHV. Likewise, in CBS, the specimen can be removed by dividing the MHV using a laparoscopic vascular stapler. Finally, the specimen is retrieved using a plastic bag through a Pfannenstiel skin incision.

Results

Table 1 shows the characteristics and operative data of the study patients. By chance, the open approach was performed only in male patients. The proportion of hepatocellular carcinoma was relatively high in the laparoscopic group. Other characteristics were similar between the two groups. Table 2 shows the perioperative outcomes. There was no conversion to open surgery in the laparoscopic group. The mean operative times of the laparoscopic and open approaches were comparable (333 ± 76 vs. 305 ± 62 min, respectively, $p = 0.345$). Intraoperative blood loss (535 ± 443 vs. 966 ± 650, $p = 0.056$) and postoperative complication (1 vs. 3, $p = 0.065$) were slightly less in the laparoscopic group, but the difference was not statistically significant. Surgical margins were comparable between the laparoscopic and open groups (0.8 ± 0.6 vs. 0.7 ± 0.2 cm, $p = 0.671$). The length of hospital stay after surgery was significantly shorter in the laparoscopic group (8.8 ± 2.6 vs. 17.1 ± 12.7 days, $p = 0.015$).

Discussion

Although the indications for laparoscopic liver resection have expanded, laparoscopic CBS and RAS continue to be regarded as highly advanced laparoscopic procedures [6]. The difficulty of laparoscopic liver resection is largely dependant on tumor location, visibility of the plane of resection, relationship between major vessels and the Glissonian pedicle, and extent of parenchymal resection needed. Need for extensive parenchymal resection surface during anatomical liver resections and poor visualization of the resection plane are the main causes of difficulty encountered during the laparoscopic approach for CBS and RAS.

Table 1 Patients' characteristics and operative data

	Laparoscopic group (n = 17)	Open group (n = 9)	p value
Age (years, median)	56 (30–81)	55 (42–71)	0.936
Gender (male/female)	10:7	9:0	0.024
Liver cirrhosis	14 (82.4%)	5 (55.6%)	0.291
Diagnosis			0.049
HCC	13 (76.5%)	4 (44.4%)	
CCC	0	3 (33.3%)	
Combined HCC–CCC	2 (11.8%)	0	
Liver metastasis of colon cancer	1 (5.9%)	2 (22.2%)	
Intrahepatic duct stone	1 (5.9%)	0	
Largest tumor size (cm, mean ± SD)	3.4 ± 1.6	2.9 ± 2.6	0.651
Multiple tumors (n)	6 (35.3%)	5 (55.6%)	0.320
Operation			0.500
Central bisectionectomy	9 (52.9%)	6 (66.7%)	
Anterior sectionectomy	8 (47.1%)	3 (33.3%)	

HCC hepatocelluar carcinoma, *CCC* cholangiocellular carcinoma, *BMI* body mass index, *SD* standard deviation

Table 2 Perioperative outcomes

	Laparoscopic group (n = 17)	Open group (n = 9)	p value
Open conversion	0	–	
Operative time (min, mean ± SD)	334 ± 76	305 ± 62	0.345
Estimated blood loss (ml, mean ± SD)	535 ± 443	966 ± 650	0.056
Blood transfusion (yes)	8 (47.1%)	5 (55.5%)	0.680
Postoperative complications (n, > grade II)	1 (5.9%)	3 (33.3%)	0.065
Wound seroma	1	0	
Ascites	0	2	
Biloma	0	1	
Postoperative hospital stay (day, mean ± SD)	8.8 ± 2.6	17.1 ± 12.7	0.015
Surgical margin (cm, mean ± SD)	0.8 ± 0.6	0.7 ± 0.2	0.671

SD standard deviation

The scoring system suggested by Ban et al. [5] classified laparoscopic liver resection by CBS and RAS as having a high level of difficulty considering five factors, namely tumor location, extent of liver resection, tumor size, proximity to major vessels, and effect on liver function. Recently, Kawaguchi et al. [6] also scored CBS and RAS as having a high level of difficulty based on poor intraoperative and postoperative outcomes. However, the cases that these classifications were based on showed a longer operation time, large amount of blood loss, higher conversion rate, and greater amount of postoperative complications.

Despite the disadvantages described above, parenchyma-preserving CBS and RAS procedures can be associated with decreased rates of postoperative liver failure and faster recovery compared to traditional extended right and left hepatectomy for centrally located tumors [18]. Thus, CBS and RAS are not only attractive surgical options for removing tumor-bearing segments while sparing normal liver tissue but are also oncologically safe in terms of rates of R0 resection and overall survival. Although portal vein embolization (PVE) can induce hypertrophy of future liver remnants to enable safe extended hepatectomy, there are several problems such as complications of PVE itself, time delay during hypertrophy of the future liver remnant, and hypertrophy below expectations [19]. Therefore, CBS and RAS can obviate the inconvenience of PVE and associated morbidities.

CBS and RAS procedures for preserving bilateral liver segments for centrally located tumors should be considered when there is a need for two different transection planes. The major concerns are to delimitate the second resection line that matches the right hepatic vein and expose the transection plane appropriately. This surgical plane, which coincides with the resection plane for the right posterior sectionectomy, is often the reason why the surgery becomes technically difficult. Specifically, there can be poor visualization of the operative field resulting in difficultly controlling bleeding and an extensive parenchymal transection area associated with a high conversion rate [6, 20]. Indeed, we had experienced large amount of blood loss and high transfusion rate during the initial period, when effective exposure techniques have not been established.

We used two methods to ensure proper exposure of the second parenchymal transection field. First, we used a rubber band self-retraction method for automatic and stable bilateral retraction of the liver during the parenchymal transaction [17]. Respective rubber band retraction methods were applied for each surgical plane. This technique provides a very stable retraction environment during parenchymal dissection and allows the operator to freely use both hands, which is important in that allows for the operator to take immediate action against unforeseen situations such as bleeding. However, when proceeding to the posterosuperior part of the second parenchymal transection plane, additional traction is required as the central specimen side becomes redundant and narrows the operative field. To address this problem, we used a snake retractor to push the specimen part mediosuperiorly through the right flank 5-mm trocar (Fig. 5). This traction helped to lift up and widen the right deep lateral surgical plane, moving it medially. Even in the open approach for CBS and RAS, the end of the second resection plane takes place in a narrow space inside the ribs, resulting in a poor operative field and difficult operation. Therefore, our methods for exposure of the surgical field using a rubber band self-retraction method and a snake retractor facilitate a safer laparoscopic approach with acceptable operative time as well as comparable intraoperative blood loss and surgical margin compared to open surgery without conversion to laparotomy.

There were fewer complications in the laparoscopic group in our series, while the difference was not statistically significant. This result may have been influenced by selection bias, as the open approach was typically used for more difficult cases.

In conclusion, the laparoscopic approach for CBS and RAS is a demanding procedure with a long operative time. However, it is feasible and safe in regard to short-term perioperative outcomes, and in select patients it may provide several benefits commonly attributed to minimally invasive surgery.

Acknowledgements The authors would like to express special thanks to Yoon Jang (Medical student, CHA medical University, Seongnam, Republic of Korea) for the comprehensive narration of this multimedia article.

Compliance with ethical standards

Conflict of interest Dr. Il Han Jeung, Sung Hoon Choi, Seungki Kim, and Sung Won Kwon have no conflicts of interest or financial ties to disclose.

References

1. Alkhalili E, Berber E (2014) Laparoscopic liver resection for malignancy: a review of the literature. World J Gastroenterol 20:13599–13606
2. Di Carlo I, Toro A (2015) Is it time to change the standard procedure for hepatocellular carcinoma from an open to a laparoscopic approach? J Am Coll Surg 220:975
3. Schiffman SC, Kim KH, Tsung A et al (2015) Laparoscopic versus open liver resection for metastatic colorectal cancer: a metaanalysis of 610 patients. Surgery 157:211–222
4. Parks KR, Kuo YH, Davis JM et al (2014) Laparoscopic versus open liver resection: a meta-analysis of long-term outcome. HPB 16:109–118
5. Ban D, Tanabe M, Ito H et al (2014) A novel difficulty scoring system for laparoscopic liver resection. J Hepatobiliary Pancreat Sci 21:745–753
6. Kawaguchi Y, Fuks D, Kokudo N et al (2018) Difficulty of laparoscopic liver resection: proposal for a new classification. Ann Surg 267:13–17
7. Ho CM, Wakabayashi G, Nitta H et al (2013) Total laparoscopic limited anatomical resection for centrally located hepatocellular carcinoma in cirrhotic liver. Surg Endosc 27:1820–1825
8. Machado MA, Kalil AN (2011) Glissonian approach for laparoscopic mesohepatectomy. Surg Endosc 25:2020–2022
9. Yoon YS, Han HS, Cho JY et al (2009) Totally laparoscopic central bisectionectomy for hepatocellular carcinoma. J Laparoendosc Adv Surg Tech A 19:653–656
10. Cho CW, Rhu J, Kwon CHD et al (2017) Short-term outcomes of totally laparoscopic central hepatectomy and right anterior sectionectomy for centrally located tumors: a case-matched study with propensity score matching. World J Surg 41:2838–2846. https://doi.org/10.1007/s00268-017-4105-5
11. Wolters U, Wolf T, Stutzer H et al (1996) ASA classification and perioperative variables as predictors of postoperative outcome. Br J Anaesth 77:217–222
12. Dindo D, Demartines N, Clavien PA (2004) Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 240:205–213
13. Han HS, Shehta A, Ahn S et al (2015) Laparoscopic versus open liver resection for hepatocellular carcinoma: case-matched study with propensity score matching. J Hepatol 63:643–650
14. Koch M, Garden OJ, Padbury R et al (2011) Bile leakage after hepatobiliary and pancreatic surgery: a definition and grading of severity by the International Study Group of Liver Surgery. Surgery 149:680–688
15. Ishii M, Mizuguchi T, Harada K et al (2014) Comprehensive review of post-liver resection surgical complications and a new universal classification and grading system. World J Hepatol 6:745–751

16. Rahbari NN, Garden OJ, Padbury R et al (2011) Posthepatectomy liver failure: a definition and grading by the International Study Group of Liver Surgery (ISGLS). Surgery 149:713–724
17. Choi SH, Choi GH, Han DH et al (2015) Laparoscopic liver resection using a rubber band retraction technique: usefulness and perioperative outcome in 100 consecutive cases. Surg Endosc 29:387–397
18. Lee SY, Sadot E, Chou JF et al (2015) Central hepatectomy versus extended hepatectomy for liver malignancy: a matched cohort comparison. HPB (Oxford) 17:1025–1032
19. van Gulik TM, van den Esschert JW, de Graaf W et al (2008) Controversies in the use of portal vein embolization. Dig Surg 25:436–444
20. Kim WJ, Kim KH, Shin MH et al (2017) Totally laparoscopic anatomical liver resection for centrally located tumors: a single center experience. Medicine (Baltimore) 96:e5560