Chapter

Laparoscopic Hepatectomy

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Abstract

Despite its initial cautious adoption and implementation, laparoscopic liver resection (LLR) has been gaining popularity in recent decades. Over 9000 cases were published in the form of case series [1-4], case-controlled study [5-15] or systemic review and meta- analysis [16-18]. The feasibility and safety of LLR has been demonstrated in the early series [16-18] with less blood loss, blood transfusion rate, less morbidity with shorter hospital stay. Two international consensus meetings were held in Louisville in 2008 [22] and Morioka in 2014 [23], aiming to standardize the practice and improve its safety. Laparoscopic minor liver resection (<2 liver segments) has become the standard practice, especially for lesions in the antero-lateral segments; while laparoscopic major resection (33 segments) is still regarded as in its innovative phase and should be performed in experienced centers. A difficulty scoring system [24] is proposed to assess the complexity of the procedure, based on the tumor location, extent of liver resection, tumor size, proximity to major vessels and liver function. The scoring system was shown to correlate well with the conversion rate, operation time and blood loss. The incidence of post-operative liver failure and mortality rate was higher in the higher difficulty score group [25]. It is recommended that surgeons should begin with low difficulty-level operations. In fact, this offers an objective evaluation and a platform for systematic training of the laparoscopic liver surgeons, which is the setting stone for upholding the standard and safety of the procedure and the popularization of the technique.

Techniques

Anesthesia

Large bore peripheral intravenous access should be obtained to prepare for the possibility of major intra-operative bleeding. By maintaining a low central venous pressure (CVP) of <5mmHg, bleeding from hepatic vein branches during parenchymal transection can be minimized. It is achieved by a combination of minimal fluid resusci-

tation and use of venodilational agents, which is rarely necessary. A minimum intraoperative urine output of 20-25ml/hour is generally well tolerated until the end of the parenchymal transection.

Significant bleeding can occur from the hepatic veins or inferior vena cava. Therefore, the principle of meticulous dissection and individual ligation of the vein branches should be followed. When bleeding occurs, the carbon dioxide (CO_2) pneumoperitoneum can be increased to 15-20mmHg to temporarily slow down the bleeding for application of sutures or clips for definite hemostasis. Though CO2 gas embolism is one of the concerns from raising the intraperitoneal pressure, a recent meta-analysis reported a 0.1% incidence of gas embolism without significant hemodynamic disturbance [26].

At the completion of the parenchymal transection, hemostasis should be checked with lowering the pneumoperitoneal pressure (8-12mmHg) and adequate fluid resuscitation to restore the patient to euvolemic status.

Positioning and Ports

The reverse Trendelenburg position with or without legs apart is a commonly used patient position in LLR [23,27]. In our institute, we adopt the French position with the surgeon standing between the patient's legs [28]. For right hepatectomy, right posterior sectionectomy or resection of lesions in the supero-posterior segments, a wedge support is placed on the patient's right side. By positioning the operating table and with the help of gravity, the liver can be retracted for better exposure.

The setup of the theatre is described in diagram 1.

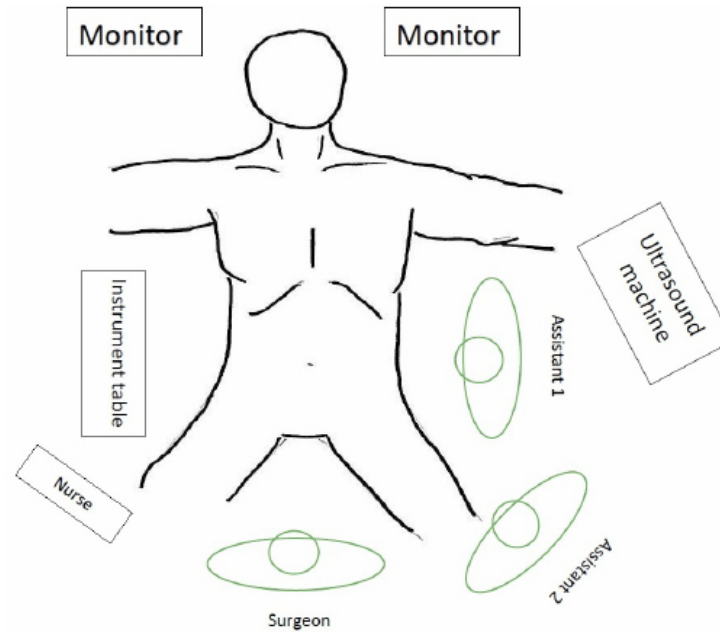

Diagram 1: Theatre set up

Flexible camera is used for all cases of laparoscopic liver resection. It has the advantage of reaching different extremes of angles and avoid being in the same axis with the working instruments.

Four to five ports were used. A 12mm sub umbilical port is used as the camera port and another 12mm port in the right subcostal region is used for intraoperative ultrasound. Ports A and B are the surgeon's working port and the assistant uses ports C and D for retraction (Diagram 2). The specimen is retrieved in a retrieval bag via a Pfannestial incision.

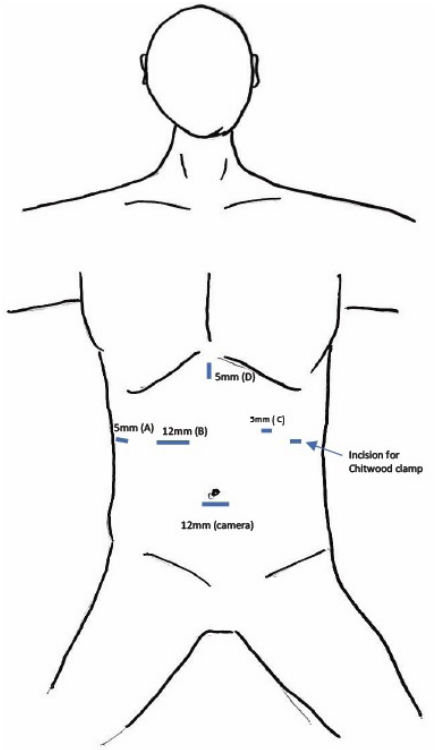

Diagram 2: Trocar placement

The position of the ports is similar for both right and left hepatectomy as the transection line is along the same main portal fissure along the middle hepatic vein. As for right posterior sectionectomy, the right lobe is not mobilized as the coronary and triangular ligaments will serve as a counter-tractional force for exposure of the transection plane (Diagram 3).

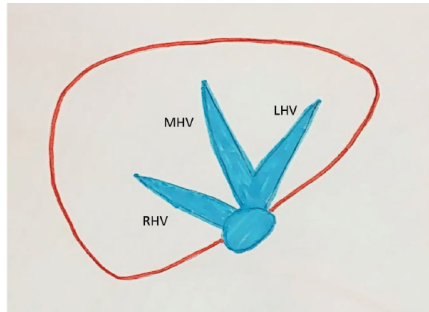

Diagram 3a: Position of RHV before right lobe mobilization

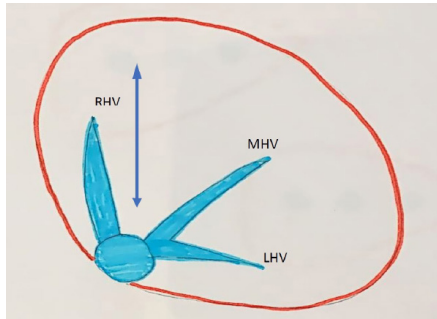

Diagram 3b: Direction of RHV and transection plane after mobilization

Inflow Control

For anatomical resection, the Glissonean approach [29] allows a selective inflow control to the resected area of the liver. It decreases the need for total inflow occlusion by Pringle maneuver and avoids extensive hilar dissection of the hepatic pedicle, which can result in bleeding and devascularization of the biliary duct.

A hepatotomy is made along the expected course of the Glissonean pedicle. With adequate dissection, the pedicle can be encircled and slung with vessel loop. In case of cirrhotic liver, this complete

dissection and encirclement can be difficult. A bulldog vascular clamp can be temporarily applied over the exposed portion of the Glissonean pedicle. Part of the ischemic demarcation is shown and checked with intraoperative ultrasound. Parenchymal transection is then performed along the ischemic line until the whole Glissonean pedicle is exposed, which can be encircled and divided with endostaplers.

Intraoperative fluorescent imaging with indocyanine green (ICG) is another adjunct in better visualization of the ischemic demarcation. ICG is injected intravenously at a dose of 0.5mg/kg after the application of the bulldog clamp. The unperfused liver segments are discerned (diagram 4).

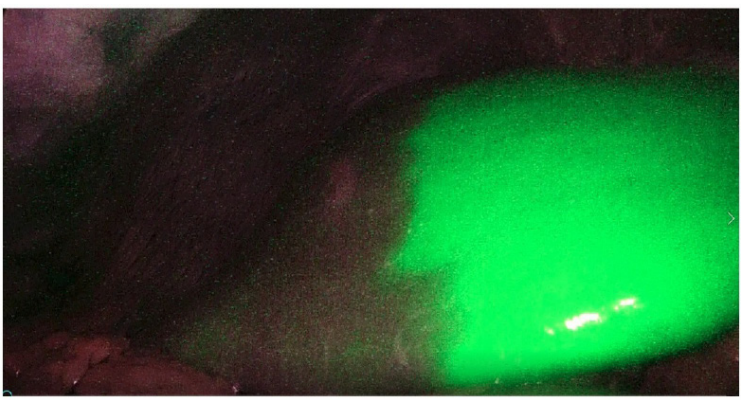

Diagram 4: Intraoperative fluorescent imaging with Indocyanine green (ICG) in right hepatectomy after clamping of right Glissonean pedicle.

Besides, early identification of the major hepatic vein branch guides the plane for anatomical resection. For instance, the right hepatic vein serves as an anatomical landmark for right posterior sectionectomy (diagram 5) and middle hepatic vein for hemihepatectomies [29]. By following the anatomical plane, remnant liver ischemic (RLI) can be minimized. Severe RLI was shown to be associated with

more complications and longer hospital stay. It was also an independent factor for early recurrence and poor overall survival [31].

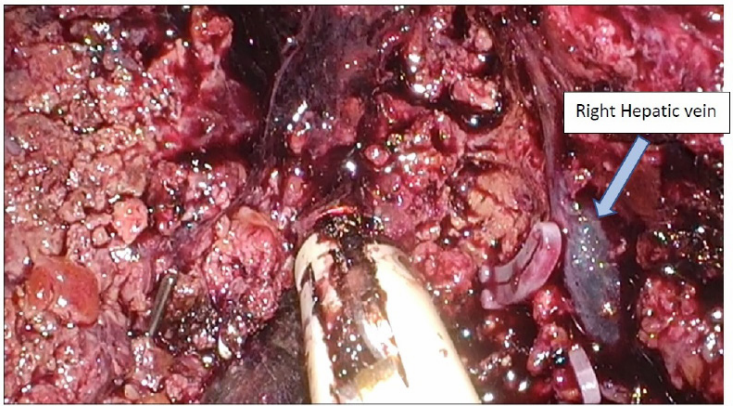

Diagram 5: Right posterior sectionectomy with exposure of the right hepatic vein

Intermittent Pringle maneuver is still an effective method to control bleeding. However, the ischemia and reperfusion injury to the liver can have potential impact on the liver function especially in cirrhotic patients. We do not routinely apply Pringle maneuver in our center. A Chitwood clamp can be inserted transcutaneously over the porta if needed.

Methods of Parenchymal Transection

Numerous surgical techniques and energy devices have been described in the literature for parenchymal transection [32-33]. The Harmonic scalpel®, Cavitron ultrasonic surgical aspirator (CUSA), Ligasure®, bipolar diathermy and Tissuelink® are the commonly used energy devices. Each device has its own merits and the best method of parenchymal transection should be according to the surgeons' famili-

arity with the device and technique. Nonetheless, the principle still lies in effective hemostasis and meticulous dissection and control of individual vessels and bile duct. This can avoid in inadvertent injury to the vessels and bile leak.

On the other hand, intraoperative ultrasound (IOUS) plays a pivotal role in laparoscopic liver resection. It helps in identifying the liver lesion, marking and accessing the adequacy of the resection margin and locating the major vein branches in guiding the resection in hemihepatectomies. In non-anatomical resection, a 'diamond technique' has been described [34]. The resection margin is marked at 1-2cm from the lesion under ultrasound guidance. The transection lines are marked as straight line in a square shape. The depth of transection is frequently checked with ultrasound and the transection line is adjusted to give a semi-diamond 'frustum-shaped' specimen.

Caudal View

The caudal view approach in LLR is different from the anterior approach in open hepatectomy. Other than the visual view, the laparoscopic instruments are working in a caudal-to-cranial direction.

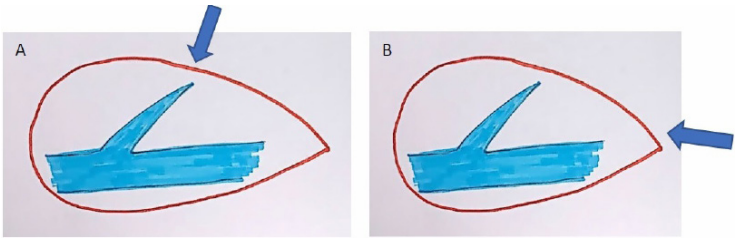

Diagram 6: (a) anterior approach in open hepatectomy (b) caudal approach in laparoscopic liver resection.

With the caudal approach in laparoscopy, if the parenchymal transection is done from anterior surface towards the IVC (as in the anterior approach), it may pose a problem when a vein branch is injured, which will be in the 'valley' of the transection plane. The deep

and buried position of the vein branch makes hemostasis very difficult. Therefore, the transaction should be performed in the 'convex' manner (diagram 7).

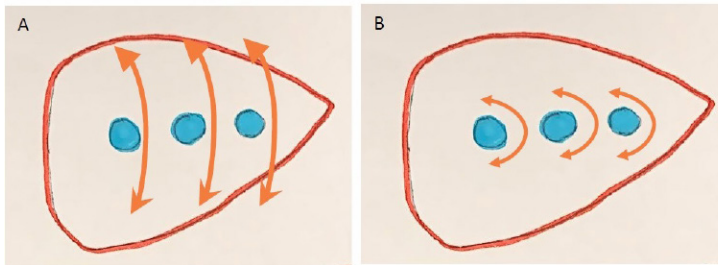

Diagram 7: (A) Anterior approach: injured vessel at the trough (B) Convex manner in "V-shape"

Dissection is done on the anterior surface, followed by the 'undersurface' in a V-shaped. Once a vascular structure or bile duct is identified, it can be easily isolated and clipped. Even a minor injury is made, the vessel can be lifted from the undersurface to slow down the bleeding for further dissection and subsequent hemostasis. This method borrows the concept of Belghiti's hanging maneuver [35]. By lifting up the working area, the transection plane is opened up and the venous backflow bleeding is reduced. It also allows easier identification of the bleeding vessels or bile duct for definitive control [36-37].

Outcomes

Nguyen et al. [38] reviewed a series of 2806 cases worldwide and found that the overall mortality rate for LLR was 0.3%. A number of large volume center series [12,15,39-41] and meta-analysis [42] showed no significant difference in mortality rate in laparoscopic liver resection and open resection.

A number of meta-analyses [42-52] were published in the literature on the perioperative outcomes. LLR was shown to have a significantly less blood loss and transfusion rate, lower complication rates and shorter hospital stay.

Feasibility and safety aside, the long-term oncological outcome is equally important. Achieving a R0 resection margin remains the golden oncological principle. In the systemic review by Ciria et al. [17], R0 resection margin was achieved in 82-100% of the 9000 cases reviewed. The 5-year disease free and overall survival of LLR were comparable with open liver resection [55].

Major Versus Minor

In the Morioka consensus statement in 2014, laparoscopic minor resection is the standard practice, especially for lesions in the antero-lateral segments [23]. Laparoscopic major hepatectomy (LMH) is still regarded as an innovative procedure in its exploration. With gaining experience and improvement in surgical technique and energy devices, increasing number of LMH are now performed in experienced centers.

Careful patient selection and surgical planning remains the core to the success for LMH. The absence of severe portal hypertension, adequate functional reserve and future remnant volume are the pre-requisites. Tumors greater than 5cm, located next to major portal pedicles or IVC, central lesions close to the suprahepatic junctions of major hepatic veins are not the best candidates for LMH.

The amount of blood loss, transfusion rate and R0 resection were comparable for laparoscopic and open resection, while the operating time is significantly longer in LMH. The 5-year disease free and overall survival rates were similar for both groups [53-54]. The comparable short-term and long-term outcomes demonstrated the feasibility and safety of LMH. However, caution has to be exercised in analyzing the results, as the selection criteria for LMH creates an intrinsic difference in the laparoscopic and open group in terms of tumor size and proximity to the major vascular structures. The longer operating time for LMR and an estimated conversion rate of 17.7% (9-42%) reflects the technical challenge and complexity of LMH [54]. Moreover, the comparable major complication rate in LMH is in contrary to the no-

tion that minimally invasive approach has fewer major complications. A potential dilutional effect of the surgeons' learning curve was postulated. CUSUM analysis suggested that the learning curve for LMH included 45 to 75 patients [56]. Further large-scale matched study is recommended to further access the role of LMH.

Limitations

Albeit the enthusiasm and advances in LLR, it has its limitations to overcome.

"Difficult" Segments

The posterior-superior segments are difficult to approach through standard laparoscopic view, which sees the liver from its visceral surface. A large amount of liver parenchyma interposed between the surgeon's view and the operating field. Besides, full mobilization of the right lobe of liver may be needed for exposure and retraction. These difficulty in obtaining access and stable view resulted in longer operative time, difficulty to obtain adequate margins, increased blood loss and higher conversion rates [57]. The transthoracic laparoscopic approach was described to allow direct visualization and operation on the posterior-superior segments [58]. The safety and feasibility were reported in retrospective series [59-61].

Safe Dissemination of LLR

The Morioka consensus meeting proposed a difficulty scoring system to categorize LLR into easy, intermediate and expert levels [23]. It offered an objective way in assessing the complexity of the surgery and it was shown to correlate well with the conversion rate, operation time and blood loss. The incidence of post-operative liver failure and mortality rate was higher in the higher difficulty score group [25]. Increasing numbers of retrospective reviews from large volume centers had demonstrated the safety and feasibility of intermediate and expert level of LLR [53-54]. A stepwise approach in climbing the difficulty ladder is recommended in upholding the standard and safety of the procedure.

Conclusion

Laparoscopic liver resection is shown to have comparable short-term and long-term outcomes as open hepatectomy. With gaining experience and improvement in surgical instruments, more difficult operations can be performed with this minimally invasive approach. Yet, it is important to remember that LLR is an entity that encompasses procedures of different complexity ranging from easy to expert. The challenge ahead will be the standardization of these procedures and propagation of the skills to the younger surgeons.

References

1. Hwang DW, Han HS, Yoon YS, Cho JY, Kwon Y, Kim JH, et al. Laparoscopic major liver resection in Korea: a multicenter study. J Hepatobiliary Pancreat Sci. 2013;20:125-130.
2. Shehta A, Han HS, Yoon YS, Cho JY, Choi Y. Laparoscopic liver resection for hepatocellular carcinoma in cirrhotic patients: 10-year single center experience. Surg Endosc. 2016; 30:638-648.
3. Komatsu S, Brustia R, Goumard C, Sepulveda A, Perdigao F, Soubrane O et al. Clinical impact of laparoscopic hepatectomy: technical and oncological viewpoints. Surg Endosc. 2017; 31:1442-1450.
4. Goh BK, Chan CY, Lee SY, Lee VT, Cheow PC, Chow PK et al. Laparoscopic liver resection for tumors in the left lateral liver resection. JSLS 2016; 20:e2015.00112.
5. Belli G, Limongelli P, Fantini C, D'Agostino A, Cioffi L, Belli A, et al. Laparoscopic and open treatment of hepatocellular carcinoma in patients with cirrhosis. Br J Surg 2009; 96:1041-1048.
6. Truant S, Bouras AF, Hebbar M, Boleslawski E, Fromont G, Dharancy S, et al. Laparoscopic resection vs. open liver re-

section for peripheral hepatocellular carcinoma in patients with chronic liver disease: a case-matched study. Surg Endosc. 2011; 25:3668-3677.

7. Kanazawa A, Tsukamoto T, Shimizu S, Kodai S, Yamazoe S, Yamamoto S et al. Impact of laparoscopic liver resection for hepatocellular carcinoma with F4-liver cirrhosis. Surg Endosc. 2013; 27:2592-2597.

8. Memeo R, de'Anegelis N, Compagnon P, Salloum C, Cherqui D, Laurent A, et al. Laparoscopic liver resection for hepatocellular carcinoma of cirrhotic liver; a case control study. World J Surg. 2014;38:2919-2926.

9. Siniscalchi A, Ercolani G, Tarozzi G, Gamberini L, Cipolat L, Pinna AD, et al. Laparosocpic versus open liver resection: differences in intraoperative and early operative outcome among cirrhotic patients with hepatocellular carcinoma – a retrospective observational study. HPB Surg 2014:871251.

10. Yamashita Y, Ikeda T, Kurihara T, Yoshida Y, Takeishi K, Itoh S, et al. Long-term favorable surgical results of laparoscopic hepatic resection for hepatocellular carcinoma in patients with cirrhosis: a single-center experience over a 10-year period. *J Am Coll Surg* 2014; 219:1117-1123.

11. Luo L, Zou H, Yao Y, Huang X. Laparoscopic versus open hepatectomy for hepatocellular carcinoma: a short- and long-term outcomes comparison. Int J Clin Exp Med 2015; 8:187772-187778.

12. Han HS, Shehta A, Ahn S, Yoon YS, Cho JY, Choi Y. Laparoscopic versus open liver resection for hepatocellular carcinoma: case-matched study with propensity score matching. J Hepatol 2015;63:643-650.

13. Untereiner X, Cagnet A, Memeo R, De Blasi V, Tzedakis S, Pairdi T, et al. Short-term and middle-term evaluation of laparoscopic hepatectomies compared with open hepatecto-

mies: a propensity score matching analysis. World J Gastrointest Surg 2016;8:643-650.

14. Xiang L, Li J, Chen J, Wang X, Guo P, Fan Y, et al. Prospective cohort study of laparoscopic and open hepatectomy for hepatocellular carcinoma. Br J Surg 2016.

15. Cheung TT, Dai WC, Tsang SH, Chan AC, Chok KS, Chan SC, et al. Pure laparoscopic hepatectomy versus open hepatectomy for hepatocellular carcinoma in 110 patients with liver cirrhosis: a propensity analysis at a single center. Ann Surg 2016;264:612-620.

16. Twaij A, Pucher PH, Sodgergren MH, Gall T, Darzi A, Jiao LR. Laparoscopic vs. open approach to resection of hepatocellular carcinoma in patients with known cirrhosis: systemic review and meta-analysis. World J of Gastroenterol 2014;20:8274-8281.

17. Ciria R, Cherqui D, Geller DA, Briceno J, Wakabayashi G. Comparative short-term benefits of laparoscopic liver resection: 9000 cases and climbing. Ann Surg 2016; 263:761-777.

18. Di Sandro S, Danieli M, Ferla F, Lauterio A, De Carlis R, Benuzzi L, Buscemi V, Pezzoli I, De Carlis L. The current role of laparoscopic resection for HCC: a systemic review of past ten years. Transd Gastroenterol Hepatol 2018;3:68.

19. Twaij A, Pucher PH, Sodgergren MH, Gall T, Darzi A, Jiao LR. Laparoscopic vs. open approach to resection of hepatocellular carcinoma in patients with known cirrhosis: systemic review and meta-analysis. World J of Gastroenterol 2014;20:8274-8281.

20. Ciria R, Cherqui D, Geller DA, Briceno J, Wakabayashi G. Comparative short-term benefits of laparoscopic liver resection: 9000 cases and climbing. Ann Surg 2016; 263:761-777.

21. Di Sandro S, Danieli M, Ferla F, Lauterio A, De Carlis R, Benuzzi L, Buscemi V, Pezzoli I, De Carlis L. The current role of laparoscopic resection for HCC: a systemic review of past ten years. Transd Gastroenterol Hepatol 2018;3:68.

22. Buell JF, Cherqui D, Geller DA, O'Rourke N, Iannitti D, Dagher I et al. The international position on laparoscopic liver surgery: The Louisville Statement 2008. Ann Surg 2009;250:825-830.

23. Wakabayashi G, Cherqui D, Geller DA. Buell JF, Kaneko H, Han HS et al. Recommendations for laparoscopic liver resection: a report from the second international consensus conference held in Morioka. Ann Surg 2015; 261: 619-629.

24. Ban D, Tanabe M, Ito H, Otsuka Y, Nitta H, Abe Y, Hasegawa Y, Katagiri T, Takagi C, Itano O, Kaneko H, Wakabayashi G. A novel difficulty scoring system for laparoscopic liver resection. J Hepatobiliary Pancreat Sci. 2014 Oct;21(10):745-53.

25. Tanaka S, Kubo S, Kanazawa A, Takeda Y, Hirokawa F, Nitta H, Nakajima T, Kaizu T, Kaneko H, Wakabayasho G. Validation of a difficulty scoring system for laparoscopic liver resection: a multicenter analysis by the Endoscopic Liver Surgery Group in Japan. *J Am Coll Surg*. Aug 2017:225(2):249-258. e1.

26. Mirnezami R, Mirnezami AH, Chandrakumaran K, Abu Hilal M, Pearce NW, et al. Short- and long-term outcomes after laparoscopic and open hepatic resection: systemic review and meta-analysis. HPB. 2011;13:295-308.

27. HS Han, Cho JY, Yoon YS. Techniques for performing laparoscopic liver resection in various hepatic locations. J Hepatobiliary Pancreat Surg. 16(2009):427-432.

28. Cheng KC, Yeung YP, Ho KM, Chan FK. Laparoscopic right posterior sectionectomy for malignant lesions: an anatom-

ic approach. J Laparoendosc Adv Surg Tech A. 2015 Aug; 25(8):646-50.

29. Launois B, Jamieson GG. The posterior intrahepatic approach for hepatectomy or removal of segments of the liver. Surg Gynecol Obstet. 1992; 174:155-158.

30. Yeung YP. Laparoscopic anatomical monosegmentectomy of hepatocellular carcinoma of right hepatic lobe. Surg Laparosc Endosc Percutan Tech. 2012; Oct 22(5):e259-62.

31. Cho JY, Han HS, Choi Y, Yoon YS, Kim S, Choi JK, Jang JS, Kwon SU, Kim H. Association of remnant liver ischemia with early recurrence and poor survival after liver resection in patients with hepatocellular carcinoma. JAMA Surgery. 2017 Apr (1); 152(4):386-392.

32. Scatton O, Brustia R, Belli G, et al. What kind of energy devices should be used for laparoscopic liver resection? Recommendation from a systemic review. J Hepatobiliary Pancreat Sci 2015;22:327-34.

33. Morise Z, Wakabayashi G. First quarter century of laparoscopic liver resection. World J Gastroenterol 2017;23:3581-8.

34. Cipriani F, Shelat VG, Rawashdeh M, Francone E, Aldrighetti L, Takhar A, Armstrong T, Pearce NM, Abu Abu Hilal M. Laparoscopic Parenchymal-Sparing Resections for Non-peripheral Liver Lesions, the Diamond Technique: Technical Aspects, Clinical Outcomes, and Oncologic Efficiency. J Am Coll Surgeons. Aug 2015;221(2):261-72.

35. Liddo G, Buc E, Nagarajan G, Hidaka M, Dokmak S, Belghiti J. The liver hanging manoeuvre. HPB (Oxford). 2009 Jun: 11(4):296-305.

36. Belghiti J, Guevara OA, Noun R, Saldinger PF, Kianmanesh R. Liver hanging manoeuvre: a safe approach to right hepatectomy without liver mobilization. *J Am Coll Surg*. 2001;193:109–111

37. Gaujoux S, Douard R, Ettorre GM, Delmas V, Chevallier JM, Cugnenc PH. Liver hanging manoeuvre: an anatomic and clinical review. Am J Surg. 2007;193:488–492.

38. Nguyen KT, Gamblin TC, Geller DA. World review of laparoscopic liver resection – 2804 patients. Ann Surg 2009;250:831-841.

39. Ahn KS, Kang KJ, Kim YH, Kim TS, Lim TJ. A propensity score-matched case-control comparative study of laparoscopic and open liver resection for hepatocellular carcinoma. Journal of Laparoendoscopic & advanced surgical technqiues Part A. 2014;24:872-877.

40. Hasegawa Y, Nitta H, Sasaki A, Takahara T, Itabashi H. Long term oputcoimes of laparoscopic versus open liver resection for liver metastases from colorectal cancer: a comparative analysis of 168 consecutive cases at a single center. Surgery 2015;157:105-1072.

41. Lee KF, Chong CN, Wong J, Cheung YS, Wong J. Long-term results of laparoscopic hepatectomy versus open hepatectomy for hepatocellular carcinoma: a case-matched analysis. World J Surg 20112; 35:2268-2274.

42. Jackson NR, Hauch A, Hu T, Buell JF, Slakey DP. The safety and efficacy of approaches to liver resection: a meta-analysis. JSLS 2015;19:e2014.

43. Croome KP, Yamashita MH. Laparoscopic vs. open hepatic resection for benign and malignant tumors: An updated meta-analysis. Arch Surg 2010; 145:1109-1118.

44. Fancellu A, Rosman AS, Sanna V, Nigri GR, Zorcolo L. Meta-analysis of trials comparing minimally-invasive and open liver resections for hepatocellular carcinoma. J Surg Res 2011; 171:e33-45.

45. Li N, Wu YR, Wu B, Lu MQ. Surgical and oncological outcomes following laparoscopic versus open liver resection for hepatocellular carcinoma: A meta-analysis. Hepatology research: the official journal of the Japan Society of Hepatology 2012;42:51-59.

46. Luo LX, Yu ZY, Bai YN. Laparoscopic hepoatectomy for liver metastases from colorectal cancer: a meta-analysis. J Laparoendosc Adv Surg Tech A. 2014; 24:213-222.

47. Mizuguchi T, Kawamoto M, Meguro M, Shibata T, Nakamura Y. Laparoscopic hepatectomy: a systematic review, meta-analysis, and power analysis. Surg Today. 2011;41:39-47.

48. Morise Z, Ciria R, Cherqui D, Chen KH, Belli G. Can we expend the indications for laparoscopic liver resection? A systemic review and meta-analysis of laparoscopic liver resection for pateints with hepatocellular carcinoma and chronic liver disease. Journal of hepato-biliary-pancreatic sciences. 2015;22:342-352.

49. Parks KR, Kuo YH, Davis JM, O'Brien B, Hagopian EJ. Laparoscopic versus open liver resection: a meta-analysis of long term outcome. HPB (Oxford). 2014:16;109-118.

50. Ahsan Rao, Ghaus Rao, Irfan Ahmed. Laparoscopic or open liver resection? Let systemic review decide it. American journal of surgery. 2012;204:222-231.

51. Rao A, Rao G, Ahmed I. Laparoscopic vs. open liver resection for malignant liver disease. A systematic review. Surgeon, 2012;10:194-201.

52. Schiffman SC, Kim KH, Tsung A, Marsh JW, Geller DA. Laparoscopic versus open liver resection for metastatic colorectal cancer: a metaanalysis of 610 patients. Surgery. 2015; 157:211-222.

53. Guro H, Cho JY, Han HS, Yoon YS, Choi YR, Kim SH, Kim K, Hyun IG. Outcomes of major laparocopsic liver resection for hepatocellular carcinoma. Surgical Oncology. 27 (2018) 31-35.

54. Kasai M, Cipriani F, Gayet B, Aldrighetti L, Ratti F, Sarmiento JM, Scatton O, Kim KH, Dagher I, Topal B, Primrose J, Nomi T, Fuks D, Abu Hilal M. Laparoscopic versus open major hepatectomy: a systemic review and meta-analysis of individual patient data. Surgery. 2018; 163:985-995.

55. Chen K, Pan Y, Zhang B, Liu XL, Maher H, Zheng XY. Laparoscopic versus open surgery for hepatocellular carcinoma: a meta-analysis of high-quality case-matched series. Can. J. Gastroenterol. Hepatol. 2018 Mar 1;2018:1746895.

56. Nomi T, Fuks D, Kawaguchi Y, Mal F, Nakajima Y, Gayet B. Learning curve for laparoscopic major hepatectomy. Br J Surg. 2015 Jun;102(7):796-804.

57. Cho JY, Han HS, Yoon YS, et al. Experiences of laparoscopic liver resection including lesions in the posterosuperior segments of the liver. Surg Endosc. 2008;22:2344–2349.

58. Kruger JAP, Coelho FF, Perini MV, Paulo H. Laparoscopic transthoracic liver resection. Arq Bras Cir Dig. 2014 Oct-Dec; 27(4):288-290.

59. Chiow AKF, Lewin J,m Monoharan B, Cavallucci D, Bryant R, O'Rourke N. Intercostal and transthoracic trocars enable easier laparoscopic resection of dome liver lesions. HPB (Oxford). 2015 April; 17(4):299-303.

60. Cloyd JM, Visser BC. Video-assisted thoracoscopic transdiaphragmatic liver resection for hepatocellular carcinoma. Surg Endosc. 2012;26:1772–1776.

61. Ishizawa T, Gumbs AA, Kokudo N, Gayet B. Laparoscopic segmentectomy of the liver: from segment I to VIII. Ann Surg. 2012;256:959–964.