Review Article

How to perform a minimally invasive hepatic parenchymal transection: a clinical practice review

Abderrahim Sanoussi, Vito De Blasi, Juan Santiago Azagra, Edoardo Rosso

Department of General, Oncologic, Mini-Invasive and Robotic Surgery, Centre Hospitalier du Luxembourg, Luxembourg, Luxembourg

Contributions: (I) Conception and design: A Sanoussi, E Rosso; (II) Administrative support: A Sanoussi, E Rosso; (III) Provision of study materials or patients: A Sanoussi, E Rosso; (IV) Collection and assembly of data: A Sanoussi, E Rosso; (V) Data analysis and interpretation: A Sanoussi, E Rosso; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Abderrahim Sanoussi, MD. Department of General, Oncologic, Mini-Invasive and Robotic Surgery, Centre Hospitalier du Luxembourg, 4 Rue Nicolas Ernest Barblé, L-1210 Luxembourg, Luxembourg. Email: sanoussi.abderrahim@chl.lu.

Abstract: Minimally invasive techniques have become the gold standard for many hepatic surgeries. However, some major hepatectomies still require open surgery due to the difficulties encountered during hepatic transection. An adjustment before the liver transection is essential for the smooth running of the operation. It will consist of the correct determination of the hepatic transection line guided by pre and intraoperative imaging and by an adequate mobilization of the liver. In addition, the positioning of the patient in reverse Trendelenburg and the various anesthetic techniques allowing the maintenance of the central venous pressure <5. Finally, maintaining a pneumoperitoneum and reducing inspiratory pressure contributes to reducing bleeding. Intermittent Pringle's maneuver reduces bleeding from the liver transection surface. The transection of the hepatic parenchyma can be done using various instruments and surgical techniques. The transection device (the cavitron ultrasonic surgical aspirator and the Water-Jet) allows the destruction of the hepatic parenchyma while preserving the vessels and bile ducts. The energy device has a role in the coagulation of small vessels, but they can also be used for liver transection according to the kellyclasia technique. The aim of this review is to highlight the different hepatic transection techniques in minimally invasive surgery and illustrate them with videos.

Keywords: Hepatic surgery; hepatic parenchymal transection; minimally invasive surgery; laparoscopic surgery; robotic surgery

Received: 09 January 2022; Accepted: 20 April 2022; Published: 30 June 2022.
doi: 10.21037/dmr-22-3
View this article at: https://dx.doi.org/10.21037/dmr-22-3

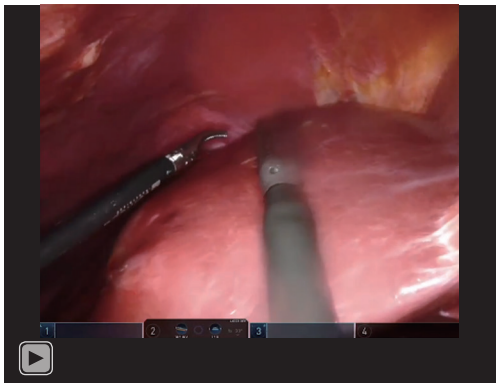
Introduction

Minimally invasive hepatic surgery currently occupies a key place in the treatment of many benign and malignant pathologies for which it often the only curative treatment.

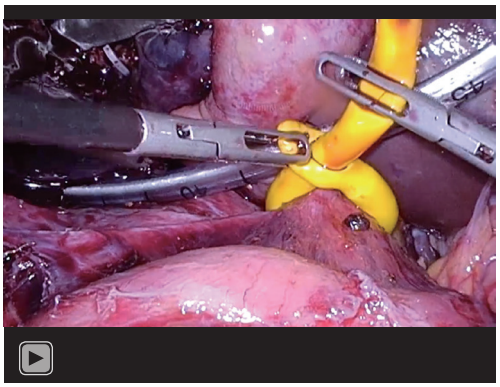
Since its introduction in the 1990s (1), improvement in surgical techniques and development of increasingly efficient surgical instruments have made performing liver resection by laparoscopy a standard practice (2). However, the difficulties encountered during the hepatic parenchymal transection step such a hemostasis of the transection surface, control of hemorrhage from intrahepatic vessel prevented laparoscopy from becoming a common practice in performing major hepatectomy (3).

Realization of increasingly complex hepatic resection requires hepatic transection techniques which minimize bleeding from hepatic section.

Currently, there are few studies allowing to choose the best minimally invasive liver transection techniques. The aim of this review is to highlight the different hepatic transection techniques in minimally invasive surgery and illustrate them with videos (*Videos 1-3*).



Video 1 Kellyclasia.



Video 3 Hepatic transection with stapler.

Video 2 Ultrasound dissection (cavitron ultrasonic surgical aspirator).

Methods

We performed a review of the literature on minimally invasive liver surgery and liver transection techniques. To do this, we searched PubMed published up to December 2021.

Additional publications were identified in the references cited in the original articles.

Discussions with experts in field of hepatic surgery and personal experience in mini-invasive liver surgery were helpful in writing this review.

Setting before hepatic parenchymal transection

How to correctly determine the transection line?

Determining the hepatic transection line is an essential step before starting a liver resection. A perfect knowledge of anatomy allows to avoid incorrect in major bleeding. To do this, there are multiple imaging techniques with different temporality to determine the best resection plan. Preoperative imaging including abdominal computed tomography (CT) scan, hepatic nuclear magnetic resonance (NMR) or 3D reconstruction computed tomography (4) combined with intraoperative ultrasound (5) and/or indocyanine green fluorescence imaging (6) are essential in order to assess the best surgical strategy.

Further, adequate hepatic mobilization depending on the type and location of hepatectomy is essential in order to optimally expose the hepatic transection line.

How to minimize the bleeding during the liver transection?

Heavy intraoperative bleeding has been shown to be associated with increased post-liver resection morbidity (7) especially if it requires intraoperative blood transfusion (8). Therefore, it is essential to minimize bleeding as much as possible during liver transection. The management of the infusions by the anesthetist making it possible to maintain a central venous pressure <5 mmHg (9) or a stroke volume variation between 18% and 21% (10) is associated with a reduction in blood loss and intraoperative transfusions.

In addition, reducing venous return by positioning the patient in reverse Trendelenburg due to gravity also make it central venous pressure to be maintained <5 mmHg. This position should therefore be privileged when its realization is possible.

Besides, maintaining the pneumoperitoneum between 10 and 12 mmHg contributes to the maintenance of an intra-abdominal pressure higher than the intravenous pressure is thus to the better control of the bleeding (9).

Finally, decrease of airway pressure by briefly interrupting

Table 1 Instruments for mini-invasive hepatic parenchymal transection

Instruments	Examples
Transection device	Ultrasonic dissector
	Water-Jet
Energy device	Bipolar
	Sealing device
	Ultrasonic shears
	Pre-coagulators
Others	Clips
	Stapler

ventilation during heavy bleeding has been shown to reduce blood loss (11).

Pringle maneuver

Intermittent Pringle maneuver reduces hepatic inflow and therefore reduces hepatic transection surface bleeding (12) both in open surgery and in laparoscopy (13). This hepatic pedicle clamping technique can be performed intra- or extracorporeally (14). The choice of technique will depend on the approach (laparoscopy or robotic) and the surgeon's preference.

Instruments for minimally invasive liver parenchymal transection

Transection device allows the destruction of the hepatic parenchyma while preserving the vessels and bile ducts.

There are 2 categories: Ultrasound dissection such as the cavitron ultrasonic surgical aspirator (CUSA), which is widely used by surgeons both in laparotomy (86.2% of cases) and laparoscopy (64.6% of cases) (15) and the Water-Jet Energy device will have an important role in the coagulation of small vessels, but they can also be used for liver transection according to the kellyclasia technique.

Energy devices include monopolar and bipolar cautery, Sealing device, Ultrasonic shears or even the pre-coagulators.

Clips or stapler is mainly used in the control of major vessels, but stapler can also be used for hepatic parenchymal transection.

Table 1 summarizes various instruments for parenchymal transection.

How we do it?

Transection of superficial parenchyma

Liver transection begins with the opening of the liver capsule. This step can easily be done using a vessel sealer (Thunderbeat) and continue at the first centimeter of liver parenchyma in which there is usually no major vessel or bile duct. To do this, the sealer must start when the instrument is opened and continue all the way through the slow closing in order to prevent bleeding from the parenchyma.

Transection of deeper parenchyma

The laparoscopic approach allows the use of the ultrasonic dissection to separate the hepatic parenchyma and expose the vessels and bile ducts without injuring them. Concomitantly, the bipolar forceps are used to achieve hemostasis.

In the robotic approach, the use of ultrasonic dissection is not possible. Therefore, the deep liver parenchyma transection is performed using the vessel sealer and/or the bipolar forceps. The separation of the parenchyma is done by kellyclasia. This technique consists in the crushing of the hepatic parenchyma with repeated movements of opening and closing of the forceps. The small vessels are coagulated with the vessel sealer and hemostasis is achieved with the bipolar forceps.

Major hepatic vessels and major bile ducts are usually controlled by clips or vascular staplers.

Acknowledgments

Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned by the editorial office, *Digestive Medicine Research* for the series "Focus on Technical Advancement in Mini-invasive HPB Surgery". The article has undergone external peer review.

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://dmr.amegroups.com/article/view/10.21037/dmr-22-3/coif). The series "Focus on Technical Advancement in Mini-invasive HPB Surgery" was commissioned by the editorial

office without any funding or sponsorship. ER and JSA served as the unpaid Guest Editors of the series. ER serves as an unpaid editorial board member of *Digestive Medicine Research* from September 2020 to August 2022. The authors have no other conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

References

1. Reich H, McGlynn F, DeCaprio J, et al. Laparoscopic excision of benign liver lesions. Obstet Gynecol 1991;78:956-8.
2. Abu Hilal M, Aldrighetti L, Dagher I, et al. The Southampton Consensus Guidelines for Laparoscopic Liver Surgery: From Indication to Implementation. Ann Surg 2018;268:11-8.
3. Wakabayashi G, Cherqui D, Geller DA, et al. Recommendations for laparoscopic liver resection: a report from the second international consensus conference held in Morioka. Ann Surg 2015;261:619-29.
4. Nakayama K, Oshiro Y, Miyamoto R, et al. The Effect of Three-Dimensional Preoperative Simulation on Liver Surgery. World J Surg 2017;41:1840-7.
5. Araki K, Conrad C, Ogiso S, et al. Intraoperative ultrasonography of laparoscopic hepatectomy: key technique for safe liver transection. J Am Coll Surg 2014;218:e37-41.
6. Ishizawa T, Saiura A, Kokudo N. Clinical application of indocyanine green-fluorescence imaging during hepatectomy. Hepatobiliary Surg Nutr 2016;5:322-8.
7. Jarnagin WR, Gonen M, Fong Y, et al. Improvement in perioperative outcome after hepatic resection: analysis of 1,803 consecutive cases over the past decade. Ann Surg 2002;236:397-406; discussion 406-7.
8. Stephenson KR, Steinberg SM, Hughes KS, et al. Perioperative blood transfusions are associated with decreased time to recurrence and decreased survival after resection of colorectal liver metastases. Ann Surg 1988;208:679-87.
9. Jayaraman S, Khakhar A, Yang H, et al. The association between central venous pressure, pneumoperitoneum, and venous carbon dioxide embolism in laparoscopic hepatectomy. Surg Endosc 2009;23:2369-73.
10. Dunki-Jacobs EM, Philips P, Scoggins CR, et al. Stroke volume variation in hepatic resection: a replacement for standard central venous pressure monitoring. Ann Surg Oncol 2014;21:473-8.
11. Honda G, Kurata M, Okuda Y, et al. Totally laparoscopic hepatectomy exposing the major vessels. J Hepatobiliary Pancreat Sci 2013;20:435-40.
12. Ercolani G, Ravaioli M, Grazi GL, et al. Use of vascular clamping in hepatic surgery: lessons learned from 1260 liver resections. Arch Surg 2008;143:380-7; discussion 388.
13. Decailliot F, Streich B, Heurtematte Y, et al. Hemodynamic effects of portal triad clamping with and without pneumoperitoneum: an echocardiographic study. Anesth Analg 2005;100:617-22.
14. Lim C, Osseis M, Lahat E, et al. Extracorporeal Pringle Maneuver During Laparoscopic and Robotic Hepatectomy: Detailed Technique and First Comparison with Intracorporeal Maneuver. J Am Coll Surg 2018;226:e19-25.
15. Scatton O, Vibert E. Chirurgie hépatique par laparoscopie. Rapport présenté au 120e congrès français de chirurgie 2018. Paris: John Libbey Eurotext, 2018.

doi: 10.21037/dmr-22-3
Cite this article as: Sanoussi A, De Blasi V, Azagra JS, Rosso E. How to perform a minimally invasive hepatic parenchymal transection: a clinical practice review. Dig Med Res 2022;5:31.