World J Surg (2019) 43:1303–1307
https://doi.org/10.1007/s00268-019-04907-1

ORIGINAL SCIENTIFIC REPORT WITH VIDEO

Intrahepatic Glissonian Approach to the Ventral Aspect of the Arantius Ligament in Laparoscopic Left Hemihepatectomy

Ji Hoon Kim[1] · **Jae-Woon Choi**[2]

Published online: 16 January 2019

Abstract

Background Laparoscopic left hemihepatectomy using the Glissonian approach is technically challenging secondary to a thick Glissonian pedicle and limited maneuverability of laparoscopic instruments. This procedure demands extreme caution owing to the high risk of bile leakage associated with left hemihepatectomy. We describe the technical details and surgical outcomes of the intrahepatic Glissonian approach to the ventral aspect of the Arantius ligament in laparoscopic left hemihepatectomy.

Methods After detachment of the left side of hilar plate, the meticulous dissection was performed in the liver capsule above the left Glissonian pedicle. Dissection of the ventral aspect of the Arantius ligament creates the space between the liver parenchyma and the left Glissonian pedicle. The left Glissonian pedicle was isolated and encircled using the long curved laparoscopic instrument. During the parenchymal transection, the left Glissonian pedicle was transected using lateral to the Arantius ligament.

Results Between February 2013 and July 2018, 13 consecutive patients underwent pure laparoscopic left hemihepatectomy. The median operation time was 230 min (range 180–300 min), and the median estimated blood loss was 300 mL (range 100–600 mL). Two patients (15%) required transfusion. The median tumor size was 40 mm (range 10–105 mm). All patients showed negative resection margins. The median postoperative hospital stay was 8 days (range 6–15 days). Major postoperative complications occurred in 1 patient (7.7%). No perioperative deaths occurred.

Conclusion An intrahepatic Glissonian approach to the ventral aspect of the Arantius ligament is a feasible and effective technique in laparoscopic left hemihepatectomy.

Introduction

Laparoscopic liver resection is widely performed in recent times owing to advances in laparoscopic techniques and successful outcomes reported by several studies [1, 2]. A laparoscopic hemihepatectomy is a technically difficult and relatively innovative procedure; however, laparoscopic left hemihepatectomy is commonly performed in centers with experienced personnel [3, 4]. Vascular inflow control during hepatectomy is a critical step for which several different techniques have been described. Bleeding from

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s00268-019-04907-1) contains supplementary material, which is available to authorized users.

✉ Jae-Woon Choi
jwchoi@chungbuk.ac.kr

[1] Department of Surgery, Eulji University School of Medicine, Daejeon, Republic of Korea

[2] Department of Surgery, College of Medicine and Medical Research Institute, Chungbuk National University, Cheong-Ju, Republic of Korea

the inflow system can be controlled by the Pringle maneuver or via selective vascular occlusion [5, 6].

The 2 primary approaches to control the inflow system at the hilum are: individual hilar dissection and the Glissonian approach [7, 8]. The choice of the approach is determined by the surgeon's training and/or preference. Although individual hilar dissection is the conventional technique, the Glissonian approach has been increasingly proposed as a safe and efficient method for both open and laparoscopic liver resections [9, 10].

A few reports have demonstrated the feasibility and safety of laparoscopic left hemihepatectomy via the Glissonian approach intra- or extrahepatically [11–14]. However, these techniques are associated with drawbacks including the risk of injury to the middle hepatic vein (MHV) and bile leakage secondary to injury to the biliary system.

The use of the Glissonian approach can be technically challenging because of the thick left Glissonian pedicle and limited maneuverability of laparoscopic instruments. Furthermore, the Glissonian approach in left hemihepatectomy demands extreme caution because left hemihepatectomy is a high-risk procedure that can cause bile leakage because the right posterior bile duct commonly drains into the left duct [15]. This article describes the technical details and the surgical outcomes of laparoscopic left hemihepatectomy using the intrahepatic Glissonian approach.

Methods

Between February 2013 and July 2018, 13 consecutive patients underwent pure laparoscopic left hemihepatectomy. The surgery was performed based on our standardized laparoscopic liver resection protocol, as previously described [9–12]. Following induction of general anesthesia, the patient was placed in the lithotomy position. We placed 4–5 trocars in the upper abdomen. Intra-abdominal pressure was maintained at 10–12 mmHg. An umbilical tape was inserted to encircle the hepatoduodenal ligament to perform the intermittent Pringle maneuver.

Intrahepatic Glissonian Approach to the Ventral Aspect of the Arantius Ligament (Fig. 1, Video)

The round ligament was lifted using a laparoscopic grasper, and the left side of the hilar plate is detached from the liver parenchyma. The parenchymal dissection is performed in the liver capsule above the left Glissonian pedicle (Fig. 2a). At this stage, meticulous dissection is required to avoid injury to the MHV or the branches of the Glissonian pedicle.

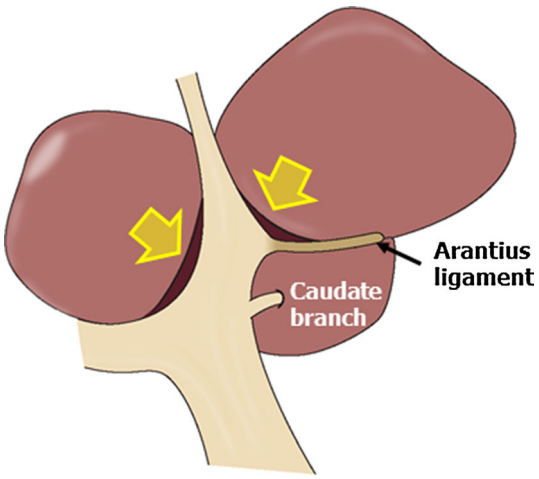

Fig. 1 Schematic diagram of Glissonian approach using anatomical landmarks Yellow arrows indicate the left side of the hilar plate and the ventral aspect of the arantius ligament

The application of traction on the left lateral sector to the right enables the surgeon to identify the Arantius ligament that is continuous with the lesser omentum. We recently did not transect the lesser omentum because the ventral aspect of the Arantius ligament could be identified easily. Inferior traction was applied to the caudal end of the Arantius ligament, and the liver parenchyma was dissected along the ventral aspect of Arantius ligament (Fig. 2b).

A curved laparoscopic instrument (Goldfinger dissector or the Endo Retract Maxi) was used to pass through the dissected space on both sides of the left Glissonian pedicle (Fig. 2c).

The left Glissonian pedicle was isolated and encircled with a cotton tape. Following clamping of the Glissonian pedicle using the laparoscopic bulldog clamp, we could identify the line of ischemic demarcation of the left hemiliver. Parenchymal transection of the liver was performed along a plane between the Cantlie's line and the MHV. During the parenchymal transection, the left Glissonian pedicle was divided using a vascular stapler lateral to the Arantius ligament (Fig. 2d).

Results

Between February 2013 and July 2018, 13 patients (9 men, 4 women) underwent laparoscopic left hepatectomy using the Glissonian approach. The median age of the study group was 70 years (range 57–83 years). Final histopathological diagnosis showed hepatocellular carcinoma in 3, intrahepatic cholangiocarcinoma in 3, mucinous cystic neoplasm in 1, and intrahepatic duct stones in 6 patients. The median operation time was 230 min (range

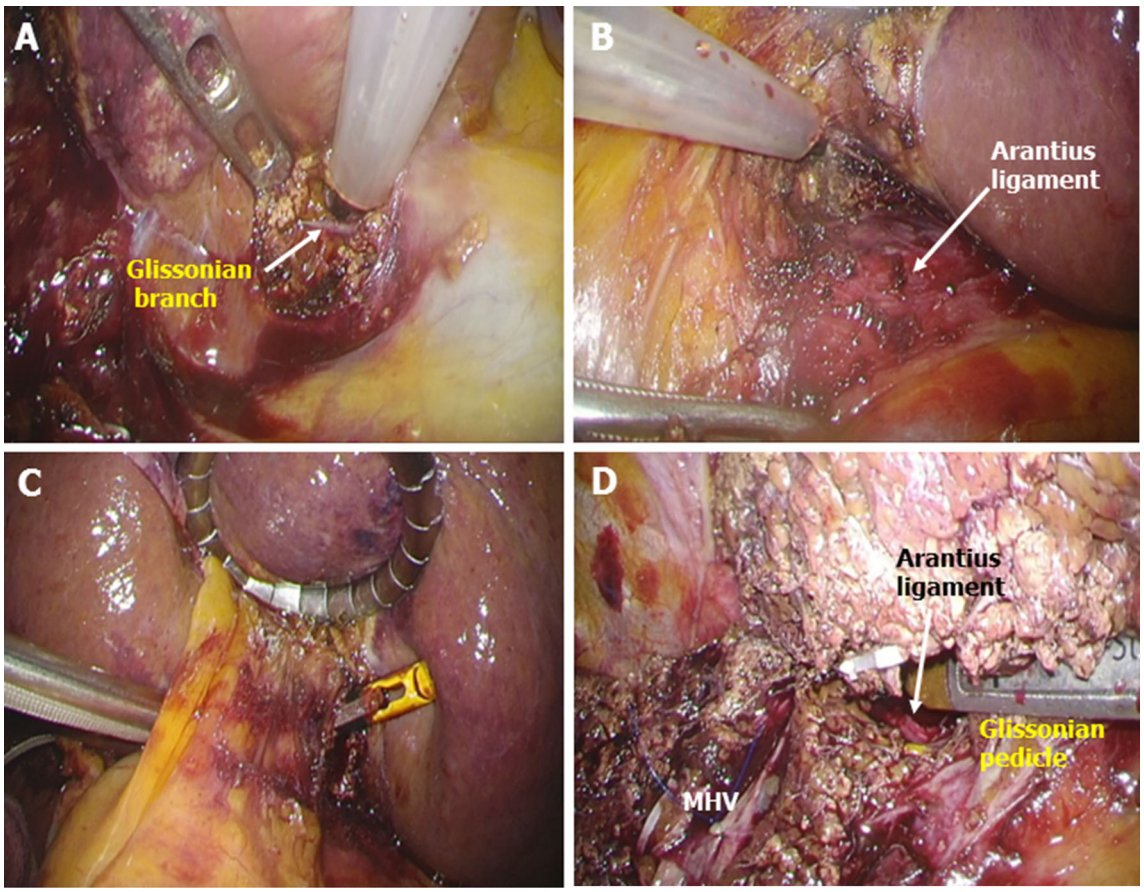

Fig. 2 Intrahepatic Glissonian approach to the ventral aspect of the arantius ligament. **a** The parenchymal dissection is performed in the liver capsule above the left Glissonian pedicle. **b** The liver parenchyma was dissected along the ventral aspect of arantius ligament. **c** A curved laparoscopic instrument was used to pass through the dissected space on both sides of the left Glissonian pedicle. **d** During the parenchymal transection, the left Glissonian pedicle was divided using a vascular stapler lateral to the arantius ligament

180–300 min), and the median estimated blood loss was 300 mL (range 100–600 mL). Two patients (15%) required transfusion. The median tumor size was 40 mm (range 10–105 mm). All patients showed negative resection margins. The median postoperative hospital stay was 8 days (range 6–15 days). Major postoperative complications occurred in 1 patient (7.7%). The only major complication reported was intra-abdominal fluid collection that was treated with percutaneous catheter drainage. No perioperative deaths occurred.

Discussion

Effective control of intrahepatic vascular inflow decreases intraoperative blood loss and improves perioperative outcomes [5, 6]. The primary techniques used to achieve inflow control include individual hilar dissection and the Glissonian approach.

The Glissonian approach is less commonly used for a left hemihepatectomy compared with a right hemihepatectomy owing to the following: (1) Individual ligation of the left liver is relatively easy to perform because this may be explained by the long extrahepatic course of the left portal vein. (2) Left hemihepatectomy is associated with a potential risk of bile duct injury because of the distribution of the bile ducts in the caudate lobe and the frequent drainage of the right posterior segments into the left bile duct. (3) It is technically difficult to encircle the left Glissonian pedicle laparoscopically because it is large and thick and deeply embedded within the left hemiliver.

Advantages of the Glissonian approach are: (1) It may be useful in patients with a history of liver surgery associated with adhesions at the hepatic hilum. (2) It is useful in patients with liver cirrhosis because the portal venous collaterals or the engorged lymphatics at the hepatic hilum are not disturbed during hilar dissection, which consequently minimizes the risk of postoperative ascites. (3)

Even in patients with anatomical variations in the hepatic pedicles, the risk of iatrogenic injury to the vascular structures is minimized. Notably, laparoscopic individual hilar dissection may be associated with a risk of iatrogenic injury owing to the lack of tactile feedback [16].

A few reports have described laparoscopic left hepatectomy using an intrahepatic or extrahepatic Glissonian approach [11–14]. Most authors use the Arantius ligament as a anatomical landmark to approach the left Glissonian pedicle [11–14, 17]. However, the extrahepatic Glissonian approach involves dissection of the dorsal aspect of the Arantius ligament, which may injure the bile ducts distributed in the caudate lobe or the right bile duct joining the left bile duct [9, 17]. Takasaki's technique for left Glissonian approach involves the dissection of the ventral aspect of the Arantius ligament to avoid bile duct injury [18]. This method is safe and unaffected by variations in the biliary anatomy, such as the right posterior bile duct commonly draining into the left duct. Our technique is a modification of Takasaki's technique for laparoscopic approach.

The gap between the Laennec's capsule and the Glissonian pedicle can be identified using a magnified laparoscopic view and allows easy implementation of the Glissonian approach [19]. Parenchymal injury can be avoided by entering this gap cautiously to encircle the Glissonian pedicle. Although the extrahepatic Glissonian approach is ideal to avoid liver injury, this may not always be possible technically because the left Glissonian pedicle is large and thick and deeply embedded within the left hemiliver. An intrahepatic left Glissonian approach with minimal liver dissection is a practically easy strategy that can be applied for left hemihepatectomy.

The intrahepatic Glissonian approach reported by Machado et al. is performed by small incisions on two anatomical landmarks of the left Glissonian pedicle [14]. However, this technique is associated with a risk of injury to the MHV or the Glissonian pedicle because the vascular stapler is introduced intrahepatically without meticulous dissection. And the tip of the vascular stapler cannot be followed clearly owing to limited vision and narrow space. Furthermore, the left Glissonian pedicle is large and thick; the left Glissonian pedicle may not be successfully transected using a single vascular stapler.

The feasibility of the Glissonian approach in laparoscopic liver resection may be lower than that in open liver resection because of limited maneuverability and the lack of tactile feedback during the process of encircling the Glissonian pedicle [10, 16].

Using the Pringle maneuver reduces the volume of blood loss during dissection of the Glissonian pedicle. A bloodless operative field and meticulous dissection are mandatory because the left Glissonian pedicle is located close to the MHV and its branches supplying the liver hilum. Early in the introductory phase of this technique, we observed injuries to the branches of the MHV during dissection of the Glissonian pedicle. We used gauze and hemostatic agents to compress the bleeding points of the hepatic vein in segment 4 and controlled bleeding with ligation performed during parenchymal transection. After adopting the Pringle maneuver as a component of our routine surgical protocol, we have not observed injury to and bleeding from the branches of the MHV.

A laparoscopic long curved instrument (Endo Retract Maxi or Goldfinger dissector) is useful in encircling the left Glissonian pedicle. Blunt dissection is minimized by performing dissection of the right side of the umbilical plate and the ventral aspect of the Arantius ligament. When the surgeon experiences resistance during the process of encircling the left Glissonian pedicle, the procedure is abandoned because the posterior portion of the Glissonian pedicle is not clearly visualized.

Notwithstanding its many potential benefits, the Glissonian approach should be used cautiously in laparoscopic left hemihepatectomy and remains a technically demanding procedure needing a long learning curve.

The choice of individual hilar dissection or Glissonian approach should be determined by surgical training or preference. For the appropriate use of the laparoscopic Glissonian approach, the surgeon needs training in both the open Glissonian approach and laparoscopic surgical skills. Additionally, appropriate patient selection is important because the Glissonian approach is not suitable for tumors near the left portal pedicle.

The appropriate application of this technique requires accurate dissection along the ventral aspect of the Arantius ligament (used as an anatomical landmark), as well as meticulous dissection around the left Glissonian pedicle to reduce the risk of bile leakage and injury to the MHV. We propose that the intrahepatic Glissonian approach along the ventral aspect of the Arantius ligament is a feasible and effective technique in laparoscopic left hemihepatectomy.

Compliance with ethical standards

Conflict of interest All the authors declare that they have no conflict of interests.

References

1. Wakabayashi G, Cherqui D, Geller DA et al (2015) Recommendations for laparoscopic liver resection: a report from the second international consensus conference held in Morioka. Ann Surg 261:619–629
2. Wakabayashi G, Cherqui D, Geller DA et al (2014) Laparoscopic hepatectomy is theoretically better than open hepatectomy:

preparing for the 2nd international consensus conference on laparoscopic liver resection. J Hepatobiliary Pancreat Sci 21:723–731
3. Belli G, Gayet B, Han HS et al (2013) Laparoscopic left hemihepatectomy a consideration for acceptance as standard of care. Surg Endosc 27:2721–2726
4. Cai XJ, Wang YF, Liang YL et al (2009) Laparoscopic left hemihepatectomy: a safety and feasibility study of 19 cases. Surg Endosc 23:2556–2562
5. Pringle JH (1908) Notes on the arrest of hepatic hemorrhage due to trauma. Ann Surg 48:541–549
6. Figueras J, Llado L, Ruiz D et al (2005) Complete versus selective portal triad clamping for minor liver resections: a prospective randomized trial. Ann Surg 241:582–590
7. Figueras J, Lopez-Ben S, Llado L et al (2003) Hilar dissection versus the "Glissonean" approach and stapling of the pedicle for major hepatectomies: a prospective, randomized trial. Ann Surg 238:111–119
8. Takasaki K (1998) Glissonean pedicle transection method for hepatic resection: a new concept of liver segmentation. J Hepatobiliary Pancreat Surg 5:286–291
9. Yamamoto M, Katagiri S, Ariizumi S et al (2012) Glissonean pedicle transection method for liver surgery. J Hepatobiliary Pancreat Sci 19:3–8
10. Moris D, Rahnemai-Azar AA, Tsilimigras DI et al (2018) Updates and critical insights on Glissonian approach in liver surgery. J Gastrointest Surg 22:154–163
11. Cho A, Yamamoto H, Kainuma O et al (2012) Arantius' ligament approach for the left extrahepatic Glissonean pedicle in pure laparoscopic left hemihepatectomy. Asian J Endosc Surg 5:187–190
12. Rotellar F, Pardo F, Benito A et al (2012) A novel extra-Glissonian approach for totally laparoscopic left hepatectomy. Surg Endosc 26:2617–2622
13. Chen HW, Deng FW, Hu JY et al (2017) Extra-Glissonian approach for total laparoscopic left hepatectomy: a prospective cohort study. Surg Laparosc Endosc Percutan Tech 27:e145–e148
14. Machado MA, Surjan RC, Basseres T et al (2016) The laparoscopic Glissonian approach is safe and efficient when compared with standard laparoscopic liver resection: results of an observational study over 7 years. Surgery 160:643–651
15. LoCM Fan ST, Liu CL et al (1998) Biliary complication after hepatic resection: risk factors, management, and outcome. Arch Surg 133:156–161
16. Kawaguchi Y, Velayutham V, Fuks D et al (2017) Operative techniques to avoid near misses during laparoscopic hepatectomy. Surgery 161:341–346
17. Kim JH (2018) Usefulness of the ligamentum venosum as an anatomical landmark for safe laparoscopic left hepatectomy (how I do it). J Gastrointest Surg 22:1464–1469
18. Takasaki K (2007) Glissonean pedicle transection method for hepatic resection. Springer, Tokyo, pp 62–69
19. Sugioka A, Kato Y, Tanahashi Y (2017) Systematic extrahepatic Glissonean pedicle isolation for anatomical liver resection based on Laennec's capsule: proposal of a novel comprehensive surgical anatomy of the liver. J Hepatobiliary Pancreat Sci 24:17–23