LAPAROSCOPIC LIVER SURGERY

F1 CHUNLACHES CHAIJAREENONT

OUTLINES

- Introduction
- Definition
- Complexity
- Surgical technique
  - Position, port placement, pringle, inflow/outflow approach
- Outcome

INTRODUCTION

Table 1 Development of laparoscopic liver resection over the first 25 years

Year	Procedure [Ref]	Related developments (technological, technical, conceptual)
1991	1st report of LLR[4-6] (partial resection in AL)	
1996	LLS[7,8]	
1997	Hemi-hepatectomy[13-15]	Energy devices (coagulating, sealing, shearing) CUSA HALS[19,20] and hybrid[21,22], Inflow control[17,18]
2000s-2010s	Sectionectomy (right posterior, right anterior, left medial)	Glissonian approach (extra-[26], intra-hepatic[27]) Caudal approach[10,31] Postural change[29-31]
	Segmentectomy and partial resection of segments 7, 8, 1	Postural change[29-31] Caudal approach[10,31] Lateral approach[37-39] (intercostal port) Tracoscopic approach[40,41] Simulation and navigation[46,47] 3D endoscope[45]
	Limited anatomical resection and modified anatomical (extended and/or combining limited) resection[48-51]	

Morise Z, Wakabayashi G. First quarter century of laparoscopic liver resection. World J Gastroenterol. 2017;23(20):3581-8.

THEORY

- Reduce blood loss
  - Image magnification
  - Pneumopetitoneum reduce back bleed from HV
- Gas embolism from CO2 pneumoperitoneum but does not created significant hemodynamic instability in animal experiments

DEFINITION

- Pure laparoscopy
  - Entire resection of the liver is completed through laparoscopic ports; hand-assisted devices or working incision are not used, although a small incision may be made for specimen extraction.
- Hand-assisted laparoscopy
  - The elective placement of a hand port for the purpose of facilitating the procedure. (The unplanned placement hand-port called "pure laparoscopy with hand-port conversion.")
- Hybrid technique
  - A procedure, which is started as a pure laparoscopic, or a hand-assisted procedure but the resection is performed through a mini-laparotomy incision. In the hand-assisted variant it is that incision, which is used for the mini-laparotomy part (sometimes with a small extension).

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(5):825-30.

TYPE OF HEPATECTOMIES

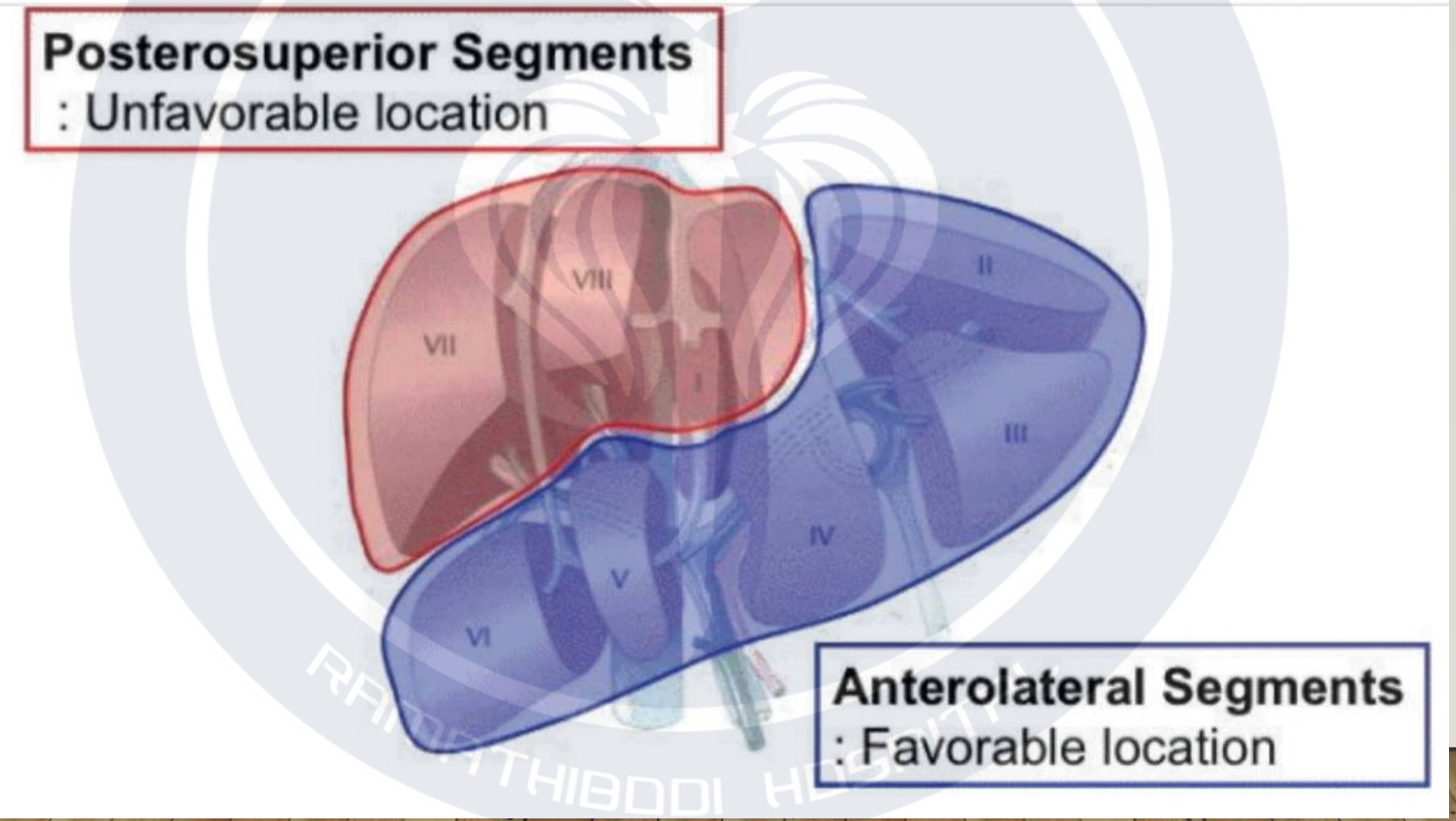
- Louisville statement 2008 – 3 categories
  - Biopsies and small wedge resections
  - Resection of Left lateral section or anterior hepatic segments (4b, 5 ,6)
  - Hemihepatectomies, trisectionectomies or resections of posterior segments (4a, 7, 8) - Major
- Morioka consensus 2015
  - MINOR resection - 2 or fewer Couinaud segments are removed (Heterogeneity of complexity/difficulty)
  - MAJOR resection - 3 or more Couinaud segments are removed

COMPLEXITY

- Location
- Proximity to major vessels
  - Major hepatic vein
  - IVC
  - Glisson's tree
- Tumor size ≥ 3 cm.
- Extent of liver resection

Ban D, Tanabe M, Ito H, Otsuka Y, Nitta H, Abe Y, et al. A novel difficulty scoring system for laparoscopic liver resection. J Hepatobiliary Pancreat Sci. 2014;21(10):745-53.

LOCATION


Posterosuperior Segments
: Unfavorable location
VIII
VII
II
III
IV
V
VI
Anterolateral Segments
: Favorable location

Tumor location

Segment	Score
S2	2
S3	1
S4	3
S5	3
S6	2
S7	5
S8	5

Extent of liver resection

	Score
Hr0 (partial resection)	0
Hr-LLR (left lateral sectionectomy)	2
Hr-S (segmentectomy)	3
Hr-1, 2 (not less than a sectionectomy)	4

Tumor size

	Score
<3 cm	0
≥3 cm	1

Proximity to major vessel

Proximity to major vessel*	Score
no	0
yes	1

*The main or second branches of Glisson's tree, Major hepatic vein, and inferior vena cava

Liver function

	Score
Child–Pugh A	0
Child–Pugh B	1

Ban D, Tanabe M, Ito H, et al. A novel difficulty scoring system forlaparoscopic liver resection.J Hepatobiliary Pancreat Sci. 2014;21:745–753.

Difficulty of laparoscopic liver resection

10-level index	1	2	3	4	5	6	7	8	9	10
Three-level index	Low			Intermediate			High			
Definition	• For surgeons starting laparoscopic liver resection • For surgeons with experience of <10 cases of laparoscopic liver resection			• For surgeons who can consistently perform laparoscopic liver resection in "low difficulty" cases • For surgeons with experience of ≥10 and <50 cases of laparoscopic liver resection			• For surgeons who can consistently perform laparoscopic liver resection in "intermediate difficulty" cases • For surgeons with experience of ≥50 cases of laparoscopic liver resection			
Landmark Operation	Simple and small partial hepatectomy in segment 3			Left lateral sectionectomy			Simple hemihepatectomy			Technical limitation in current laparoscopic surgery

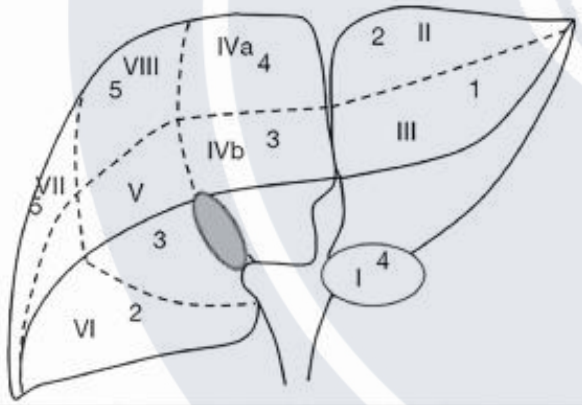
Ban D, Tanabe M, Ito H, et al. A novel difficulty scoring system forlaparoscopic liver resection.J Hepatobiliary Pancreat Sci. 2014;21:745–753.

IWATE Criteria

Difficulty index	0	1	2	3	4	5	6	7	8	9	10	11	12
Difficulty level	Low				Intermediate			Advanced			Expert		
Index surgery	Simple and small partial hepatectomy in segment III				Left lateral sectionectomy			Right or left hepatectomy			Posterior sectionectomy for segment VII tumor ≥ 3 cm		

Scoring system

Tumor location (Couinaud segment)



Segment	Score
S1	4
S2	2
S3	1
S4a	4
S4b	3
S5	3
S6	2
S7	5
S8	5

Tumor size

	Score
<3 cm	0
≥3 cm	1

Proximity to major vessel*

	Score
No	0
Yes	1

*Main or second branch of Glisson's tree, major hepatic vein, or inferior vena cava

Extent of liver resection

	Score
Partial resection	0
Left lateral sectionectomy	2
Segmentectomy	3
Sectionectomy and more	4

HALS/Hybrid

	Score
No	0
Yes	−1

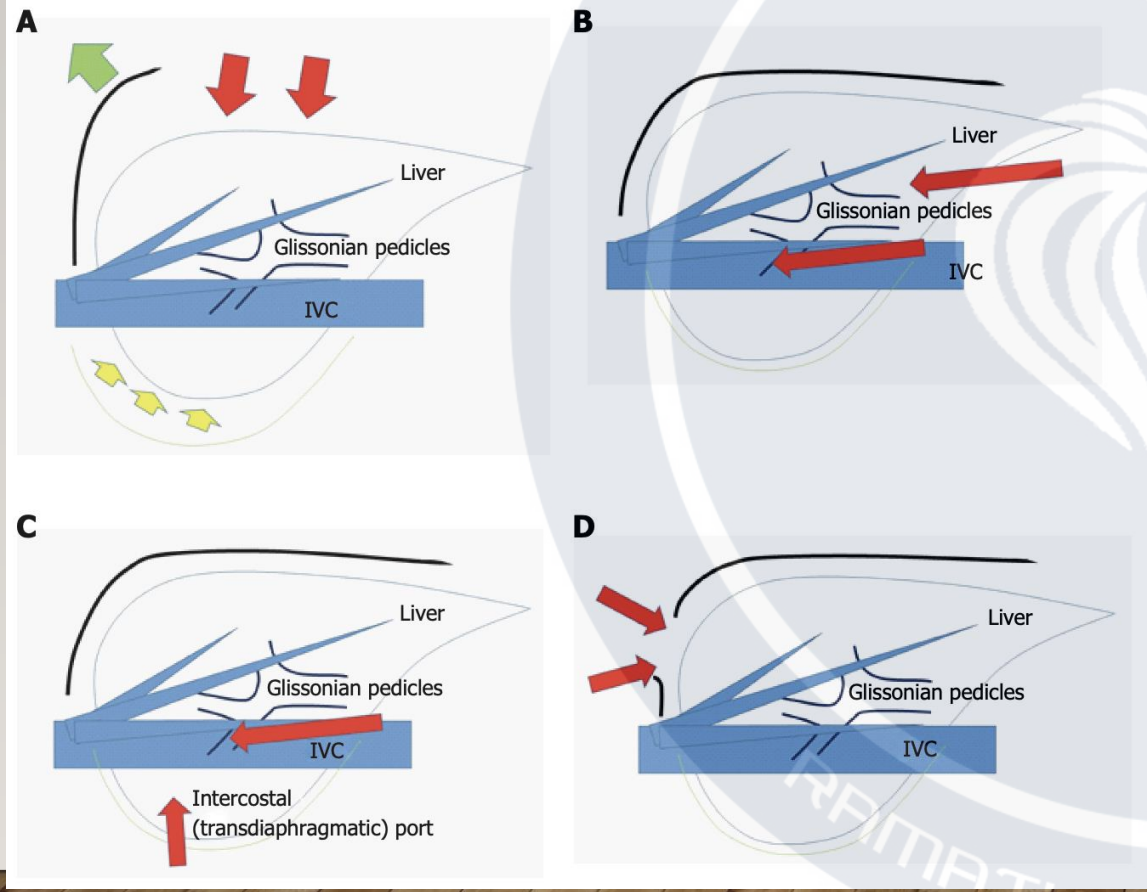
Liver function

	Score
Child Pugh A	0
Child Pugh B	1

Shogo T, Yoshikuni K, Shoji K, Akishige K, Yutaka T, Fumitoshi H, et al. Validation of index-based IWATE criteria as an improved difficulty scoring system for laparoscopic liver resection. Surgery. 2018;163(4):731-40.

SURGICAL TECHNIQUE

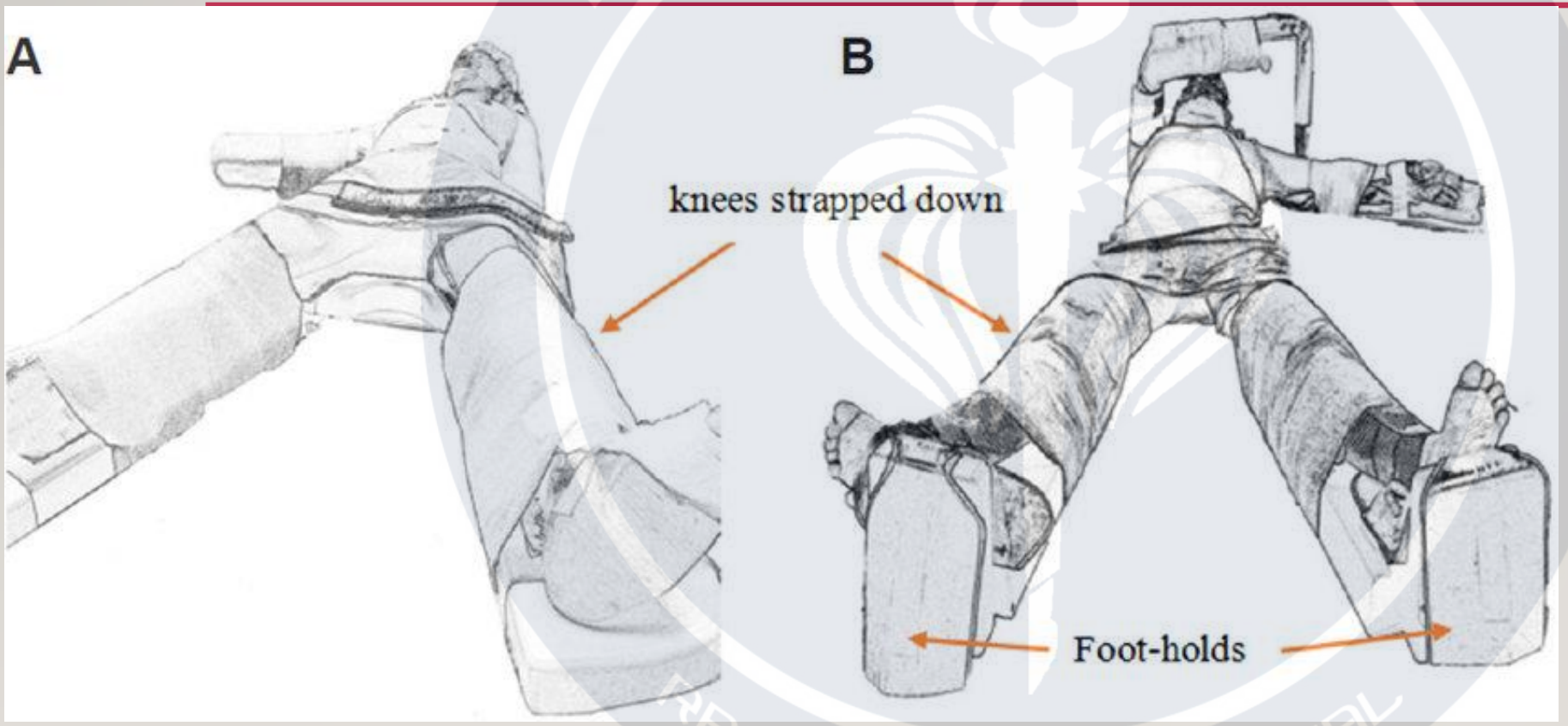
OPEN VS LAP APPROACH



- A: In the open approach, the subcostal cage containing the liver is opened with a large subcostal incision and instruments are used to lift the costal arch, after which the liver is dissected and mobilized (lifted) from the retroperitoneum
- B: In the regular laparoscopic caudal approach, the laparoscope and forceps are placed into the subcostal cage from the caudal direction, and the surgery is performed with minimal alteration and destruction of the associated structures
- C: In the laparoscopic lateral approach, the intercostal (transdiaphragmatic) ports combined with total mobilization of the liver from the retroperitoneum can allow the direct lateral approach into the cage and to the posterosuperior tumors
- D: Thoracoscopic approach is employed for lesions in segment 8, with direct exposure of the tumor into the pleural cavity upon incision on the diaphragm adjacent to the tumor, with the endoscope placed in the pleural cavity.

Morise Z, Wakabayashi G. First quarter century of laparoscopic liver resection. World J Gastroenterol. 2017;23(20):3581-8.

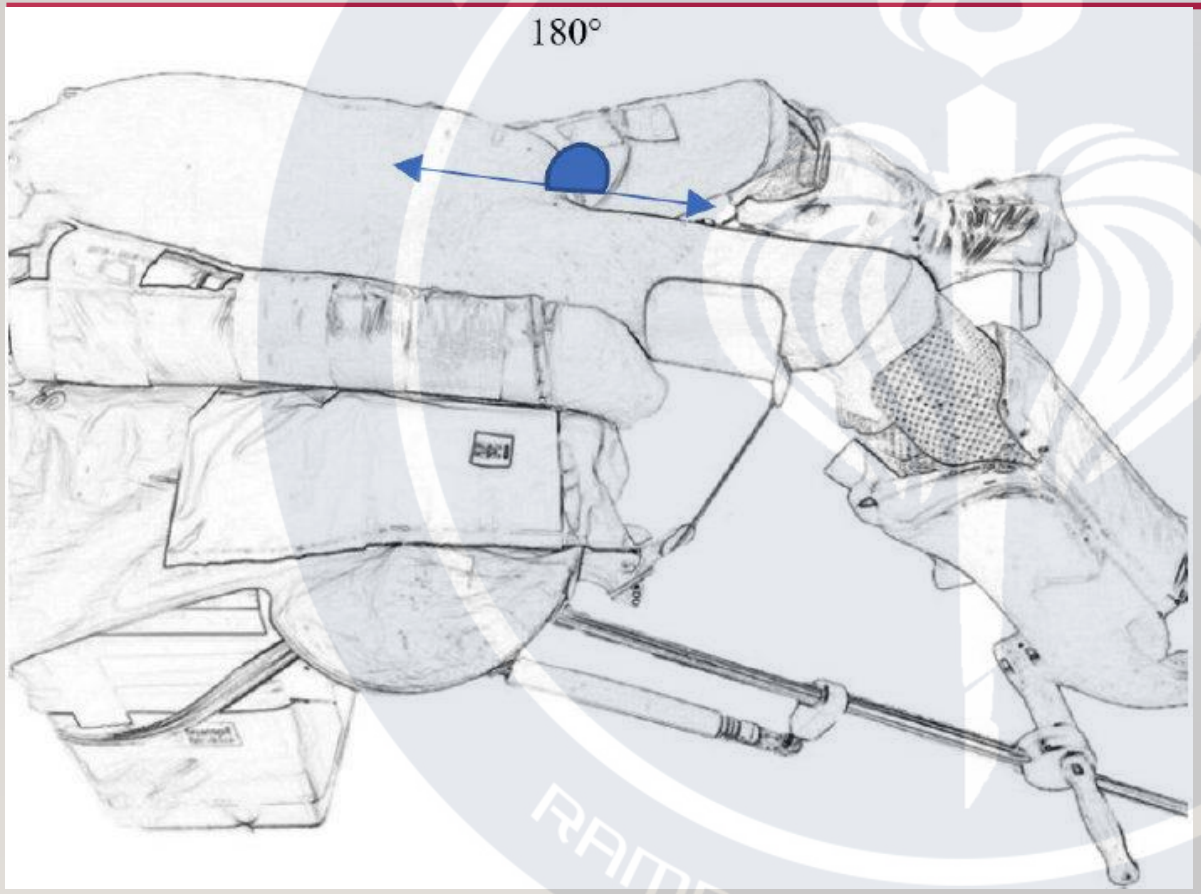
POSITION



- Supine straight split-leg position. The right arm is extended on an arm-board (A).
- The right arm is abducted and flexed overhead in an arm support, which facilitates port placement for posterior-superior resections (B).

Thiruchelvam, N., Lee, S.Y., Chiow, A.K.H., 2021. Patient and port positioning in laparoscopic liver resections. Hepatoma Research 2021.. https://doi.org/10.20517/2394-5079.2020.144

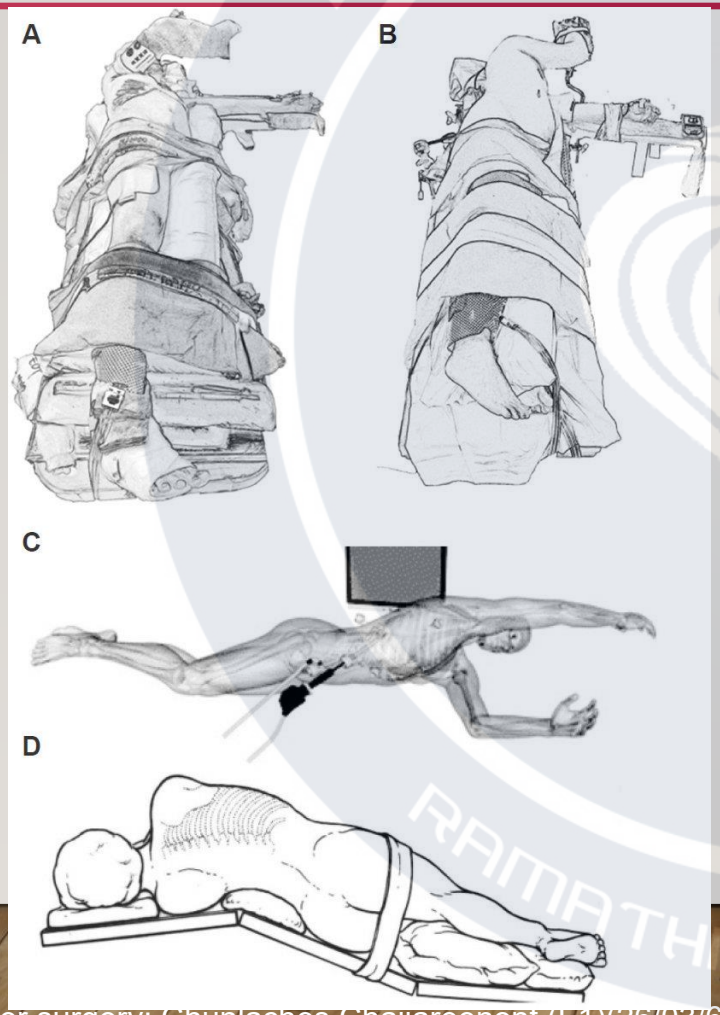
POSITION



Modified Llyod-Davies position. Care must be taken to ensure that the legs sit comfortably in the stirrups to reduce pressure on the common peroneal nerve. Ideally, the hip is maintained in neutral flexion-extension position to prevent clashing of the laparoscopic instruments with the patient's thigh intra-operatively.

Thiruchelvam, N., Lee, S.Y., Chiow, A.K.H., 2021. Patient and port positioning in laparoscopic liver resections. Hepatoma Research 2021.. https://doi.org/10.20517/2394-5079.2020.144

POSITION



- Patient positioning for laparoscopic liver resections for posterior and superior lesions. Left semi-lateral decubitus (30-45 degree tilt) (A).
- Full left lateral decubitus Semi-prone position described by Ikeda et al. (B).
- Semi-prone position described by Ikeda et al. (C).
- Left jack-knife position (D).

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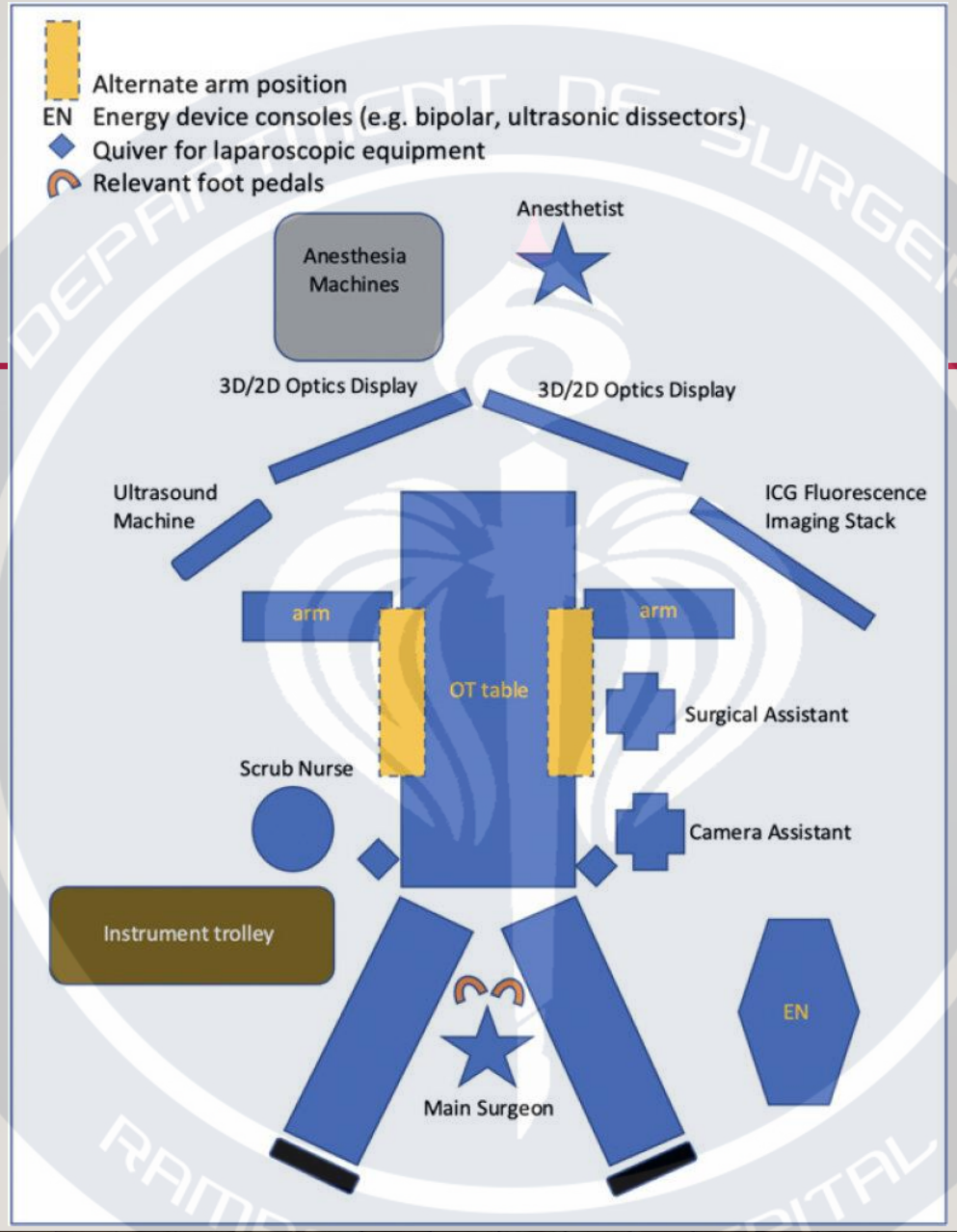

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PORT PLACEMENT

- Laparoscopic right/left hepatectomy including living donor liver transplant (LDLT). The use of 5-6 trocars for laparoscopic right hepatectomy proposed by Soubrane et al. (A).
- Port placements utilised for laparoscopic right hepatectomy for HCC with bile duct tumour thrombus (B).
- Port placements for LDLT for both right and left hepatectomy described by surgeons from Seoul National University Hospital, South Korea (C).
- Port placements for LDLT for right hepatectomy described by surgeons from Samsung Medical Centre, South Korea (D).

Thiruchelvam, N., Lee, S.Y., Chiow, A.K.H., 2021. Patient and port positioning in laparoscopic liver resections. Hepatoma Research 2021.. https://doi.org/10.20517/2394-5079.2020.144

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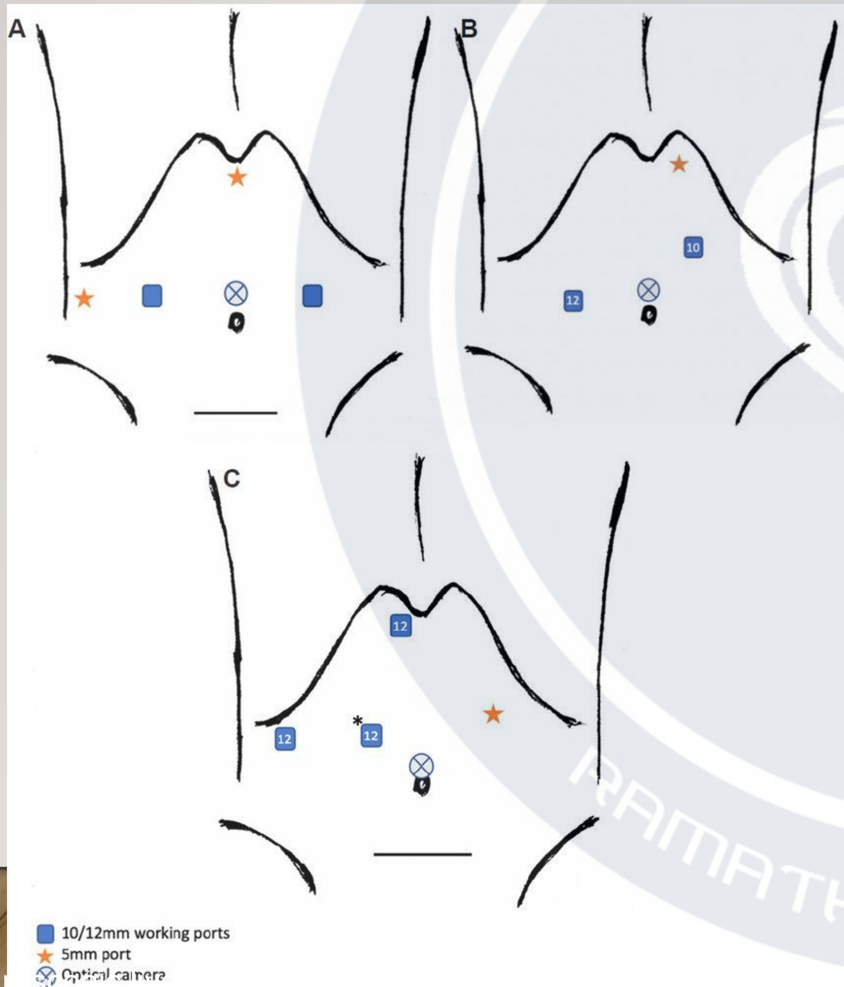

- Laparoscopic left lateral sectionectomy. Common port placement described by experienced French teams for left lateral sectionectomy (LLS) (A).
- Port placements for LLS and LDLT LLS by Troisi et al. (B).
- Port placements for LDLT LLS by Kim et al.[28] at University of Ulsan College of Medicine and Asan Medical Centre (C).

Thiruchelvam, N., Lee, S.Y., Chiow, A.K.H., 2021. Patient and port positioning in laparoscopic liver resections. Hepatoma Research 2021.. https://doi.org/10.20517/2394-5079.2020.144

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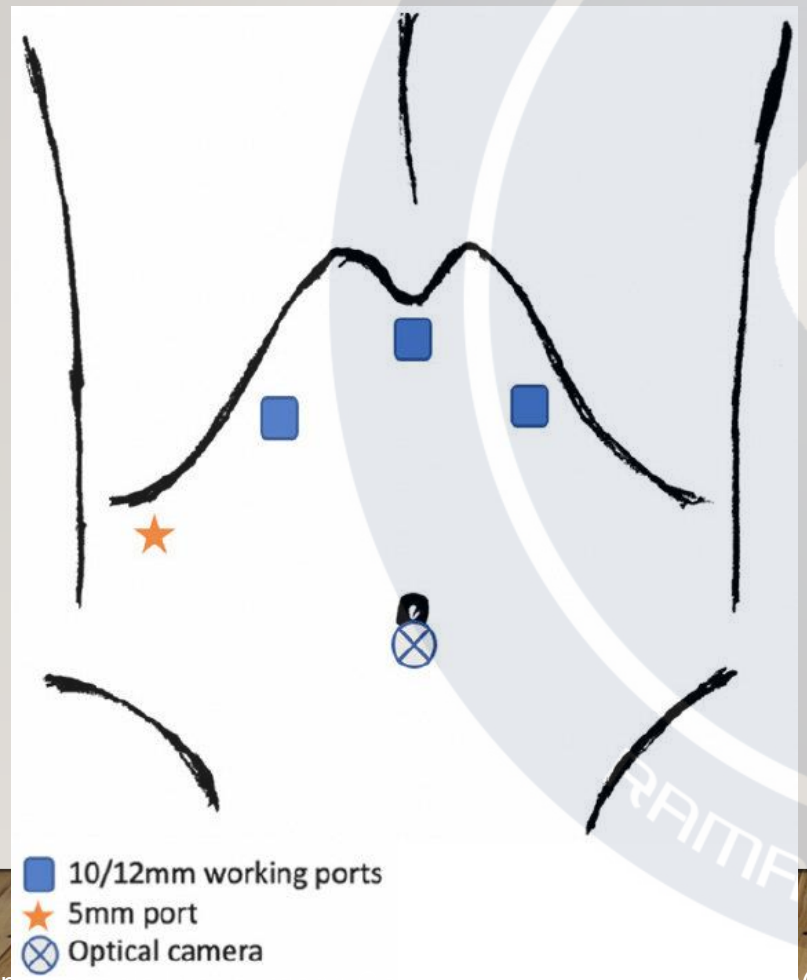

- Port placement for laparoscopic S4, subsegments S4a, S4b, and extended S4 by Kim et al.

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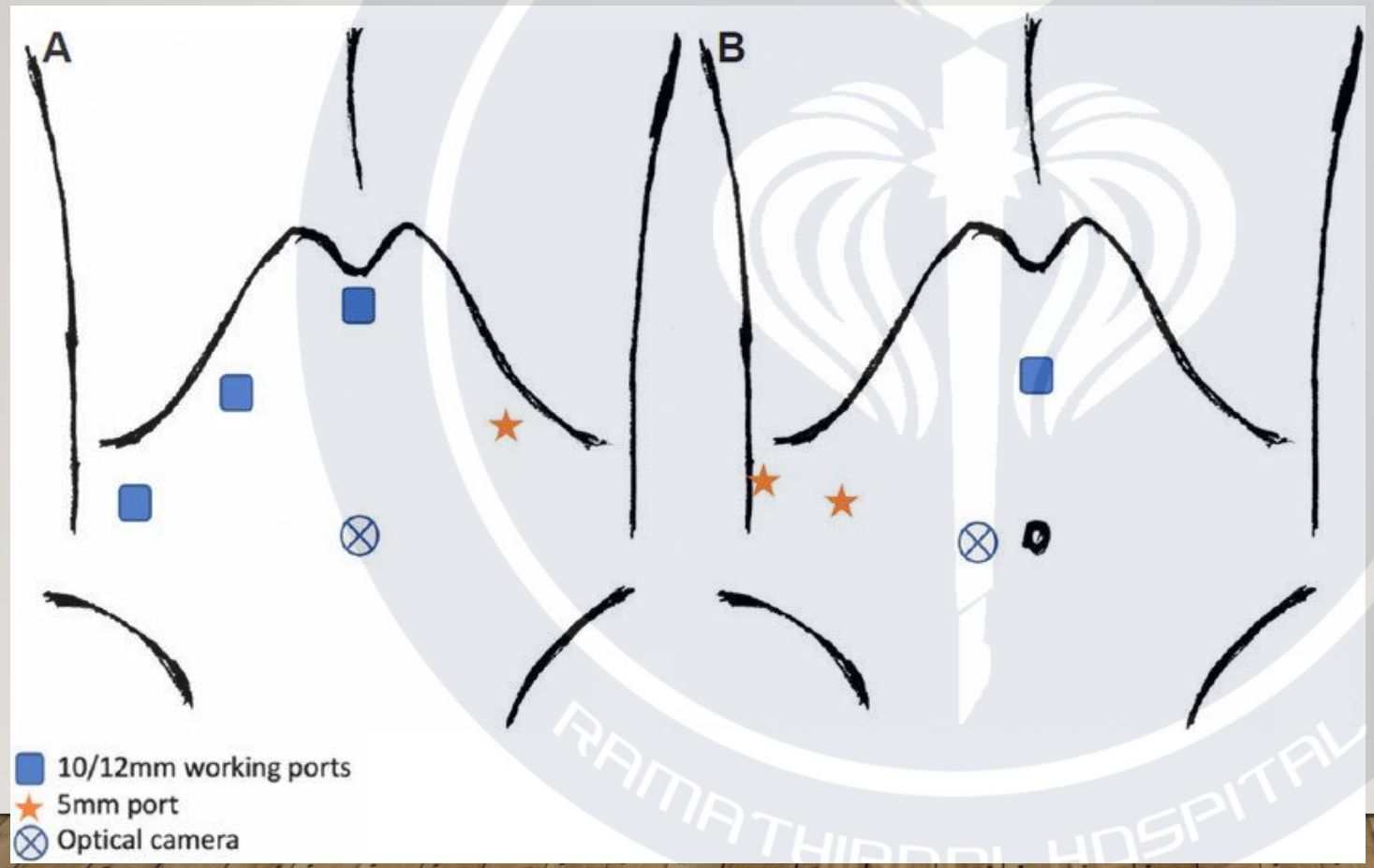

- Laparoscopic central bisectionectomy and right anterior sectionectomy. Port placement for laparoscopic central bisectionectomy and right anterior sectionectomy by Jeung et al. (A).
- Kim et al. and Ho et al. utilised similar port placements for centrally located tumours as that used by Suh et al. in LDLT right/left hepatectomy, described above (B).

Thiruchelvam, N., Lee, S.Y., Chiow, A.K.H., 2021. Patient and port positioning in laparoscopic liver resections. Hepatoma Research 2021.. https://doi.org/10.20517/2394-5079.2020.144

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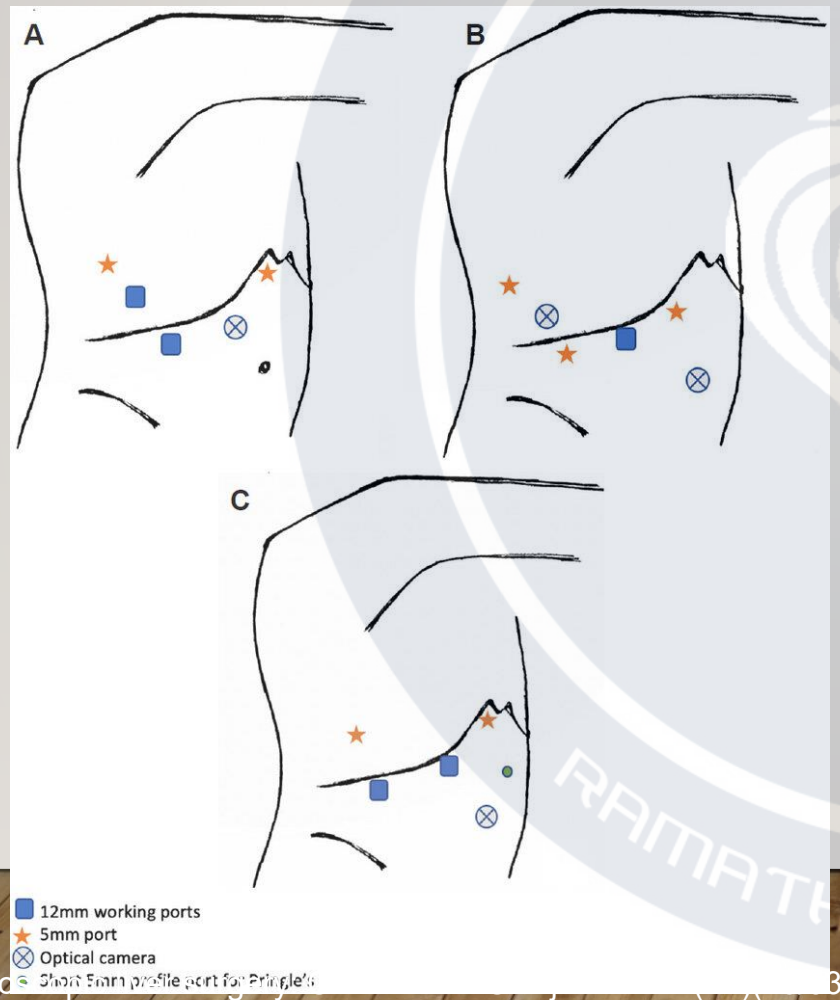

- Laparoscopic resections of dome lesions (segment 7 and 8). Laparoscopic segment 7 or 8 resections using a combined abdominal and lateral approach by Ishizawa et al. and Ogiso et al. (A).
- An alternative port positioning for posterior liver resections using combined abdominal and lateral approach (B). Port positions for laparoscopic segment 7 resections by Okuda et al. (C).

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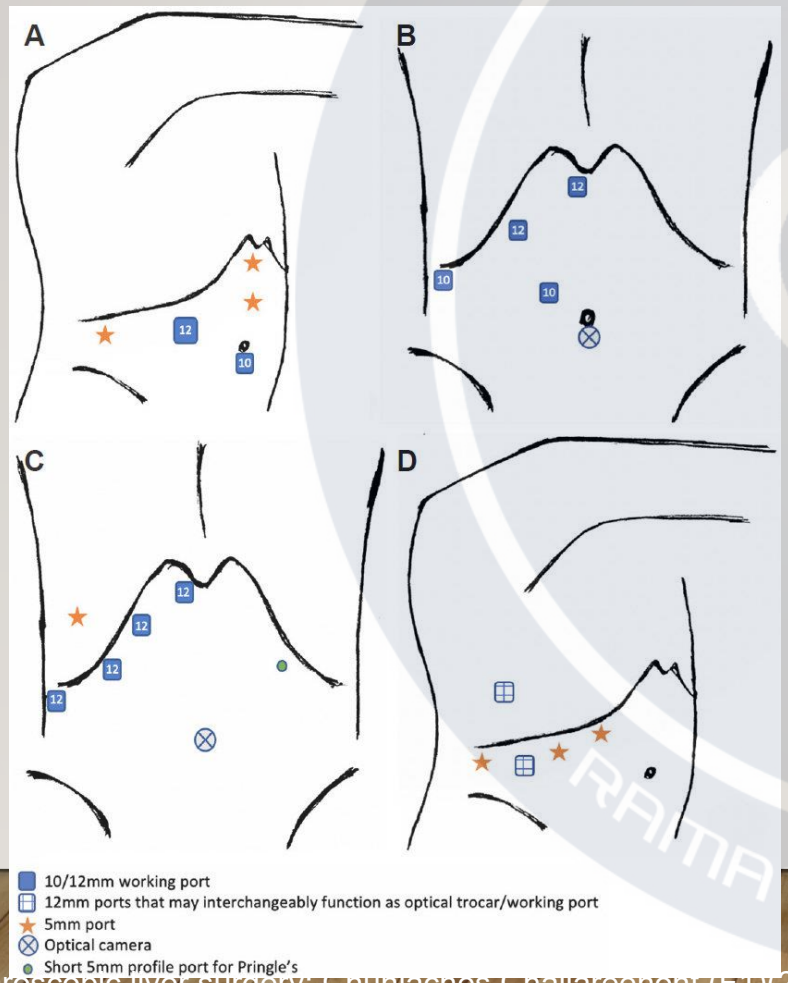

- Laparoscopic right posterior sectionectomy. Right posterior sectionectomy in the full left lateral decubitus (A).
- Right posterior sectionectomy in the semi-lateral decubitus (B).
- Right posterior sectionectomy in the left semi-lateral decubitus (30-degree tilt) (C).
- Right posterior sectionectomy with use of a trans-thoracic intercostal port (D).

Thiruchelvam, N., Lee, S.Y., Chiow, A.K.H., 2021. Patient and port positioning in laparoscopic liver resections. Hepatoma Research 2021.. https://doi.org/10.20517/2394-5079.2020.144

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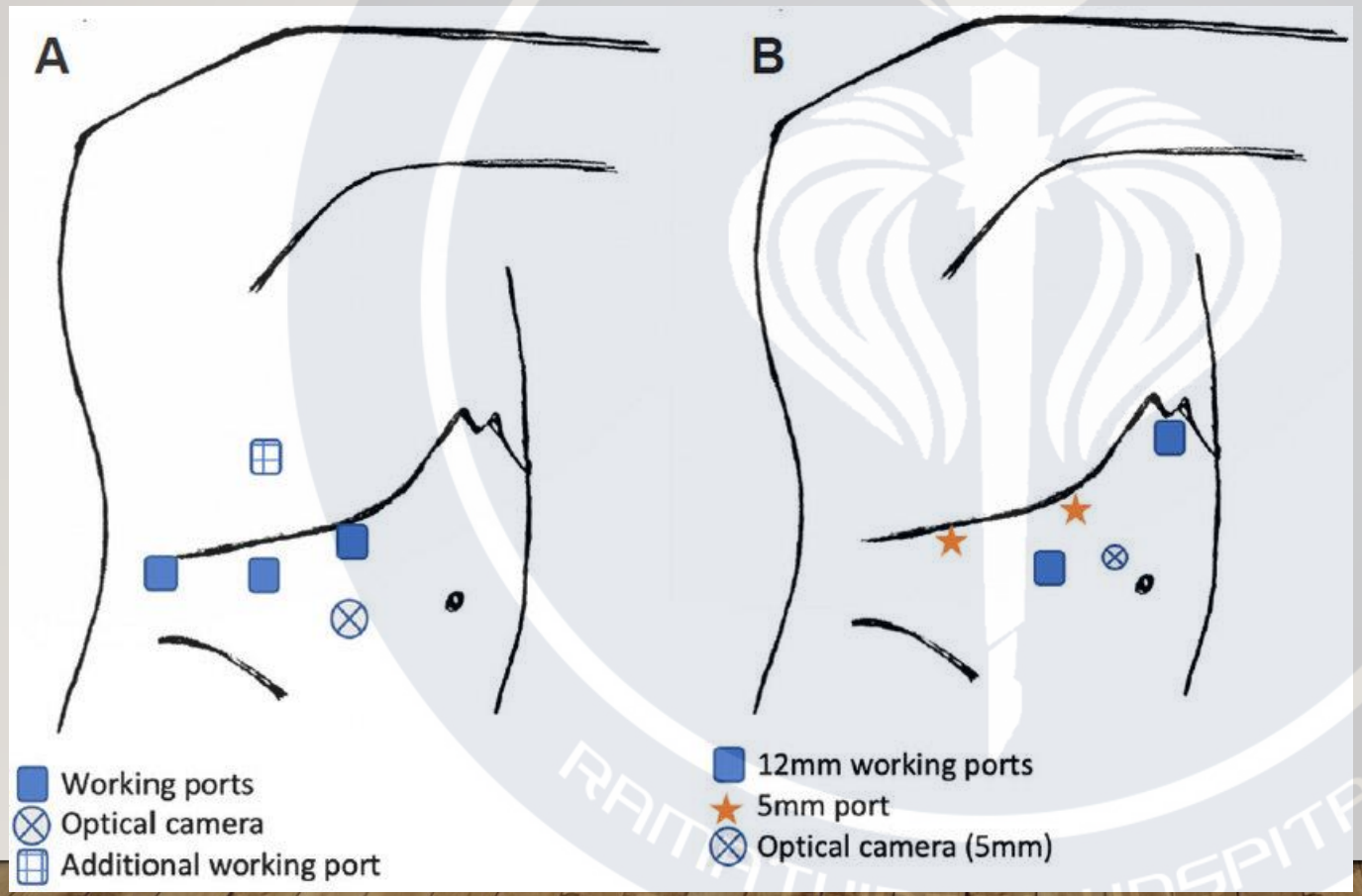

- Right-sided resections performed in the semi-prone position. Port positioning by Ikeda et al. for right sided resections in the semi-prone position (A).
- Laparoscopic right posterior sectionectomy in the left semi-prone position with jack-knife (B).

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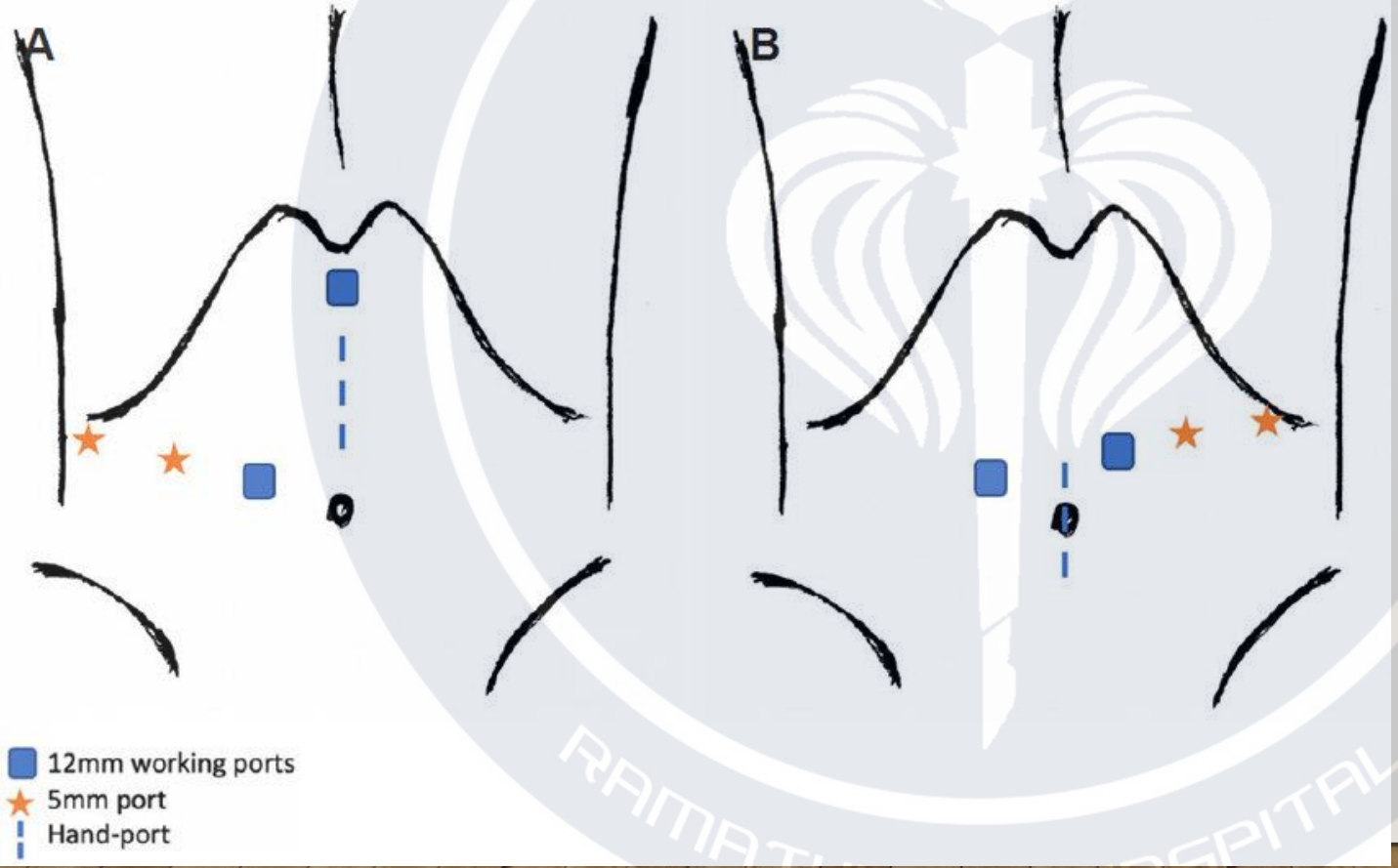
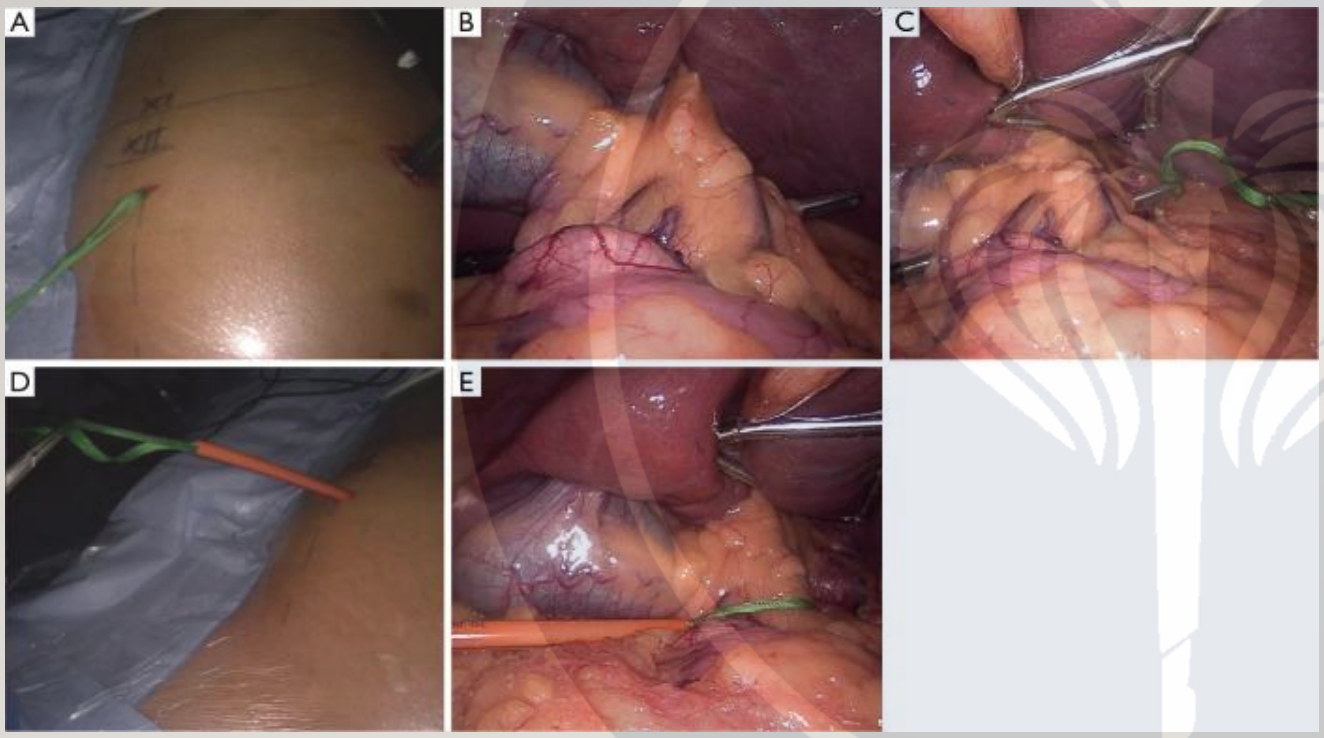


- Hand-assisted laparoscopic approach for right and left hepatectomy. Hand-assisted right hepatectomy (A).
- Hand-assisted left hepatectomy (B).

Thiruchelvam, N., Lee, S.Y., Chiow, A.K.H., 2021. Patient and port positioning in laparoscopic liver resections. Hepatoma Research 2021.. https://doi.org/10.20517/2394-5079.2020.144

EXTRACOPOREAL PRINGLE (RUMMEL)



- (A) Trocar (5 mm diameter) is placed on the mid axillary axe, 3 fingers under the tenth coast
- (B) forceps are inserted perpendiculary to hepatic pedicle
- (C) cord is inserted through anterior trocar to surround the hepatic pedicle
- (D) cord is exited through the right lateral trocar, and a tube is placed in order to do the clamp
- (E) the hepatic pedicle is surrounding and could be clamped easily at any moment by pulling the cord through the tube.

Piardi T, Lhuaire M, Memeo R, Pessaux P, Kianmanesh R, Sommacale D. Laparoscopic Pringle maneuver: how we do it? Hepatobiliary Surg Nutr. 2016;5(4):345-9.

INTRACORPOREAL PRINGLE

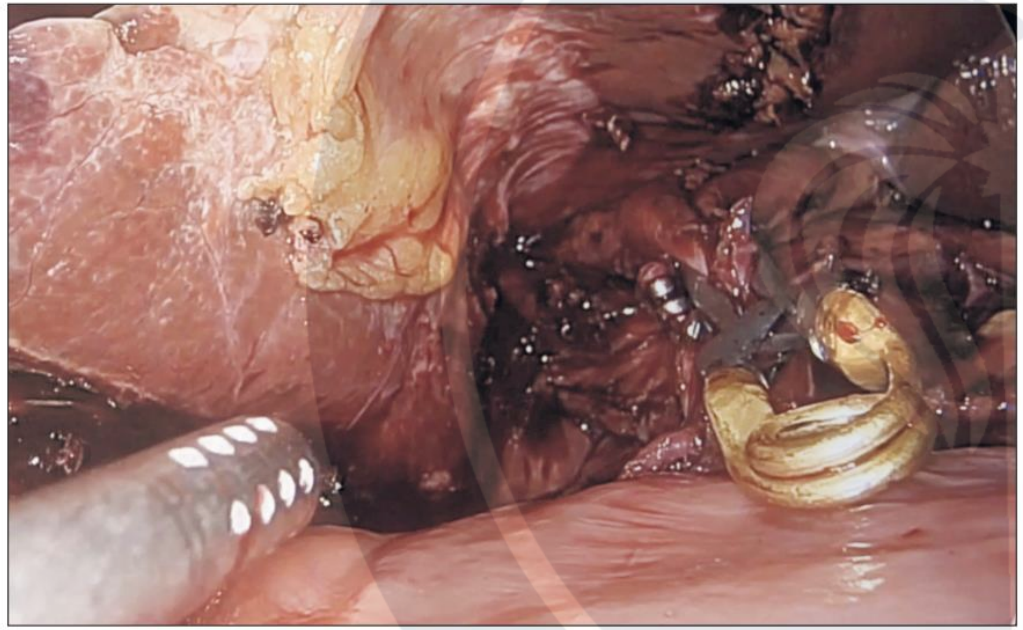


Fig. 3. The Bulldog technique.

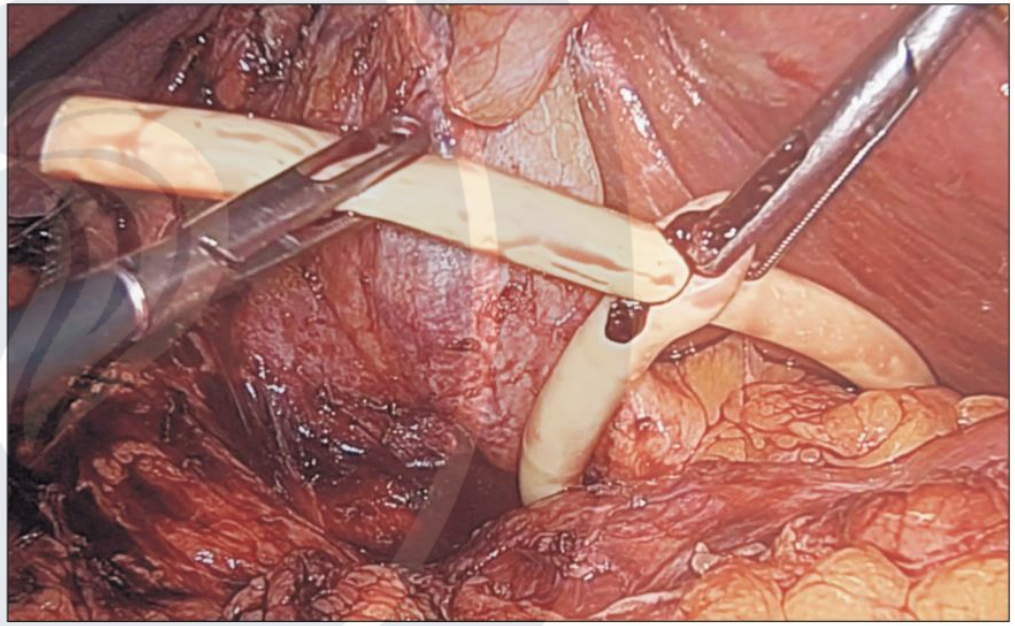


Fig. 4. The Huang Loop technique.

Piardi T, Lhuaire M, Memeo R, Pessaux P, Kianmanesh R, Sommacale D. Laparoscopic Pringle maneuver: how we do it? Hepatobiliary Surg Nutr. 2016;5(4):345-9.

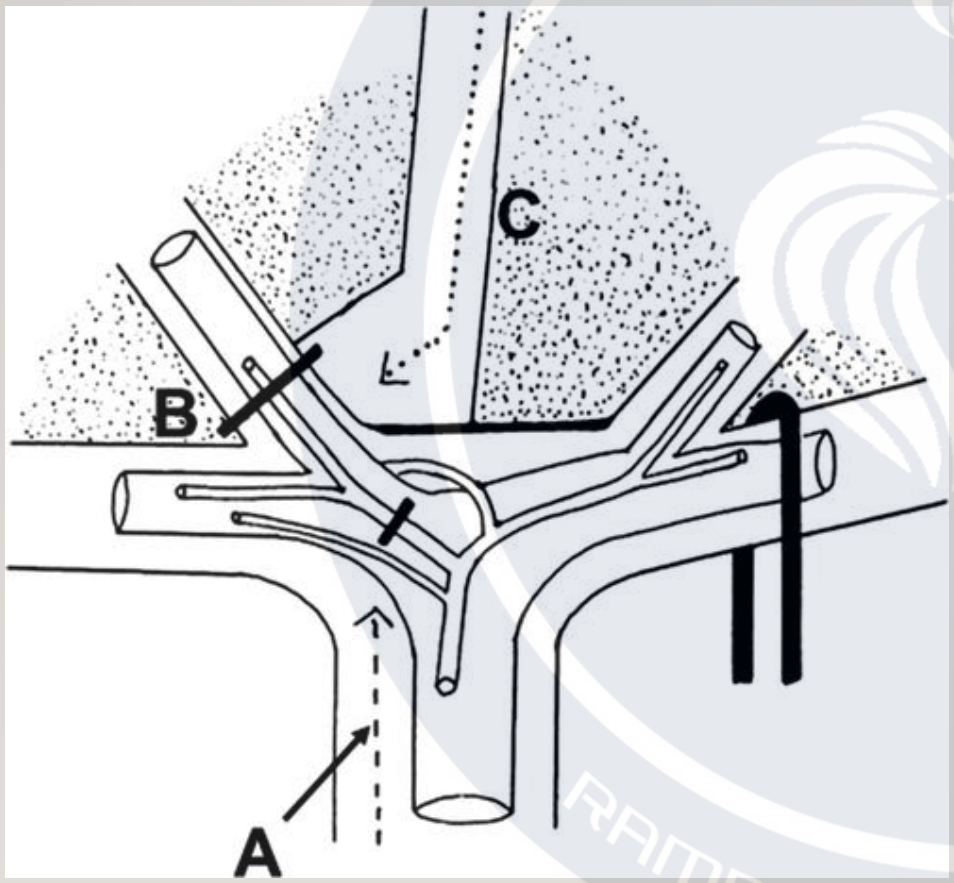
Advantage and disadvantage of different Pringle technique

Pringle technique	Advantage	Disadvantage
Intracorporeal technique	Doesn't require an additional incision	Requires specific material (hemoclips)
	Easy to perform in different positions	Not easy to achieve "in critical moments"
		Elaborated at the moment of unclamping
Extracorporeal technique	Cheap and easy to reproduce	Requires an additional incision
	Quickly usable in case of major bleeding	Complex to manoeuvre in the left side and in lateral decubitus
	Declamping easy and fast	

Piardi T, Lhuaire M, Memeo R, Pessaux P, Kianmanesh R, Sommacale D. Laparoscopic Pringle maneuver: how we do it? Hepatobiliary Surg Nutr. 2016;5(4):345-9.

- Peng, Yufu; Yang, Yubo; Chen, Kefei; Li, Bo; Zhang, Yuhan; Xu, Hongwei; Guo, Suqi; Wei, Yonggang**; Liu, Fei*. Hemihepatic versus total hepatic inflow occlusion for laparoscopic hepatectomy: A randomized controlled trial. International Journal of Surgery 107():p 106961, November 2022. | DOI: 10.1016/j.ijsu.2022.106961

INFLOW

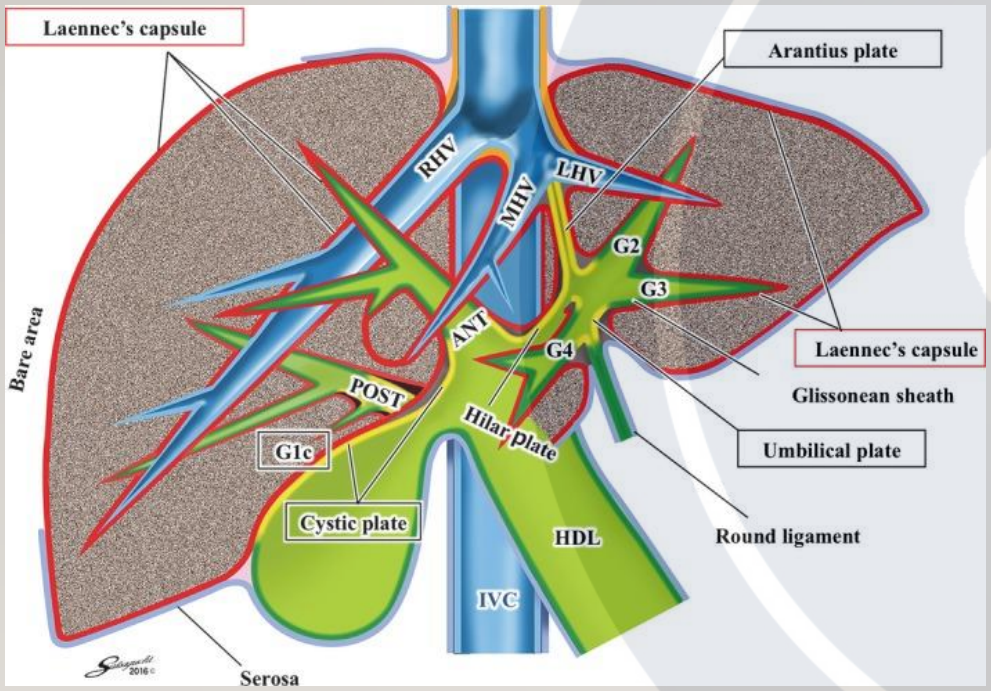


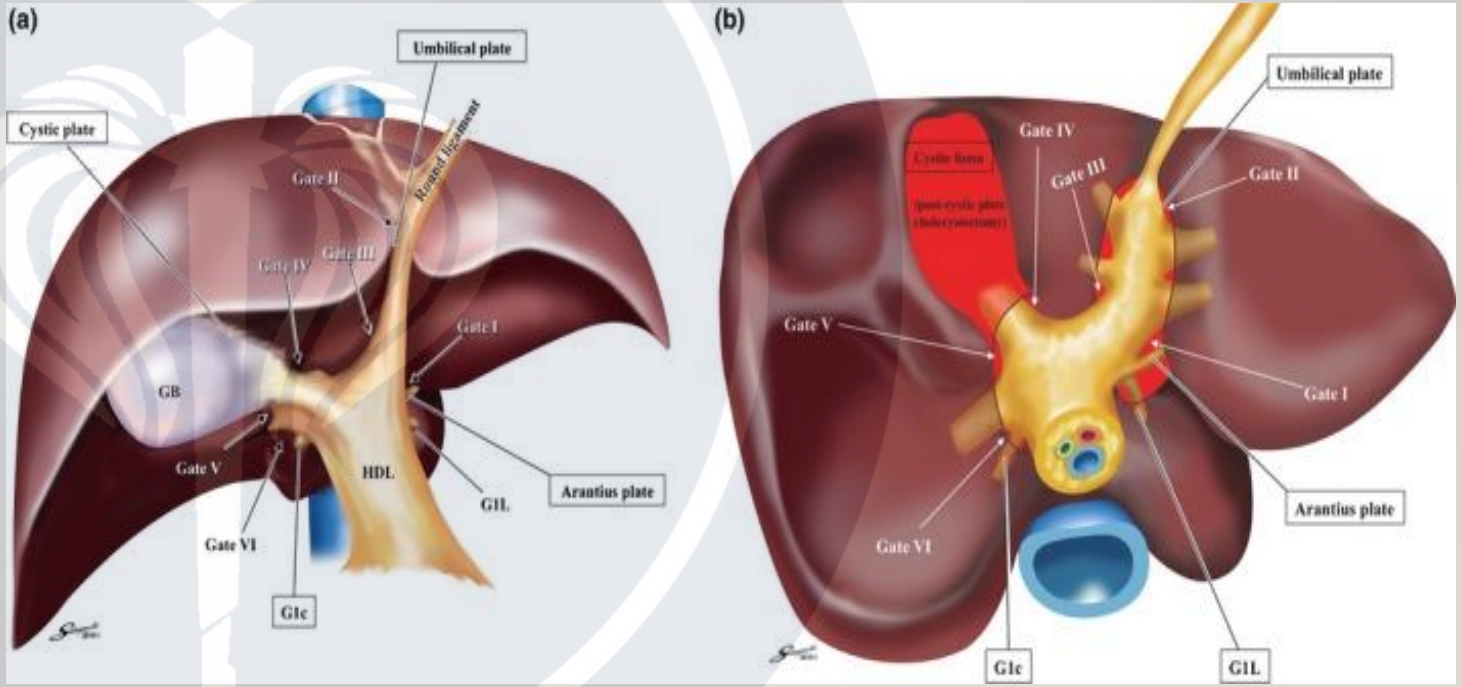
- The three methods of access to the portal pedicle.
  - A, Intrafascial approach.
  - B, Extrafascial approach.
  - C, Extrafascial and transfissural approach

Yamamoto M, Ariizumi S-i. Glissonean pedicle approach in liver surgery. Annals of Gastroenterological Surgery. 2018;2(2):124-8.

- Liao K-X, Yu F, Cao L, Wang B-L, Li X-S, Wang X-J, et al. Laparoscopic Glissonian pedicle versus hilar dissection approach hemihepatectomy: A prospective, randomized controlled trial. J Hepatobiliary Pancreat Sci 2022;29:629-40.

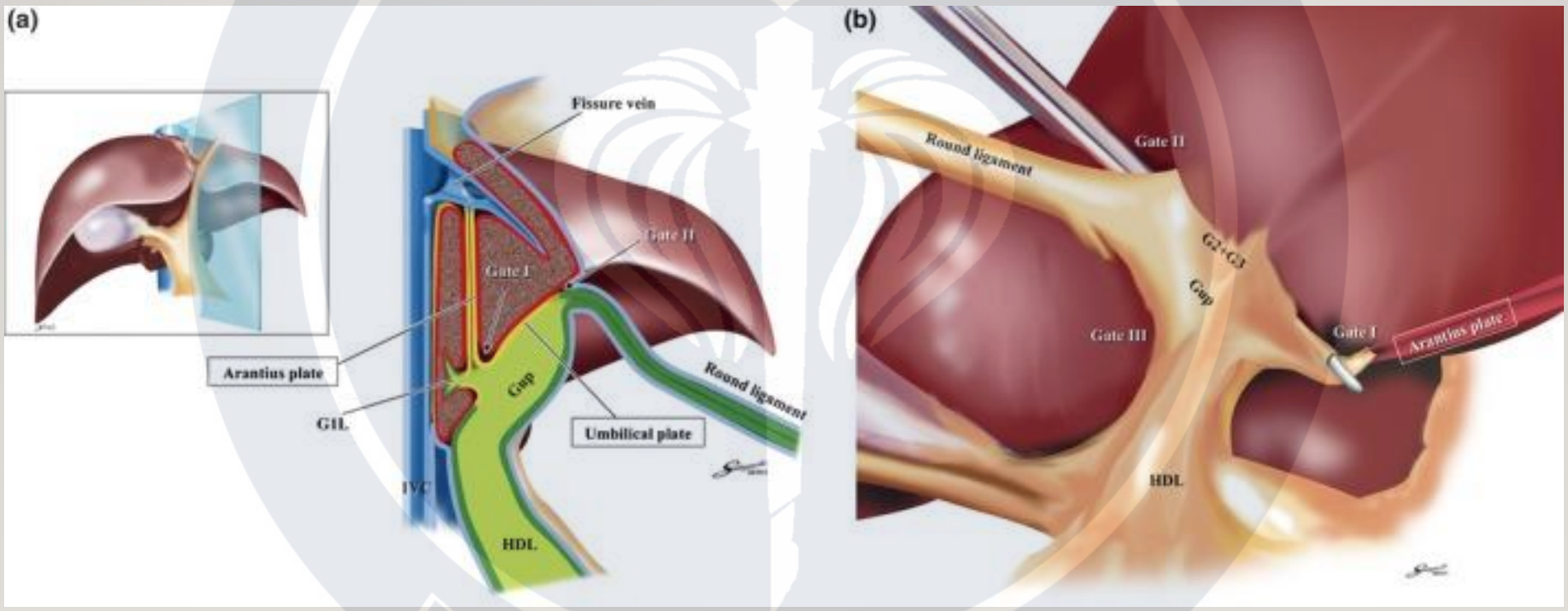
ANATOMY





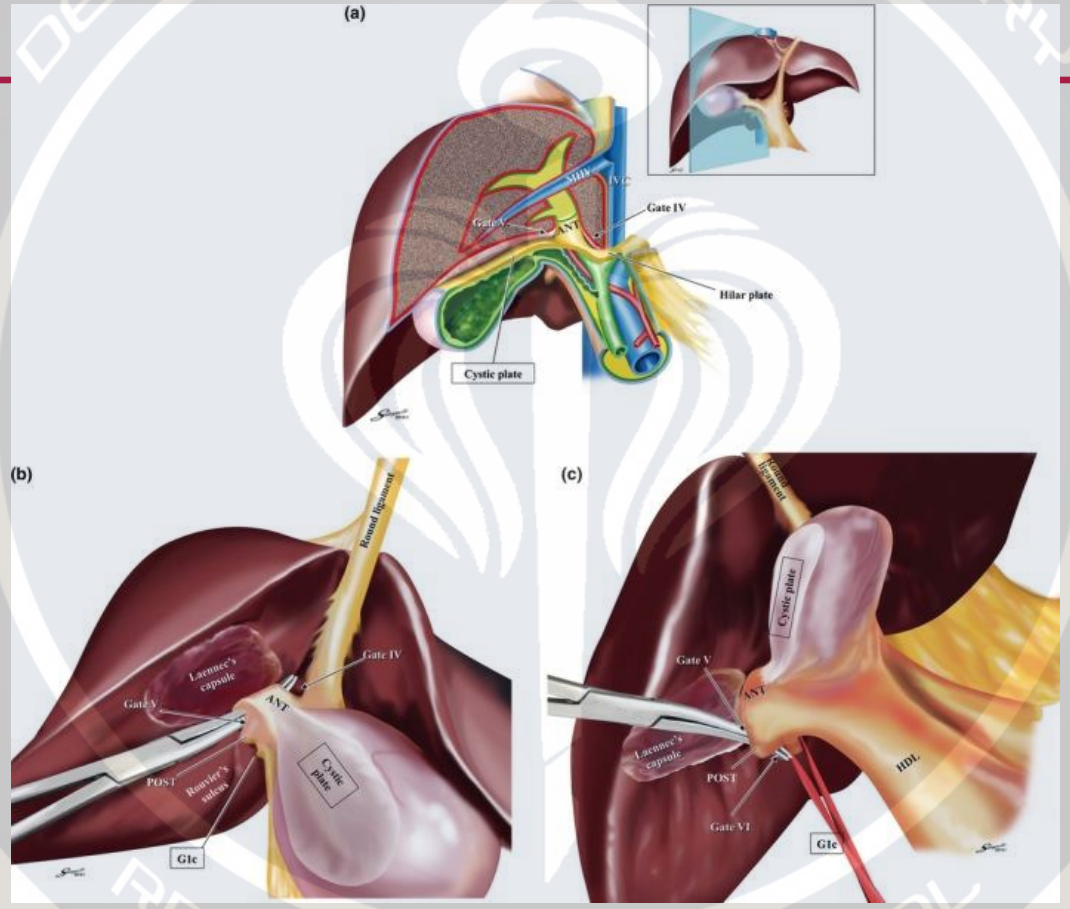
Sugioka A, Kato Y, Tanahashi Y. Systematic extrahepatic Glissonean pedicle isolation for anatomical liver resection based on Laennec's capsule: proposal of a novel comprehensive surgical anatomy of the liver. J Hepatobiliary Pancreat Sci. 2017;24(1):17-23.

INFLOW OF LEFT HEMILIVER



Sugioka A, Kato Y, Tanahashi Y. 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. 2017;24(1):17-23.

INFLOW OF RIGHT HEMILIVER



Sugioka A, Kato Y, Tanahashi Y. 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. 2017;24(1):17-23.

INFLOW

Topic 1: Hepatic inflow "Glissonean approach during minimally invasive anatomic liver resection (MIALR)"	Literature evidence score	Expert agreement
CQ1-1: Is the Glissonean approach preferable for MIALR?		
Recommendation 1: The Glissonean approach is a reasonable technique during MIALR	2++	100% (34/34)
Recommendation 2: During formal left and right hepatectomies using the Glissonean approach, it is safe to isolate and divide the 2nd order portal pedicles for inflow control. For the isolation of the 2nd and 3rd order portal pedicles during MIALR, the Glissonean approach appears to be more feasible than individual vessels and biliary ducts isolation	2+	97.1% (33/34)
Recommendation 3: The 3rd order or more peripheral Glissonean pedicles define an anatomical area named as "cone-unit". Cone units can be isolated during MIALR and their areas can be intraoperatively assessed by using ischemic demarcation, ICG negative counterstaining or both. The intra- or extra-hepatic Glissonean approach should be tailored in case-by-case basis	2−	97.1% (33/34)
CQ1-2. What are the important anatomical structures and techniques to safely perform the Glissonean approach during MIALR?		
Recommendation 1: There is a concept called "Gate Theory" in performing Glissonean pedicle isolation. According to this theory, Glissonean pedicle isolation is possible by maximizing the benefits of laparoscopic surgery	2++	100% (34/34)
Recommendation 2: Recognizing the following structures (Rouviere's sulcus, Cystic plate, Umbilical plate, Arantius Plate, the Glissonean pedicle of the Caudate process) as a landmark to isolate the Glissonean pedicle during MIALR is recommended	2++	100% (34/34)
Recommendation 3: Recognizing the Laennec's capsule as a landmark to isolate the extrahepatic Glissonean pedicles during MIALR is recommended	2++	88.2% (30/34)

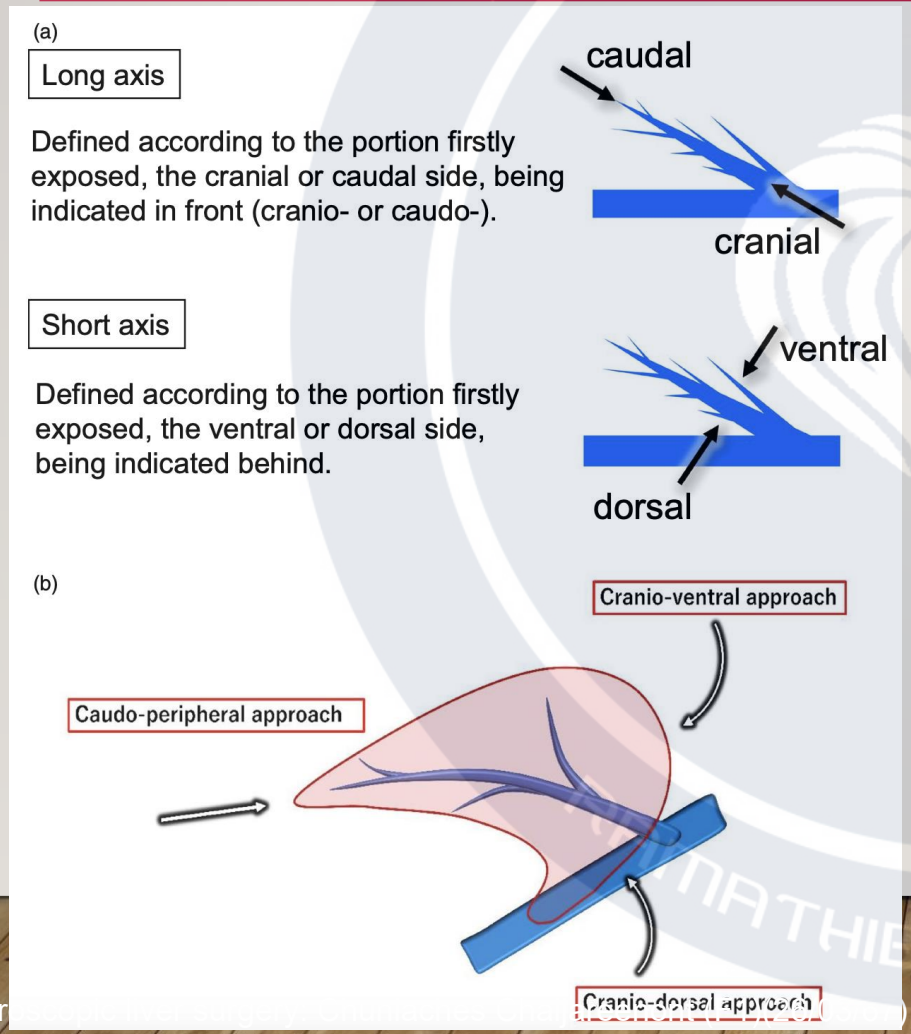
Gotohda N, Cherqui D, Geller DA, Abu Hilal M, Berardi G, Ciria R, et al. Expert Consensus Guidelines: How to safely perform minimally invasive anatomic liver resection. J Hepatobiliary Pancreat Sci. 2022;29(1):16-32.

OUTFLOW

Topic 2: Hepatic outflow	Literature evidence	Expert agreement
CQ2-1: What are the useful anatomical structures and techniques to safely expose the root of the major hepatic veins during MIALR?		
Recommendation 1: The inferior phrenic veins (IPVs) are useful landmarks to approach the suprahepatic IVC and the root of hepatic veins	3	97.1% (33/34)
Recommendation 2: The Arantius ligament is a useful landmark to identify the root of the MHV and/or LHV	3	100% (34/34)
Recommendation 3: Experts should know both the intrahepatic and extrahepatic approaches to identify the root of the right hepatic vein (RHV)	3	97.1% (33/34)

Gotohda N, Cherqui D, Geller DA, Abu Hilal M, Berardi G, Ciria R, et al. Expert Consensus Guidelines: How to safely perform minimally invasive anatomic liver resection. J Hepatobiliary Pancreat Sci. 2022;29(1):16-32.

HEPATIC VEIN-GUIDED APPROACH



- A, The definition rules for hepatic approach directions.
- B, A classification of the hepatic vein-guided approach (HVGA)

Gotohda N, Cherqui D, Geller DA, Abu Hilal M, Berardi G, Ciria R, et al. Expert Consensus Guidelines: How to safely perform minimally invasive anatomic liver resection. J Hepatobiliary Pancreat Sci. 2022;29(1):16-32.

HEPATIC VEIN-GUIDED APPROACH

CQ2-2. Is the hepatic vein guided approach (HVGA) preferable for MIALR?		
Recommendation 1: The HVGA is useful for the MIALR using the Glissonean approach because it diminishes the disadvantages of laparoscopic liver resections (LLRs), such as disorientation	3	100% (34/34)
Recommendation 2: An HVGA procedure in which the major hepatic vein is exposed continuously from its root side is useful alternative for the intrahepatic Glissonean approach	3	94.1% (32/34)

Topic 2: Hepatic outflow	**Literature evidence**	**Expert agreement**
CQ2-3. What are the preferable techniques to safely perform the hepatic vein guided approach during MIALR?		
Recommendation 1: When exposing the major hepatic vein, the device's tip should be moved from its root side to the periphery to avoid splitting the crotch between the branches	3	100% (34/34)
Recommendation 2: If there is bleeding from the hepatic vein, immediate light compression is recommended as the first step to control bleeding	3	100% (34/34)

Gotohda N, Cherqui D, Geller DA, Abu Hilal M, Berardi G, Ciria R, et al. Expert Consensus Guidelines: How to safely perform minimally invasive anatomic liver resection. J Hepatobiliary Pancreat Sci. 2022;29(1):16-32.

SEGMENT/SECTION MIALR, MINALR

Topic 3: Segment/Section "Anatomic/Non anatomic resection"	Literature evidence	Expert agreement
CQ3-1. What defines intersegmental/sectional planes and what helps to determine them during MIALR?		
Recommendation 1: The intersegmental/sectional plane (IP) is defined by the border or watershed of each order portal venous territory. Hepatic veins coursing IPs are defined as intersegmental/sectional veins (IVs)	2++	100% (34/34)
Recommendation 2A: The fundamental landmarks to determine IPs are considered as follows: the demarcation line, the IVs, the root of the responsible Glissonean pedicle, and the root of major hepatic vein(s). These landmarks should be connected during the liver transection to follow a proper IP	2–	100% (34/34)
Recommendation 2B: The use of additional landmarks, such as Rouviere's sulcus, gallbladder fossa, falciform ligaments and inferior vena cava to assist in the identification of IPs is recommended during MIALR parenchymal transection	3	100% (34/34)
Recommendation 2C: Preoperative planning using 3D simulation is recommended for better understanding of the vascular anatomy and the variation of the IVs along the IPs	2–	100% (34/34)
Recommendation 2D: Systemic infusion of contrasting agents for negative staining during Glissonean pedicle clamping, or their direct injection into the portal vein for positive staining is recommended in MIALR to obtain a demarcation line	2++	100% (34/34)
CQ3-2. What are the useful techniques to decide the liver transection line during MI-non anatomic liver resection (MINALR)?		
Recommendation 1: Non-anatomic resection's goals should include achieving negative margins, maximizing parenchymal preservation and maintaining sufficient vascular inflow and outflow in the remnant liver	2–	97.1% (33/34)
Recommendation 2: To determine the optimal transection plane for non-anatomic resection, tumor identification/visualization, and recognition of the anatomical relationship between the tumor and remnant liver vasculatures are key issues	2–	100% (34/34)
Recommendation 3A: US, contrast-enhanced US (CEUS) and ICG fluorescence are useful to identify and clearly visualize tumors	2++	100% (34/34)
Recommendation 3B: Preoperative simulation, US, and CE-US are useful modalities to understand the anatomical relationship between the tumor and remnant liver vasculature	3	100% (34/34)

Gotohda N, Cherqui D, Geller DA, Abu Hilal M, Berardi G, Ciria R, et al. Expert Consensus Guidelines: How to safely perform minimally invasive anatomic liver resection. J Hepatobiliary Pancreat Sci. 2022;29(1):16-32.

SEGMENT/SECTION MIALR

- In general, IVs are optimal landmarks from their root side and along the upper sections/segments between (segment VII, VIII and IVa), while in the lower part closer to the liver caudal margin (segment V, VI and IVb), hepatic veins become branched and are not necessarily representing the IP.
- When performing Glissonean pedicle clamping or occlusion, IPs are visualized not only on the liver surfaces but also on the deep raw surfaces during the liver transection using the fluorescence images after systemic injection of ICG (ICG staining). **"Game changer"**

Gotohda N, Cherqui D, Geller DA, Abu Hilal M, Berardi G, Ciria R, et al. Expert Consensus Guidelines: How to safely perform minimally invasive anatomic liver resection. J Hepatobiliary Pancreat Sci. 2022;29(1):16-32.

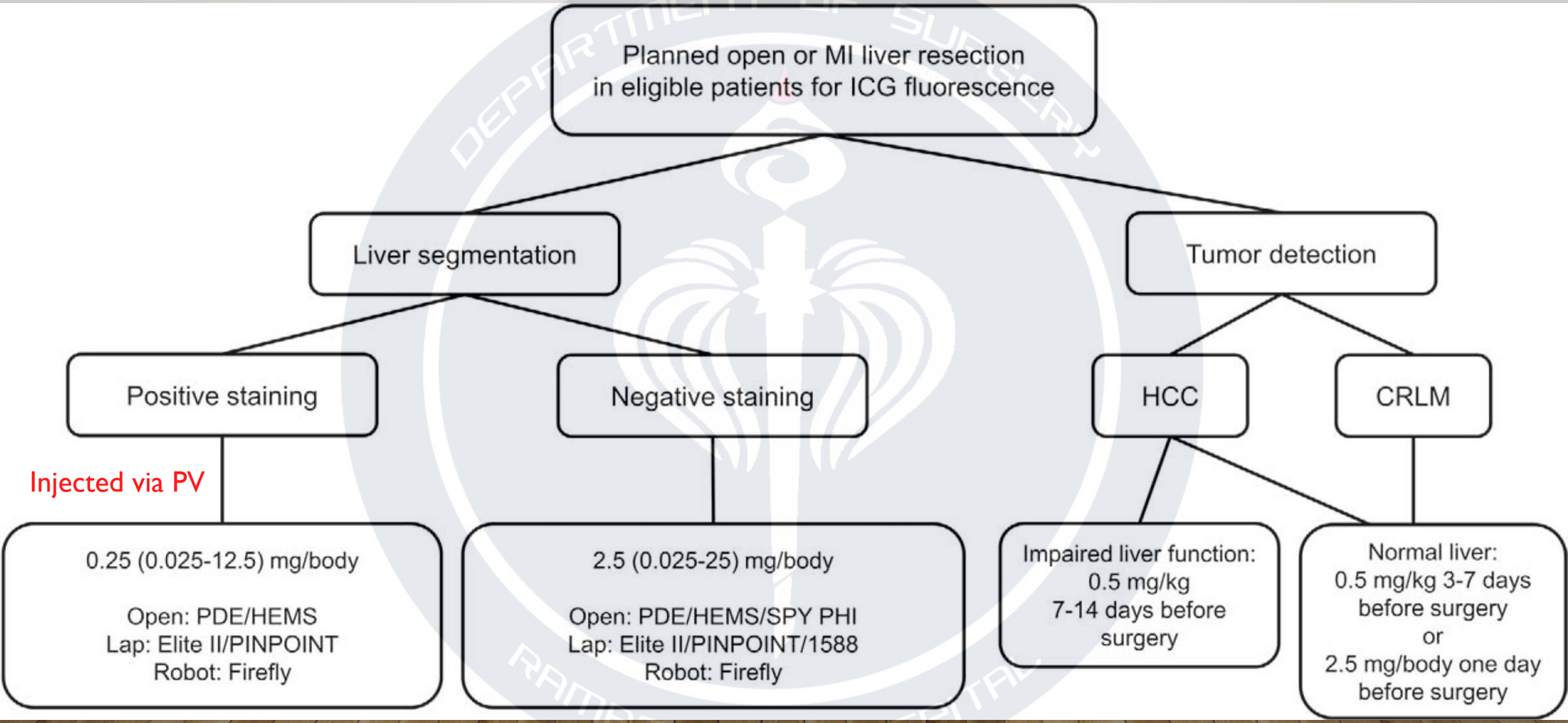
Histology of the Laennec's capsule around the hepatic veins and how it may guide approaches to laparoscopic anatomic liver resection

Video clips for inter- and outer-Laennec approaches

Kazuteru Monden[1]

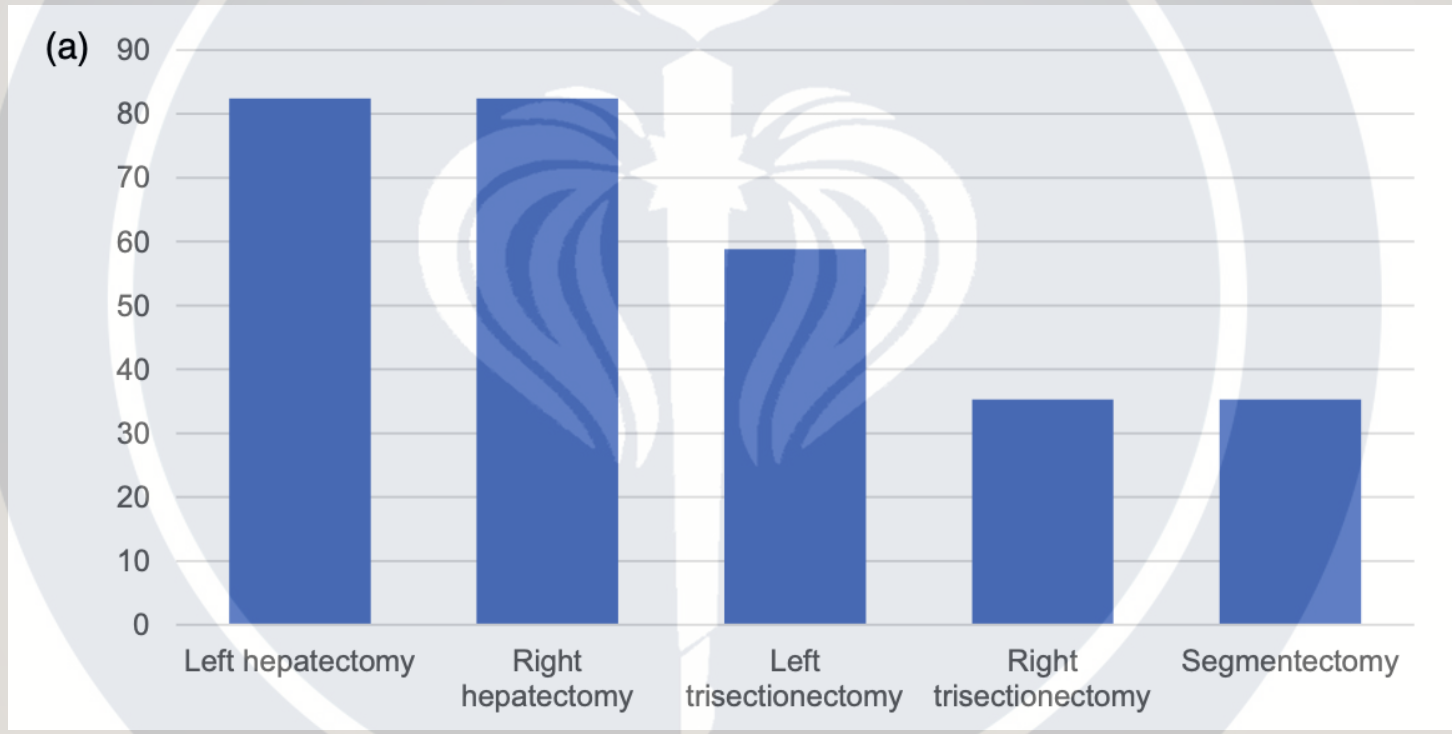
Kyotaro Ohno,[2] Hiroshi Sadamori,[1] Masayoshi Hioki,[1] Satoshi Ohno,[1] Norihisa Takakura,[1] Atsushi Sugioka[3]

[1]Department of Surgery, Fukuyama City Hospital, Hiroshima, Japan
[2]Department of Pathology, Fukuyama City Hospital, Hiroshima, Japan
[3]Department of Surgery, Fujita Health University, Aichi, Japan



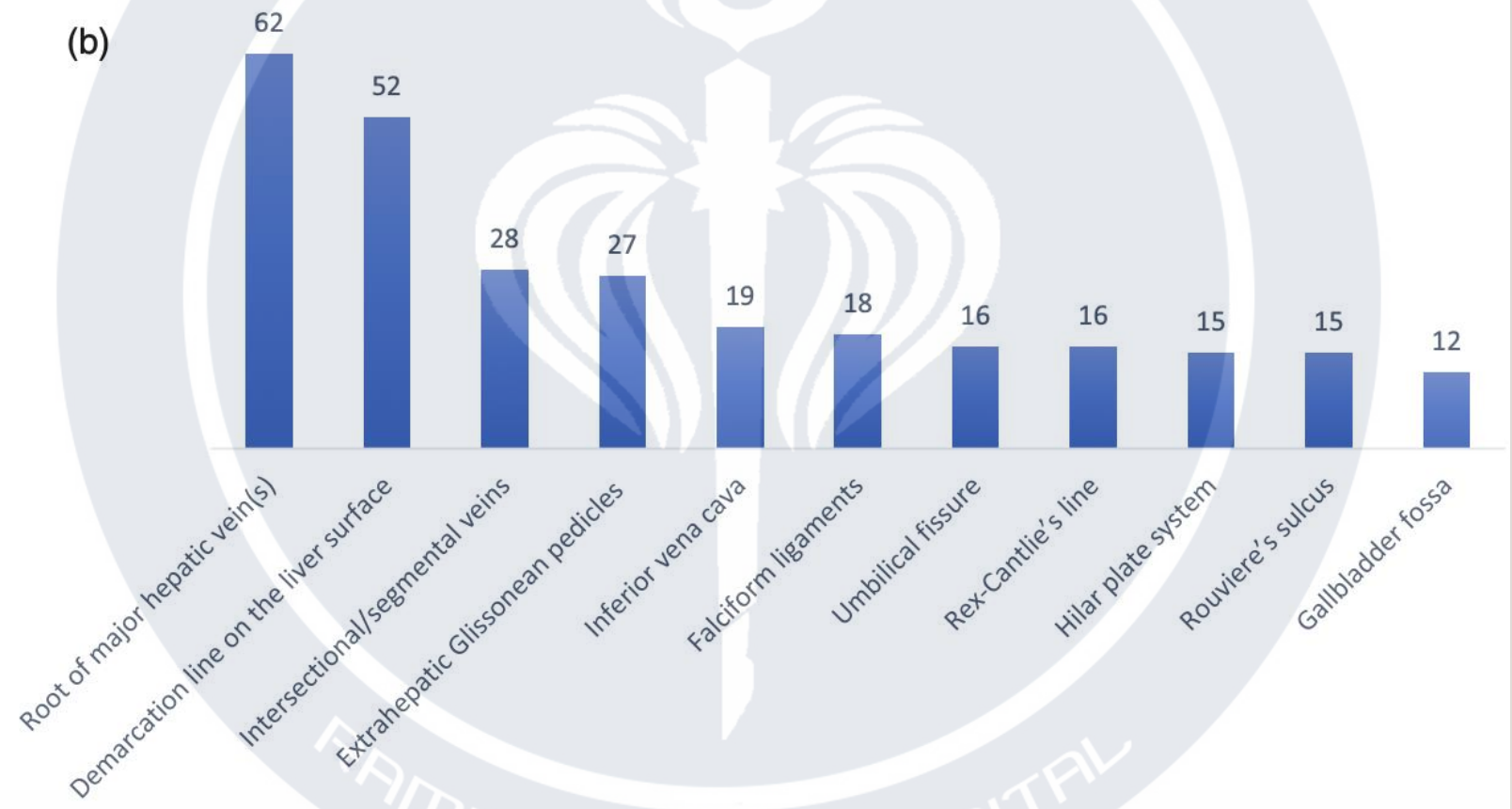
Wakabayashi T, Cacciaguerra AB, Abe Y, Bona ED, Nicolini D, Mocchegiani F, et al. Indocyanine Green Fluorescence Navigation in Liver Surgery: A Systematic Review on Dose and Timing of Administration. Annals of Surgery. 2022;275(6):1025-34.

INTERSEGMENTAL VEINS EXPOSURE



Gotohda N, Cherqui D, Geller DA, Abu Hilal M, Berardi G, Ciria R, et al. Expert Consensus Guidelines: How to safely perform minimally invasive anatomic liver resection. J Hepatobiliary Pancreat Sci. 2022;29(1):16-32.

LANDMARK TO IDENTIFY INTERSEGMENTAL VEINS



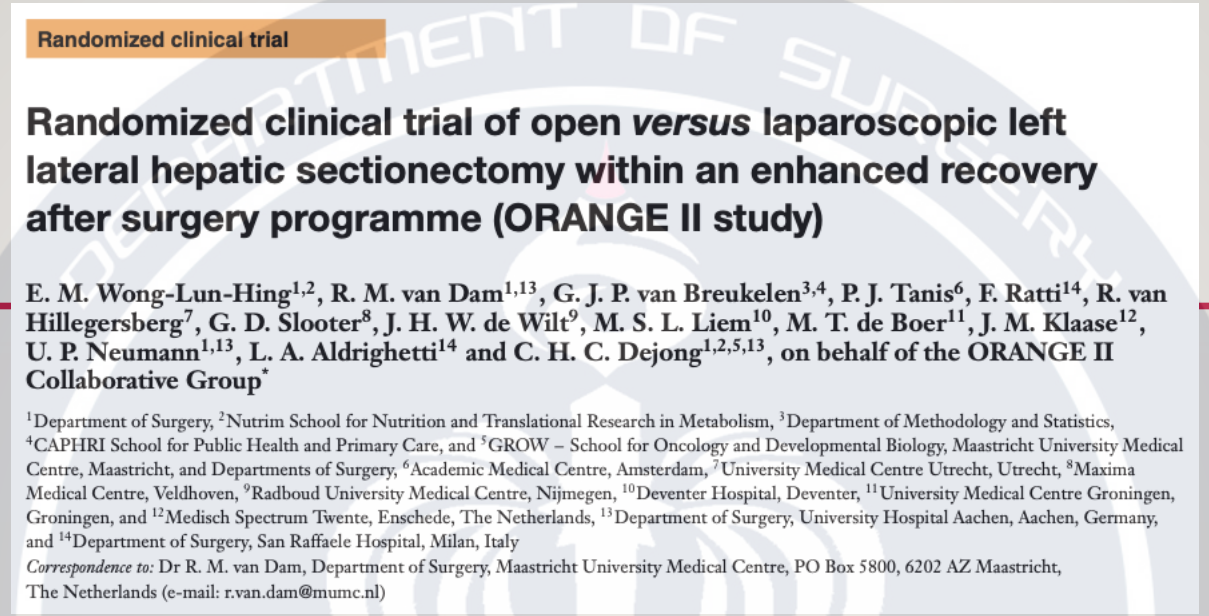
Gotohda N, Cherqui D, Geller DA, Abu Hilal M, Berardi G, Ciria R, et al. Expert Consensus Guidelines: How to safely perform minimally invasive anatomic liver resection. J Hepatobiliary Pancreat Sci. 2022;29(1):16-32.

ENERGY DEVICES

- Respecting the basics of HPB surgery is the rule, and has emerged as the safest method irrespective of the ED used for transection: sharp dissection, vascular control and elective sealing.

- Mikhail E, Ivan K, Ruslan A, Andrey V, Anna K, Dmitry K, et al. A randomized prospective study of the immediate outcomes of the use of a hydro-jet dissector and an ultrasonic surgical aspirator for laparoscopic liver resection. HPB (Oxford) 2021;23:1332-8.

OUTCOME



Randomized clinical trial

Randomized clinical trial of open *versus* laparoscopic left lateral hepatic sectionectomy within an enhanced recovery after surgery programme (ORANGE II study)

E. M. Wong-Lun-Hing[1,2], R. M. van Dam[1,13], G. J. P. van Breukelen[3,4], P. J. Tanis[6], F. Ratti[14], R. van Hillegersberg[7], G. D. Slooter[8], J. H. W. de Wilt[9], M. S. L. Liem[10], M. T. de Boer[11], J. M. Klaase[12], U. P. Neumann[1,13], L. A. Aldrighetti[14] and C. H. C. Dejong[1,2,5,13], on behalf of the ORANGE II Collaborative Group*

[1]Department of Surgery, [2]Nutrim School for Nutrition and Translational Research in Metabolism, [3]Department of Methodology and Statistics, [4]CAPHRI School for Public Health and Primary Care, and [5]GROW – School for Oncology and Developmental Biology, Maastricht University Medical Centre, Maastricht, and Departments of Surgery, [6]Academic Medical Centre, Amsterdam, [7]University Medical Centre Utrecht, Utrecht, [8]Maxima Medical Centre, Veldhoven, [9]Radboud University Medical Centre, Nijmegen, [10]Deventer Hospital, Deventer, [11]University Medical Centre Groningen, Groningen, and [12]Medisch Spectrum Twente, Enschede, The Netherlands, [13]Department of Surgery, University Hospital Aachen, Aachen, Germany, and [14]Department of Surgery, San Raffaele Hospital, Milan, Italy

Correspondence to: Dr R. M. van Dam, Department of Surgery, Maastricht University Medical Centre, PO Box 5800, 6202 AZ Maastricht, The Netherlands (e-mail: r.van.dam@mumc.nl)

- N = 91
  - RCT 24 (LLS 13, OLS 11)
  - Prospective registry 67 (LLS 54, OLS 13)
- Stop trial due to poor recruitment

Wong-Lun-Hing EM, van Dam RM, van Breukelen GJP, Tanis PJ, Ratti F, van Hillegersberg R, et al. Randomized clinical trial of open versus laparoscopic left lateral hepatic sectionectomy within an enhanced recovery after surgery programme (ORANGE II study). Br J Surg 2017;104:525-35.

ABSTRACT | VOLUME 32, SUPPLEMENT 5, S531, SEPTEMBER 2021

384O Laparoscopic versus open hemihepatectomy: The ORANGE II PLUS multicenter randomized controlled trial

R.S. Fichtinger • L. Aldrighetti • R. Troisi • ... Z. Eminton • J. Primrose • R. van Dam • Show all authors

Open Archive • DOI: https://doi.org/10.1016/j.annonc.2021.08.906

- N 332 (LMH = 166, OMH = 166) Intention to treat
- Malignancy 281 (majority CRLM 166)
- Reduced time to functional recovery 4 vs 5 days ($P < 0.001$)
- Shorter LOS 5 vs 6 days ($P = 0.002$)
- Longer op time 310 vs 254 ($P < 0.001$)
- No statistical differences in blood-loss, complication, 90-day mortality. 3-yr survival

Fichtinger RS, Aldrighetti L, Troisi R, Abu Hilal M, Sutcliffe R, Besselink M, et al.. 384O Laparoscopic versus open hemihepatectomy: The ORANGE II PLUS multicenter randomized controlled trial. Annals of Oncology. 2021;32:S531.

Laparoscopic Versus Open Resection for Colorectal Liver Metastases

The OSLO-COMET Randomized Controlled Trial

Åsmund Avdem Fretland, MD,†‡ Vegar Johansen Dagenborg, MD,§‡¶ Gudrun Maria Waaler Bjørnelv, MPhil,*†††
Airazat M. Kazaryan, MD, PhD,** Ronny Kristiansen,*†† Morten Wang Fagerland, MSc, PhD,‡‡
John Hausken, MD,§§ Tor Inge Tønnessen, MD, PhD,‡§§ Andreas Abildgaard, MD, PhD,¶¶
Leonid Barkhatov, MD,*||||‡ Sheraz Yaqub, MD, PhD,† Bård I. Røsok, MD, PhD,†
Bjørn Atle Bjørnbeth, MD, PhD,† Marit Helen Andersen, RN, PhD,***††† Kjersti Flatmark, MD, PhD,¶§‡
Eline Aas, MPhil, PhD,††† and Bjørn Edwin, MD, PhD,*†‡*

- N = 273 (Lap = 129, Open = 144)
- Inclusion criteria
  - Lesion can Parenchymal-sparing liver resection
  - Multiple resections, re-resection
  - Resectable in lung and adrenal gland were allowed
- Exclusion criteria
  - Others extrahepatic metastasis
  - Concomitant ablation
  - Vascular or biliary reconstruction
  - Synchronous resection of primary tumor

- Comparable tumor location, number, complexity
- More re resection cases in LLS
- Lap lower post op complication ≥ grade 2 19% vs 31% (P = 0.021), Death 1 in Open group
- Lap lower LOS 53 vs 96 hours (P < 0.001)
- Lap lower morphine equivalent (P < 0.001)
- No statistical differences in Blood loss, transfusion, R0 resection, Missed lesion

Fretland ÅA, Dagenborg VJ, Bjørnelv GW, et al.. Laparoscopic Versus Open Resection for Colorectal Liver Metastases. *Annals of Surgery*. 2018; 267 (2): 199-207..

Open versus minimally invasive liver surgery for colorectal liver metastases (LapOpHuva): a prospective randomized controlled trial

Ricardo Robles-Campos[1] · Víctor Lopez-Lopez[1] · Roberto Brusadin[1] · Asunción Lopez-Conesa[1] · Pedro José Gil-Vazquez[1] · Álvaro Navarro-Barrios[1] · Pascual Parrilla[1]

- N = 193 (LLR = 96, OLR = 97, per protocol)
- 1^0 outcome 90 days morbidity, 2^0 outcome DFS, OS
- Inclusion criteria
  - Wedge, segmentectomies 1-8, RPS, LLS, LH
  - Include resectable lung metastasis
- Exclusion criteria
  - ASA III, cirrhotic liver ECOG > 2
  - Disseminated disease (adrenal, LN, peritoneum, multiple and bilobar disease)
  - Liver > 10 cm., close to vascular
  - Repeated resection, simultaneous, RH,, ERH, ELH and two-stage liver resetion
- No statistical difference in size of tumor (2-5), no. of tumor (1-2), location, TNM, NACT
- No statistical difference in op time, blood loss, clamp time, complication,R0, OS, DFS
- More cases in LLR use pringle maneuver
- LLR less LOS, no SSI

Robles-Campos R, Lopez-Lopez V, Brusadin R, Lopez-Conesa A, Gil-Vazquez P, Navarro-Barrios Á, et al. Open versus minimally invasive liver surgery for colorectal liver metastases (LapOpHuva): a prospective randomized controlled trial. Surg Endosc 2019 12;33(12):3926-3936.

Laparoscopic Versus Open Hepatic Resection for Solitary Hepatocellular Carcinoma Less Than 5 cm in Cirrhotic Patients: A Randomized Controlled Study

Ahmed El-Gendi, MD, MRCS, PhD,[1] Mohamed El-Shafei, MD, PhD,[2] Saba El-Gendi, MD, PhD,[3] and Ahmed Shawky, MD, PhD[1]

- N = 50
- RCT
- HCC < 5 cm. located periphery segment 2-6, Child A

- Limited resection, no conversion
- Less IV narcotic 1 vs 2.8 days (P < 0.001)
- Less time to regular diet 1.1 vs 2.8 days (P < 0.001)
- Less LOS 2.4 vs 4.2 days (P < 0.001)
- Resection time no statistical difference 66 vs 56 mins but less op time 120 vs 146 mins (P < 0.001)
- No statistical difference in blood loss, transfusion, R0, complication

El-Gendi A, El-Shafei M, El-Gendi S, Shawky A. (2018) Laparoscopic versus open hepatic resection for solitary hepatocellular carcinoma less than 5 cm in cirrhotic patients: a randomized controlled study. J Laparoendosc Adv Surg Tech Part A 28(3):302 – 310.

Laparoscopic Versus Open Hepatectomy for Large Hepatocellular Carcinoma: A Randomized Controlled Study

A. Elgendi [1], M. Elshafei [2], S. Elgendi [3], A. Shawky [1]

- N = 150
- Solitary large HCC > 5 cm., cirrhotic child A
- Shorter op time 255 vs 280 mins (P < 0.01)
- Shorter LOS 8.5 vs 10.5 days (P < 0.01)
- Comparative resection time, blood loss, transfusion rate
- Comparative oncologic outcome

Elgendi A, Elshafei M, Elgendi S, Shawky A. Laparoscopic Versus Open Hepatectomy for Large Hepatocellular Carcinoma: A Randomized Controlled Study. HPB 2021;23:S160.

Table 1 Trial and Patient Characteristics, data is presented as Mean (Standard deviation) or Median [Interquartile range] unless specified otherwise

Study	Year	Patient recruitment	No. Patients Included		Etiology	Men (No. (%))		Age (years)		Resection Type	Lesion Size	
			LLR	OLR		LLR	OLR	LLR	OLR		LLR	OLR
Liver Cancer												
"Jiang"	2015	2010–2014	50	50	PLC	35 (70)	37 (74)	55 (2,6)	57 (1,9)	Minor	3·18 (0·29)	3·22 (0·31)
"Li"	2015	2012–2013	12	14	HCC	12 (100)	14 (100)	49 (27–72)[a]	57 (33–73)[a]	Major and minor	5·96 (2·82)	6·23 (3·16)
"Sun"	2017	2013–2016	100	100	LC	56 (56)	57 (57)	48 (16·5)	48 (15·4)	Major and minor	5·35 (3·22)	5·42 (3·18)
"Wu Quiang"	2017	2011–2013	47	47	HCC	31 (66)	29 (62)	57 (11·0)	57 (10·5)	Minor (Left lateral sectionectomy)	4·88 (0·65)	4·92 (0·61)
"El-Gendi-1"	2018	–	25	25	HCC	16 (64)	14 (56)	55 (7·0)	54 (7·4)	Minor (HCC < 5 cm)	3·33 (0·57)	3·38 (0·59)
"El-Gendi-2"	2019	–	75	75	HCC	–	–	–	–	Minor and major (HCC > 5 cm)	Not specified	
"Yan"	2020	–	80	80	HCC	–	–	–	–	Not assessable	Not specified	
Colorectal Liver Metastases												
"Kasai"	2017	2010–2011	20	20	CRLM	17 (85)	10 (50)	65 (40–86)[a]	67 (38–86)	Minor and major	2 (1–8)[b]	2·8 (0·6–11)[b]
"Fretland"	2018	2012–2016	133	147	CRLM	77 (60)	87 (60)	67 (8)	66 (10)	Minor	Not specified	
"Robles-Campos"	2019	2005–2016	96	97	CRLM	61 (64)	71 (73)	66 (58–72)	69 (56–76)	Minor, Hand-assisted	3 (3–4)	4 (2–5)
Benign and Mixed Indications												
"Lu You"	2011	2008–2009	20	22	M/B	5 (25)	11 (50)	45 (10·8)	44 (12·2)	Minor	3·42 (0·97)	3·8 (1·35)
"Ding"	2015	2010–2013	49	49	HL	23 (47)	22 (45)	58 (6·3)	58 (7·2)	Minor (only left lateral sectionectomy)	0·96 (0·26)	0·97 (0·21)
"Wong-Lun-Hing"	2017	2010–2014	13	11	M/B	9 (69)	5 (45)	67 (55–73)	58 (52–70)	Minor (left lateral sectionectomy)	Not specified	
Total without Jiang et al.												
Total												

LLR = laparoscopic liver resection; OLR = open liver resection; PLC = primary liver cancer; HCC = hepatocellular carcinoma; LC = liver cancer; CRLM = colorectal liver metastases; M/B = malignant and benign lesions; HL = hepatolithiasis.

[a] Range.

[b] Size of largest metastasis.

Caelán MH, Alexander S-F, Pascal P, Carolyn F, Philip CM, Mohammad G, et al. A systematic review and meta-analysis of randomized controlled trials comparing laparoscopic and open liver resection. Hpb. 2021;23(10):1467-81.

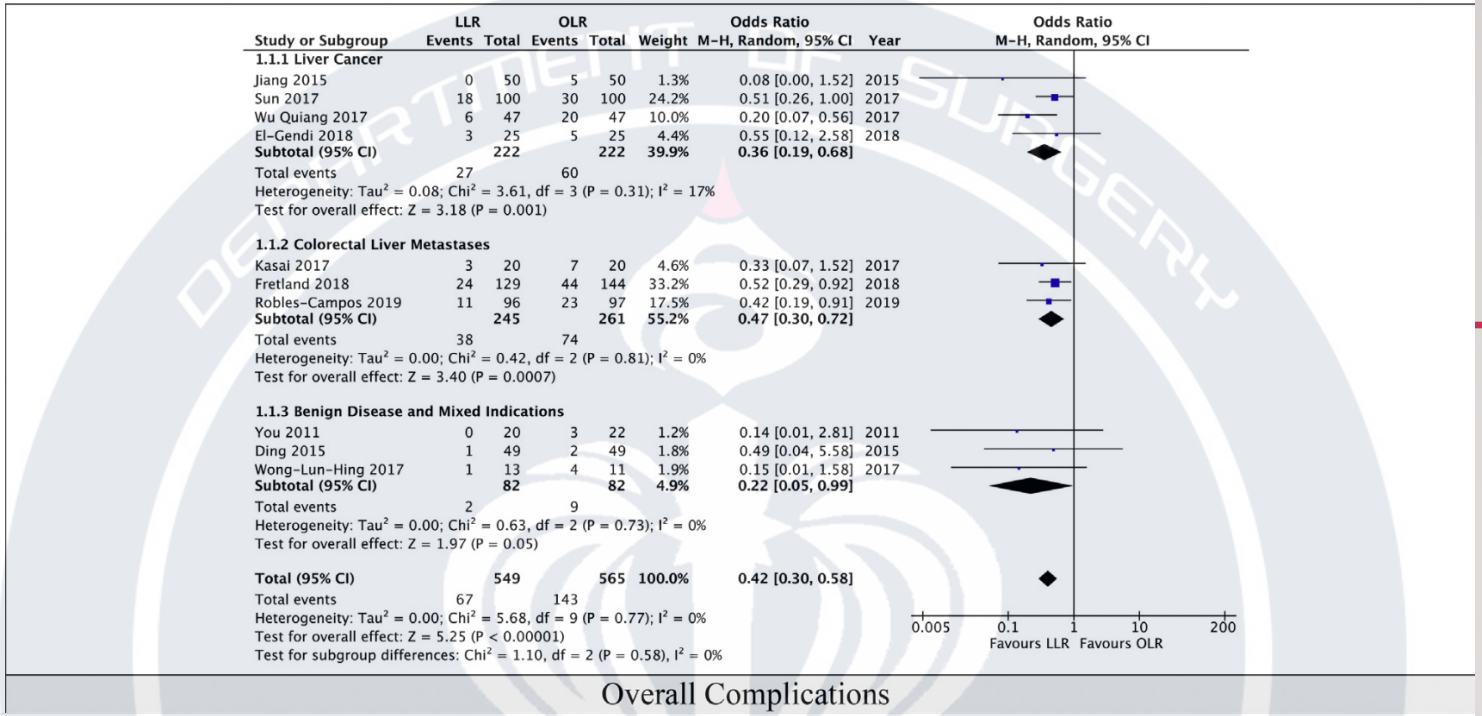
Location of Lesions (Couinaud Segments)											
8		7		5 + 6		4		2 + 3		1	
LLR	OLR	LLR	OLR	LLR	OLR	LLR	OLR	LLR	OLR	LLR	OLR
Liver Cancer											
Right liver: LLR: 35; OLR: 40						Left liver: LLR: 15; OLR: 10					
Not specified											
0	0	0	0	38	35	12	10	50	55	0	0
0	0	0	0	0	0	0	0	47	47	0	0
0	0	0	0	8	7	0	0	17	18	0	0
Not specified											
Not specified											
Colorectal Liver Metastases											
Not specified											
33	34	40	44	70	71	27	47	51	74	1	4
12	14	16	19	41	46	14	19	40	33	1	2
Benign and Mixed Indications											
Not specified											
0	0	0	0	0	0	0	0	49	49	0	0
0	0	0	0	0	0	0	0	0	13	11	0
45	48	56	63	157	159	53	76	267	287	2	6
Right liver						Left liver					
LLR: 293			OLR: 310			LLR: 337			OLR: 379		

Table 4 Long-Term Outcomes

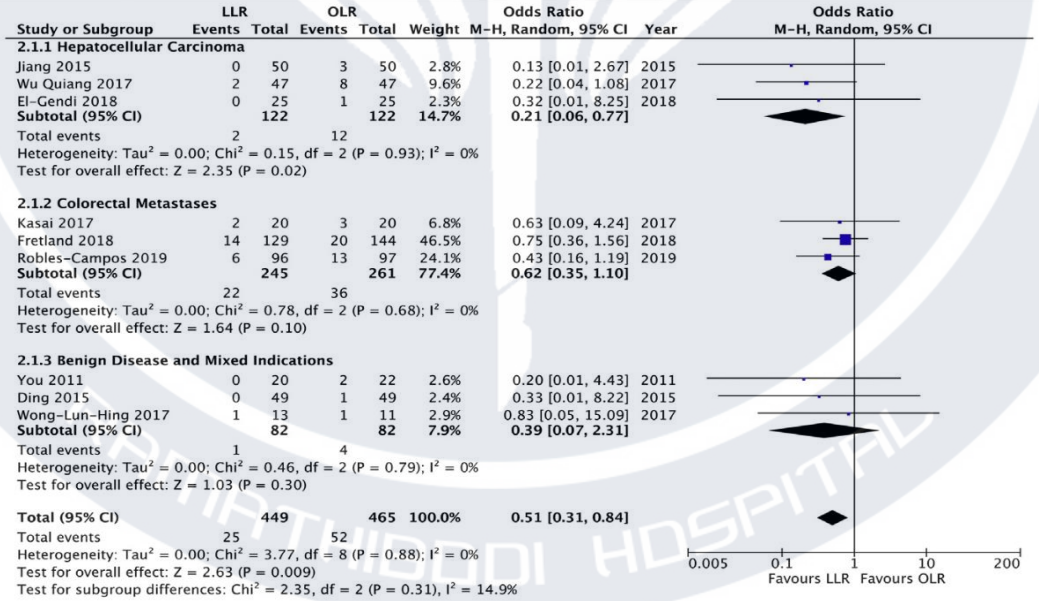
Trial	Recurrence free survival (%)								Overall survival (%)							
	LLR 1 year	LLR 1 year	LLR 3 years	OLR 3 years	LLR 5 years	OLR 5 years	LLR 7 years	OLR 7 years	LLR 1 year	LLR 1 year	LLR 3 years	OLR 3 years	LLR 5 years	OLR 5 years	LLR 7 years	OLR 7 years
Liver Cancer																
Sun	–	–	–	–	–	–	–	–	93[a]	92[a]	–	–	–	–	–	–
Wu Quiang	–	–	–	–	–	–	–	–	85·1[a]	87·2[a]	53·2[a]	51·1[a]	–	–	–	–
El Gendi 2018	88[a]	84[a]	58,7[a]	54[a]	–	–	–	–	–	–	–	–	–	–	–	–
El Gendi 2019	69[b]	65[b]	39[b]	36[b]	–	–	–	–	–	–	–	–	–	–	–	–
Yan 2020	–	–	–	–	–	–	–	–	93·75[a]	81·25	–	–	–	–	–	–
Colorectal Liver Metastases																
Fretland	55·5[c]	54·6[c]	35·9[c]	41·1[c]	29·7[c]	35·7[c]	–	–	96·6[a]	96·2[a]	71·4[a]	75·2[a]	54·1[a]	57·5[a]	–	–
Robles-Campos	72·7[c]	61·6[c]	33·5[c]	27·2[c]	22·7[c]	23·9[c]	20·8[c]	17·9[c]	92·5[c]	93·6[c]	71·5[c]	69·7[c]	49·3[c]	47·4[c]	35·6[c]	35·5[c]
Kasai	55·7[a]	69·6[a]	30·4[a]	28·5[a]	30·4[a]	19[a]	–	–	100[a]	88·9[a]	85·4[a]	48·5[a]	68[a]	48·5[a]	–	–

LLR = laparoscopic liver resection; OLR = open liver resection.
[a] Intention to treat.
[b] Congress abstract.
[c] Per protocol.

Table 2 Main Outcome: Complications (LLR = laparoscopic liver resection; OLR = open liver resection)

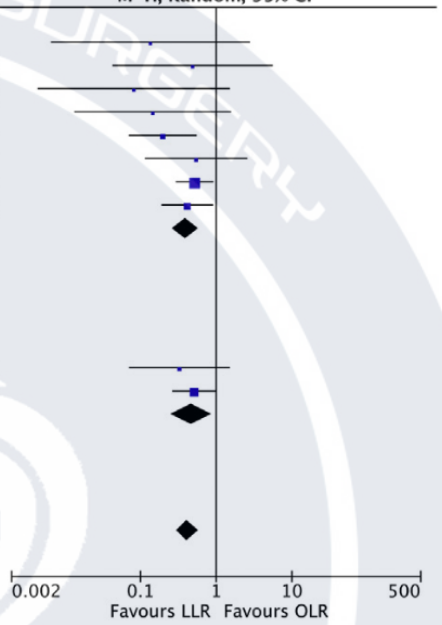


Overall Complications



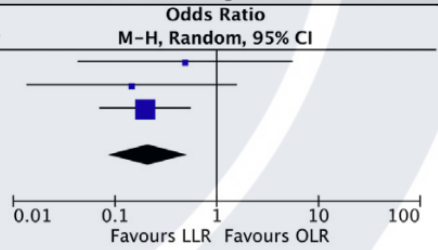
Severe Complications (Clavien-Dindo ≥3)

Study or Subgroup	LLR Events	LLR Total	OLR Events	OLR Total	Weight	Odds Ratio M-H, Random, 95% CI	Year
1.8.1 Minor							
You 2011	0	20	3	22	1.2%	0.14 [0.01, 2.81]	2011
Ding 2015	1	49	2	49	1.8%	0.49 [0.04, 5.58]	2015
Jiang 2015	0	50	5	50	1.3%	0.08 [0.00, 1.52]	2015
Wong-Lun-Hing 2017	1	13	4	11	1.9%	0.15 [0.01, 1.58]	2017
Wu Quiang 2017	6	47	20	47	10.0%	0.20 [0.07, 0.56]	2017
El-Gendi 2018	3	25	5	25	4.4%	0.55 [0.12, 2.58]	2018
Fretland 2018	24	129	44	144	33.2%	0.52 [0.29, 0.92]	2018
Robles-Campos 2019	11	96	23	97	17.5%	0.42 [0.19, 0.91]	2019
Subtotal (95% CI)		**429**		**445**	**71.3%**	**0.39 [0.27, 0.58]**	
Total events	46		106				
Heterogeneity: Tau² = 0.00; Chi² = 5.14, df = 7 (P = 0.64); I² = 0%							
Test for overall effect: Z = 4.71 (P < 0.00001)							
1.8.2 Minor and Major							
Kasai 2017	3	20	7	20	4.6%	0.33 [0.07, 1.52]	2017
Sun 2017	18	100	30	100	24.2%	0.51 [0.26, 1.00]	2017
Subtotal (95% CI)		**120**		**120**	**28.7%**	**0.48 [0.26, 0.88]**	
Total events	21		37				
Heterogeneity: Tau² = 0.00; Chi² = 0.27, df = 1 (P = 0.60); I² = 0%							
Test for overall effect: Z = 2.37 (P = 0.02)							
Total (95% CI)		**549**		**565**	**100.0%**	**0.42 [0.30, 0.58]**	
Total events	67		143				
Heterogeneity: Tau² = 0.00; Chi² = 5.68, df = 9 (P = 0.77); I² = 0%							
Test for overall effect: Z = 5.25 (P < 0.00001)							
Test for subgroup differences: Chi² = 0.27, df = 1 (P = 0.60), I² = 0%							



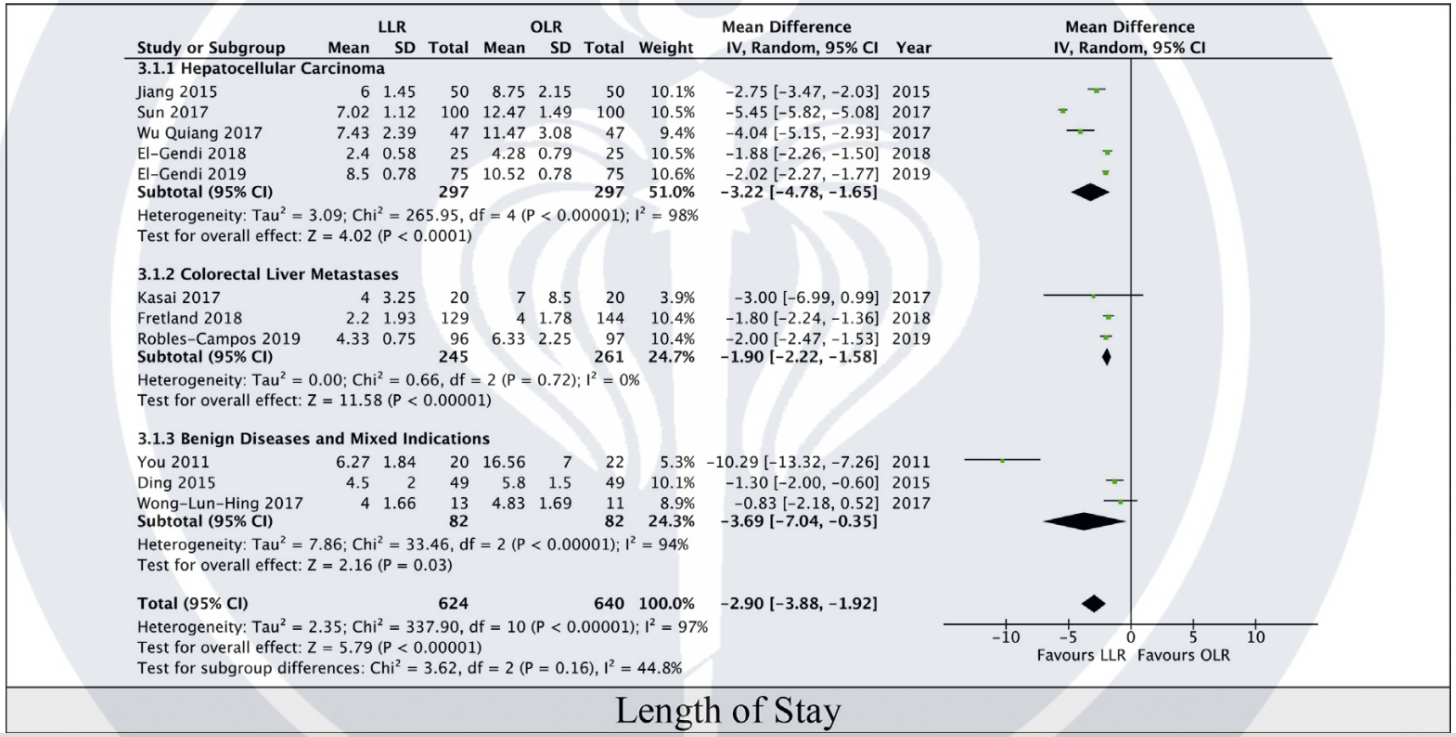
Overall Complications – Grouped by “Minor” and “Minor and Major” resection

Study or Subgroup	LLR Events	LLR Total	OLR Events	OLR Total	Weight	Odds Ratio M-H, Random, 95% CI	Year
Ding 2015	1	49	2	49	13.2%	0.49 [0.04, 5.58]	2015
Wong-Lun-Hing 2017	1	13	4	11	13.8%	0.15 [0.01, 1.58]	2017
Wu Quiang 2017	6	47	20	47	73.1%	0.20 [0.07, 0.56]	2017
Total (95% CI)		**109**		**107**	**100.0%**	**0.21 [0.09, 0.52]**	
Total events	8		26				
Heterogeneity: Tau² = 0.00; Chi² = 0.57, df = 2 (P = 0.75); I² = 0%							
Test for overall effect: Z = 3.43 (P = 0.0006)							

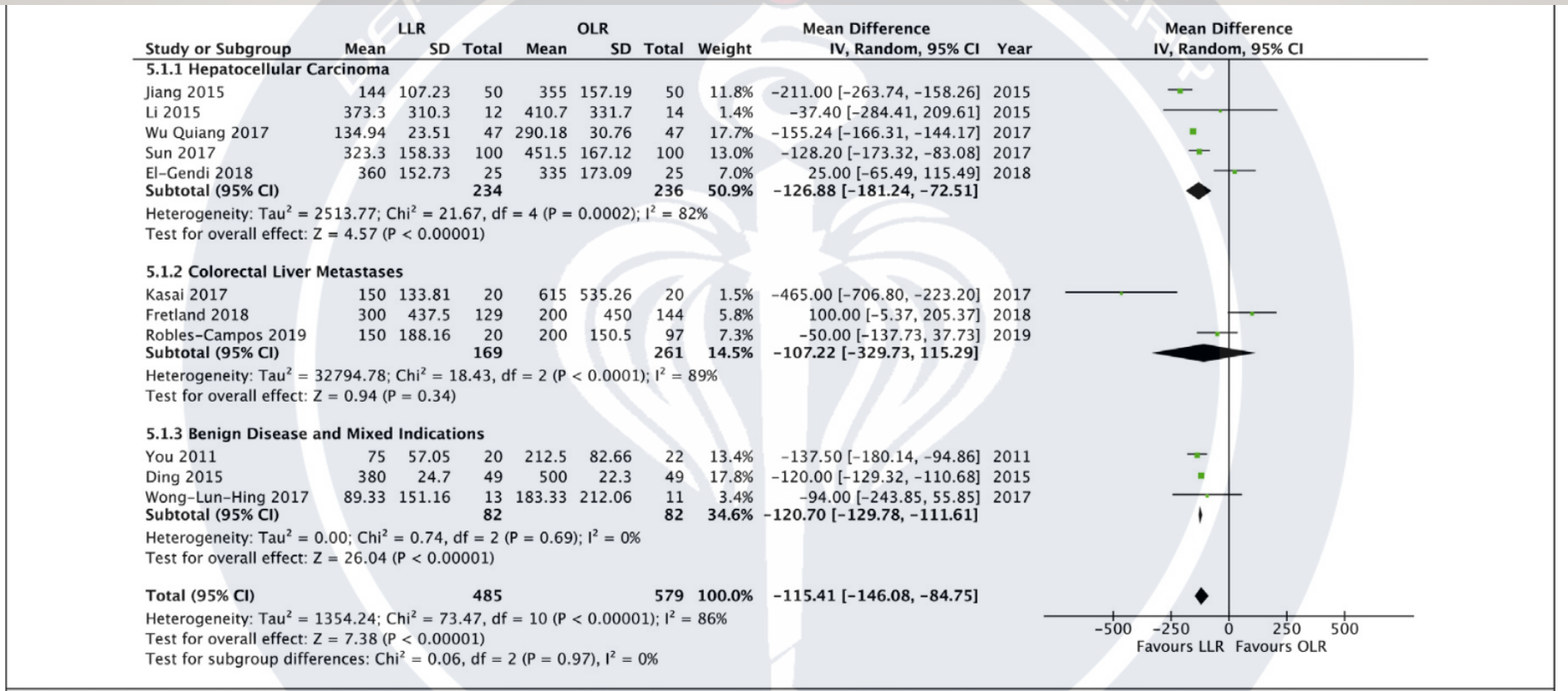


Overall Complications – Only Left Lateral Segments

Table 3 Secondary Outcomes (LLR = laparoscopic liver resection; OLR = open liver resection; SMD = standardized mean difference)

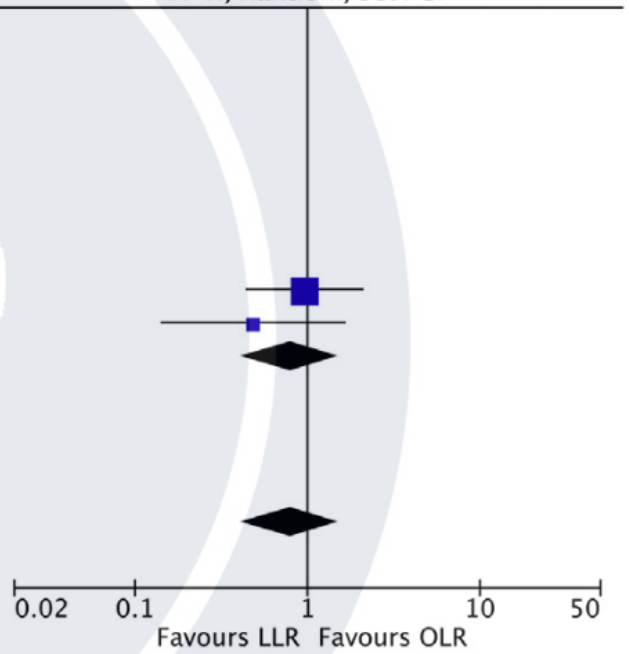


Length of Stay

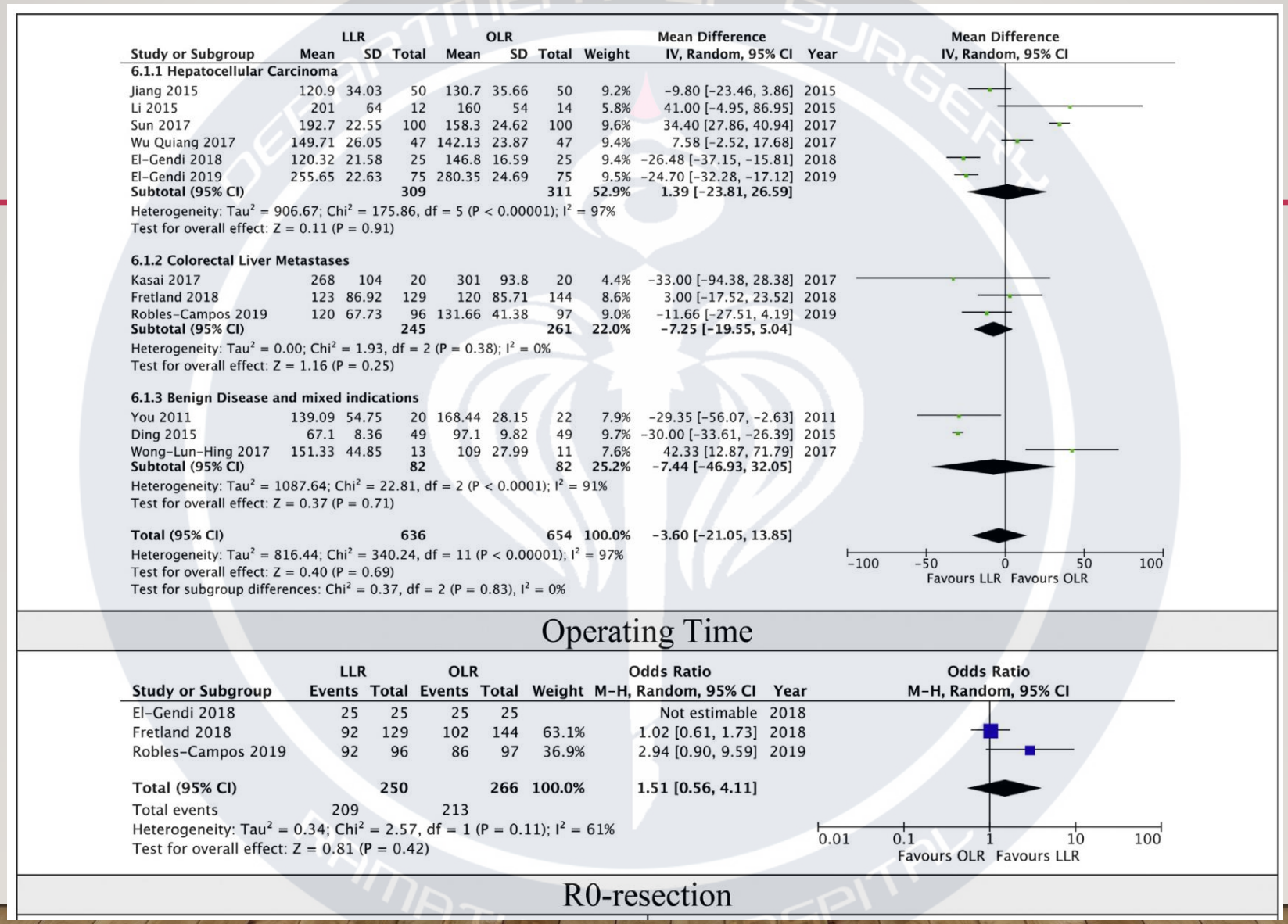

LLR
OLR
Mean Difference
Mean Difference
Study or Subgroup Mean SD Total Mean SD Total Weight IV, Random, 95% CI Year
IV, Random, 95% CI
5.1.1 Hepatocellular Carcinoma
Jiang 2015 144 107.23 50 355 157.19 50 11.8% -211.00 [-263.74, -158.26] 2015
Li 2015 373.3 310.3 12 410.7 331.7 14 1.4% -37.40 [-284.41, 209.61] 2015
Wu Quiang 2017 134.94 23.51 47 290.18 30.76 47 17.7% -155.24 [-166.31, -144.17] 2017
Sun 2017 323.3 158.33 100 451.5 167.12 100 13.0% -128.20 [-173.32, -83.08] 2017
El-Gendi 2018 360 152.73 25 335 173.09 25 7.0% 25.00 [-65.49, 115.49] 2018
Subtotal (95% CI) 234 236 50.9% -126.88 [-181.24, -72.51]
Heterogeneity: Tau² = 2513.77; Chi² = 21.67, df = 4 (P = 0.0002); I² = 82%
Test for overall effect: Z = 4.57 (P < 0.00001)
5.1.2 Colorectal Liver Metastases
Kasai 2017 150 133.81 20 615 535.26 20 1.5% -465.00 [-706.80, -223.20] 2017
Fretland 2018 300 437.5 129 200 450 144 5.8% 100.00 [-5.37, 205.37] 2018
Robles-Campos 2019 150 188.16 20 200 150.5 97 7.3% -50.00 [-137.73, 37.73] 2019
Subtotal (95% CI) 169 261 14.5% -107.22 [-329.73, 115.29]
Heterogeneity: Tau² = 32794.78; Chi² = 18.43, df = 2 (P < 0.0001); I² = 89%
Test for overall effect: Z = 0.94 (P = 0.34)
5.1.3 Benign Disease and Mixed Indications
You 2011 75 57.05 20 212.5 82.66 22 13.4% -137.50 [-180.14, -94.86] 2011
Ding 2015 380 24.7 49 500 22.3 49 17.8% -120.00 [-129.32, -110.68] 2015
Wong-Lun-Hing 2017 89.33 151.16 13 183.33 212.06 11 3.4% -94.00 [-243.85, 55.85] 2017
Subtotal (95% CI) 82 82 34.6% -120.70 [-129.78, -111.61]
Heterogeneity: Tau² = 0.00; Chi² = 0.74, df = 2 (P = 0.69); I² = 0%
Test for overall effect: Z = 26.04 (P < 0.00001)
Total (95% CI) 485 579 100.0% -115.41 [-146.08, -84.75]
Heterogeneity: Tau² = 1354.24; Chi² = 73.47, df = 10 (P < 0.00001); I² = 86%
Test for overall effect: Z = 7.38 (P < 0.00001)
Test for subgroup differences: Chi² = 0.06, df = 2 (P = 0.97), I² = 0%
-500 -250 0 250 500
Favours LLR Favours OLR

Blood Loss

Study or Subgroup	LLR Events	LLR Total	OLR Events	OLR Total	Weight	Odds Ratio M-H, Random, 95% CI	Year
4.1.1 Hepatocellular Carcinoma							
Li 2015	0	12	0	14		Not estimable	2015
Subtotal (95% CI)		**12**		**14**		**Not estimable**	
Total events	0		0				
Heterogeneity: Not applicable							
Test for overall effect: Not applicable							
4.1.2 Colorectal Liver Metastases							
Fretland 2018	13	129	15	144	71.3%	0.96 [0.44, 2.11]	2018
Robles-Campos 2019	4	96	8	97	28.7%	0.48 [0.14, 1.66]	2019
Subtotal (95% CI)		**225**		**241**	**100.0%**	**0.79 [0.41, 1.53]**	
Total events	17		23				
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.85$, df = 1 (P = 0.36); $I^2 = 0\%$							
Test for overall effect: Z = 0.70 (P = 0.49)							
Total (95% CI)		**237**		**255**	**100.0%**	**0.79 [0.41, 1.53]**	
Total events	17		23				
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.85$, df = 1 (P = 0.36); $I^2 = 0\%$							
Test for overall effect: Z = 0.70 (P = 0.49)							
Test for subgroup differences: Not applicable							

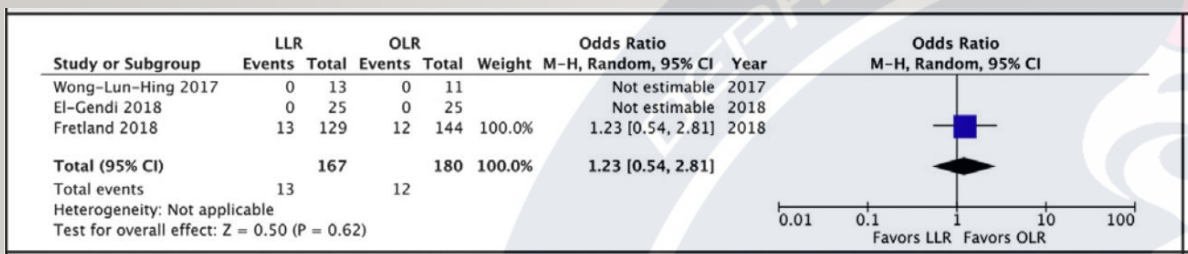


Transfusions

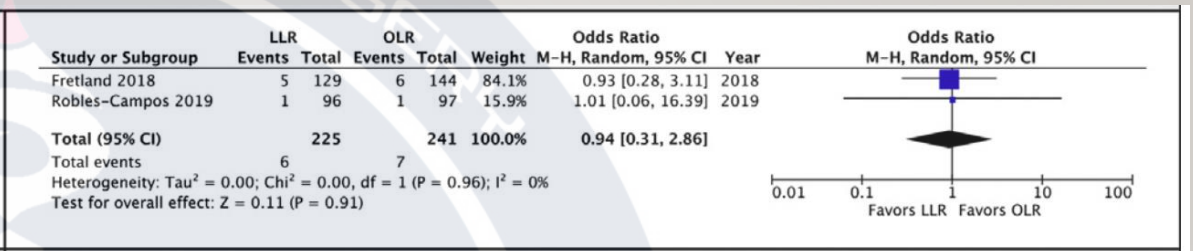


Operating Time

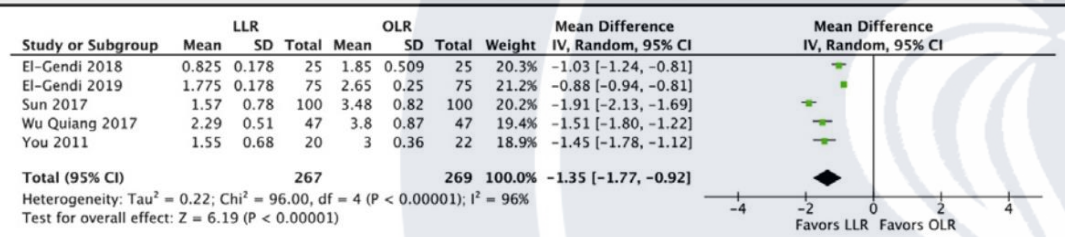
R0-resection



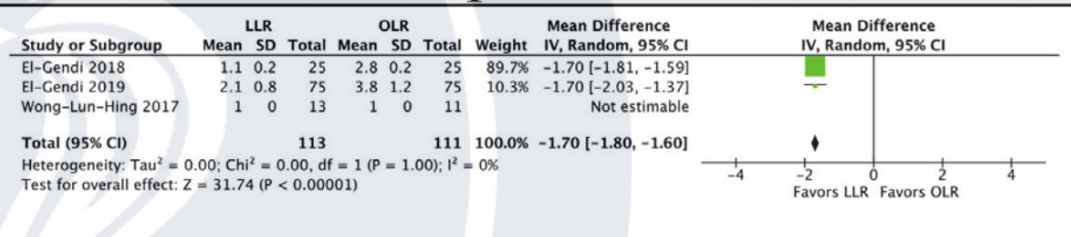
Readmissions



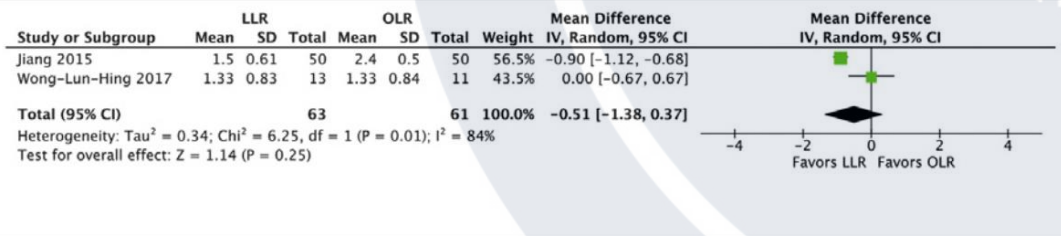
Reoperations



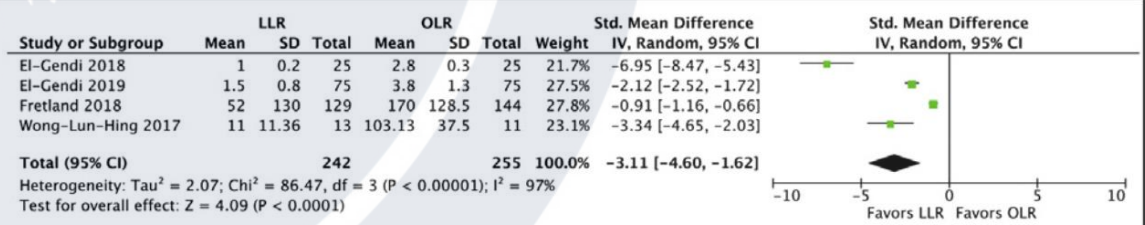
Fasting Time



Time to Regular Diet



Time to First Flatus



Narcotics Requirements (SMD)

Table 5 GRADE summary of findings table

Laparoscopic liver resection compared to Open liver resection for Malignant and Benign Liver Lesions

Outcomes	Anticipated absolute effects[g] (95% CI)		Relative effect (95% CI)	N° of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with Open liver resection	Risk with Laparoscopic liver resection				
Overall Complications	253 per 1.000	**125 per 1.000** (92–164)	**OR 0·42** (0·30 to 0·58)	1114 (10 RCTs)	⊕⊕⊕⊕ HIGH[a]	Patients receiving minor liver resections experience fewer postoperative complications when operated on laparoscopically.
Severe Complications	112 per 1.000	**60 per 1.000** (38–96)	**OR 0·51** (0·31 to 0·84)	914 (9 RCTs)	⊕⊕⊕◯ MODERATE[a,b]	Patients receiving minor liver resections experience fewer severe postoperative complications when operated on laparoscopically.
Hospital Stay	The mean hospital stay was **2·9 days lower** (3·88 day lower to 1·92 days lower) in Laparoscopic Liver Resection		–	1264 (11 RCTs)	⊕⊕⊕⊕ HIGH[c,d]	Patients receiving minor liver resections have a shorter postoperative length of hospital stay when they are operated on laparoscopically.
Transfusions	90 per 1.000	**73 per 1.000** (39–132)	**OR 0·79** (0·41 to 1·53)	492 (3 RCTs)	⊕⊕◯◯ LOW[e]	There is no significant difference in transfusion rates between the laparoscopic approach and the open approach for patients that receive minor liver resections.
Blood Loss	The mean blood loss was **115·41 ml lower** (146·08 ml lower to 84·75 ml lower) in Laparoscopic Liver Resection		–	1064 (11 RCTs)	⊕⊕⊕◯ MODERATE[f]	The intraoperative blood loss is lower with the laparoscopic approach to minor liver resection.
Fasting Time	The mean fasting time was **1·35 days lower** (1·77 days lower to 0·92 days lower) in Laparoscopic Liver Resection		–	536 (5 RCTs)	⊕⊕⊕⊕ HIGH	Patients that receive minor liver resection have a shorter postoperative fasting time when they are operated on laparoscopically.
Narcotic Requirements (Standard Mean Difference)	The SMD was **3·11 lower** (4·6 lower to 1·62 lower) in Laparoscopic Liver Resection		–	497 (4 RCTs)	⊕⊕⊕⊕ HIGH	Patients that receive minor liver resection have lower narcotics requirements when they are operated on laparoscopically.

GRADE Working Group grades of evidence **High certainty:** We are very confident that the true effect lies close to that of the estimate of the effect **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect.

CI: confidence interval; **OR:** odds ratio; **MD:** mean difference; **SMD:** standardised mean difference.

[a] While possible small study publication bias possible, sensitivity analysis with small study removal does not reveal different results, therefore, downgrading was not performed.

[b] Possibility of incorrect classification of complications as severe by authors of systematic review.

[c] Perception of readiness for release might depend on surgeons perception of invasiveness of surgery, however functional outcomes are in favor of the laparoscopic approach as well. Therefore, evidence not downgraded.

[d] One large trial included a secondary intervention that only applied to patients in the OLR group. This intervention significantly prolonged the postoperative hospital stay for the patients that received it, thereby introducing a bias benefitting the LLR group. However, all other studies show shorter hospital stay in laparoscopic surgery as well. Therefore, no downgrading.

[e] Optimal information size not reached.

[f] As blood loss is lower in LLR with a high certainty of evidence, it becomes more likely that there was a lack of sample size. Therefore, this domain was downgraded for serious imprecision.

[g] **The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

STUDY PROTOCOL Open Access

Laparoscopic versus open resections in the posterosuperior liver segments within an enhanced recovery programme (ORANGE Segments): study protocol for a multicentre randomised controlled trial

Christoph Kuemmerli[1,2†], Robert S. Fichtinger[3,4†], Alma Moekotte[1], Luca A. Aldrighetti[5], Somaiah Aroori[6], Marc G. H. Besselink[7], Mathieu D'Hondt[8], Rafael Díaz-Nieto[9], Bjørn Edwin[10], Mikhail Efanov[11], Giuseppe M. Ettorre[12], Krishna V. Menon[13], Aali J. Sheen[14], Zahir Soonawalla[15], Robert Sutcliffe[16], Roberto I. Troisi[17], Steven A. White[18], Lloyd Brandts[19], Gerard J. P. van Breukelen[20], Jasper Sijberden[2,7], Siân A. Pugh[21], Zina Eminton[22], John N. Primrose[23], Ronald van Dam[3,4,24], Mohammed Abu Hilal[1,2*] and on behalf of the ORANGE trials collaborative

- Patient required parenchymal-sparing liver resection
- RCT, Single blind
- Lesion size < 3 or ≥ 3 cm.
- Location segment 4A, 6/7, 7, 8
- Primary outcome Time to functional recovery
- Secondary outcome, Blood loss, Op time, LOS, 90 days Mortality

JOURNAL ARTICLE

Asia–Pacific multicentre randomized trial of laparoscopic *versus* open major hepatectomy for hepatocellular carcinoma (AP–LAPO trial)

Kelvin K C Ng ✉, Charing C N Chong, Kit-Fai Lee, Paul B S Lai, Thomas K C Cheng, Hua-Wei Chen, Bin Yi, Ji-Wei Huang

BJS Open, Volume 7, Issue 1, February 2023, zrac166, https://doi.org/10.1093/bjsopen/zrac166

Published: 28 February 2023 **Article history** ▾

- In five Asia-Pacific centres (China and Hongkong)
- Surgical procedures will be carried out by senior hepatobiliary surgeons. According to the international standard for laparoscopic liver surgery, each surgeon will need to have performed at least 55 resections classified as LMH to be included in the study
- Inclusion criteria consist of: a diagnosis of HCC as defined by the EASL
  - Tumour size single ≤ 8 cm. or multiple lesion in single lobe sum of all nodules diameter ≤ 8 cm.
  - Tumour suitable for both LMH and OMH requiring resection of greater than or equal to three Couinaud's segment
  - No VI, Extrahepatic metastasis
  - Child A liver function, indocyanine green retention at 15 min (ICG-15) less than or equal to 15 per cent;, adequate future liver remnant ≥ 35%
- Exclusion criteria involve
  - Previous treatment for HCC (TACE, systemic theraphy) and tumours requiring combined hepatectomy and thermal ablation therapy
  - Patients will also be excluded at the time of surgery (dropout) if there is: Bilobar, locally advanced, VI that not detect preoperative phase

SCRLM

Table 4. Studies evaluating synchronous resections of colon primary and metastatic liver tumors.

Author	Year	Nation	Study Type	Arm	N	3-y OS	*p*-Value	3-y RFS	*p*-Value	Complications (%)	*p*-Value	Periop Mortality (%)	*p*-Value
Akiyoshi [40]	2009	Japan	Single-center, retrospective	Lap	10	NR		NR		10		0	
Polignano [41]	2012	UK	Single-center, retrospective	Lap	13			90		28		0	
Hatwell [42]	2012	France	Single-center, retrospective	Lap	51	NR		NR		55		0	
Ferretti [43]	2015	International	Multi-center, retrospective	Lap	142	71.9 *		63 *		31		2.1	
Muangkaew [44]	2015	South Korea	Single-center, retrospective	Lap	55					76		0	
Tranchart [45]	2015	International	Multi-center, retrospective	Lap	89	78	0.17	64	0.13	15	1	6	0.49
				Open	89	65		52		15		0	
Chen [46]	2018	Taiwan	Single-center, retrospective	Lap	16	73	0.99	35	0.14	25	0.06	0	NR
				Open	22	48		15		36		0	
Bizzoca [47]	2019	Italy	Single-center, retrospective	Lap	17					47		0	
van der Poel [48]	2019	International	Multi-center, retrospective	Lap	61	NR		NR		15	0.237	0	1
				Open	61	NR		NR		9		2	
Perfecto [50]	2021	Spain	Single-center, retrospective	Lap	15	92.3		24		26.6		0	
Sawaied [51]	2021	Israel	Multi-center, retrospective	Lap	21	87	0.64	48	0.92	33	0.15	0	0.48
				Open	42	57		40		52		2	

* denotes 5-year survival; NR: not reported.

Lo WM, Tohme ST, Geller DA. Recent Advances in Minimally Invasive Liver Resection for Colorectal Cancer Liver Metastases-A Review. Cancers (Basel). 2022;15(1).

SCRLM

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Akiyoshi [40]	2009	Japan	Single-center, retrospective	Lap	10	NR		NR		10		0	
Polignano [41]	2012	UK	Single-center, retrospective	Lap	13			90		28		0	
Hatw			Single-center										
Ferre													
Muangk													
Tranch													0.49
Che													NR
Bizzoca [47]	2019	Italy	retrospective	Lap	17					47		0	
van der Poel [48]	2019	International	Multi-center, retrospective	Lap Open	61 61	NR NR		NR NR		15 9	0.237	0 2	1
Perfecto [50]	2021	Spain	Single-center, retrospective	Lap	15	92.3		24		26.6		0	
Sawaied [51]	2021	Israel	Multi-center, retrospective	Lap Open	21 42	87 57	0.64	48 40	0.92	33 52	0.15	0 2	0.48

* denotes 5-year survival; NR: not reported.

No Different in blood loss
5-8% required conversion to open
Complication range 10-76% (20% major complication, 4 deaths)
3-yr OS 48-92.3%, no different (5 studies)
3 yr DFS 15-64%, no different

Lo WM, Tohme ST, Geller DA. Recent Advances in Minimally Invasive Liver Resection for Colorectal Cancer Liver Metastases-A Review. Cancers (Basel). 2022;15(1).

SCRLM

The Italian Consensus on minimally invasive simultaneous resections for synchronous liver metastasis and primary colorectal cancer: A Delphi methodology

Aldo Rocca[1,2] · Federica Cipriani[3,4] · Giulio Belli[5] · Stefano Berti[6] · Ugo Boggi[7] · Vincenzo Bottino[8] · Umberto Cillo[9] · Matteo Cescon[10] · Matteo Cimino[11] · Francesco Corcione[12] · Luciano De Carlis[13] · Maurizio Degiuli[14] · Paolo De Paolis[15] · Agostino Maria De Rose[16] · Domenico D'Ugo[17] · Fabrizio Di Benedetto[18] · Ugo Elmore[4,19] · Giorgio Ercolani[20] · Giuseppe M. Ettorre[21] · Alessandro Ferrero[22] · Marco Filauro[23] · Felice Giuliante[16] · Salvatore Gruttadauria[24] · Alfredo Guglielmi[25] · Francesco Izzo[26] · Elio Jovine[27] · Andrea Laurenzi[20] · Francesco Marchegiani[9] · Pierluigi Marini[28] · Marco Massani[29] · Vincenzo Mazzaferro[30] · Michela Mineccia[21] · Francesco Minni[31] · Andrea Muratore[32] · Simone Nicosia[27] · Riccardo Pellicci[33] · Riccardo Rosati[4,19] · Nadia Russolillo[22] · Antonino Spinelli[35,36] · Gaya Spolverato[34] · Guido Torzilli[11] · Giovanni Vennarecci[37] · Luca Viganò[11] · Leonardo Vincenti[38] · Paolo Delrio[39] · Fulvio Calise[2] · Luca Aldrighetti[3,4]

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ITALIAN CONSENSUS IN SCRLM

- High risk patient (age >75, BMI > 30, previous abdominal surgery) are not contraindication, but underlying disease of liver patient recommend as open surgery
- Non complexed CRC procedure: Mobilized colon > Liver resection > colon anastomosis.
- IWATE score ≤ 3 should be considered for simultaneous resection.
- Major LLR (Posterosuperior segment) should be considered in experience hand.
- Simultaneous resection of primary tumour during the first step of a classic two-stage hepatectomy for SCRLM may be considered feasible and safe. But not for ALPPS

Rocca A, Cipriani F, Belli G, Berti S, Boggi U, Bottino V, et al. The Italian Consensus on minimally invasive simultaneous resections for synchronous liver metastasis and primary colorectal cancer: A Delphi methodology. Updates Surg. 2021;73(4):1247-65.

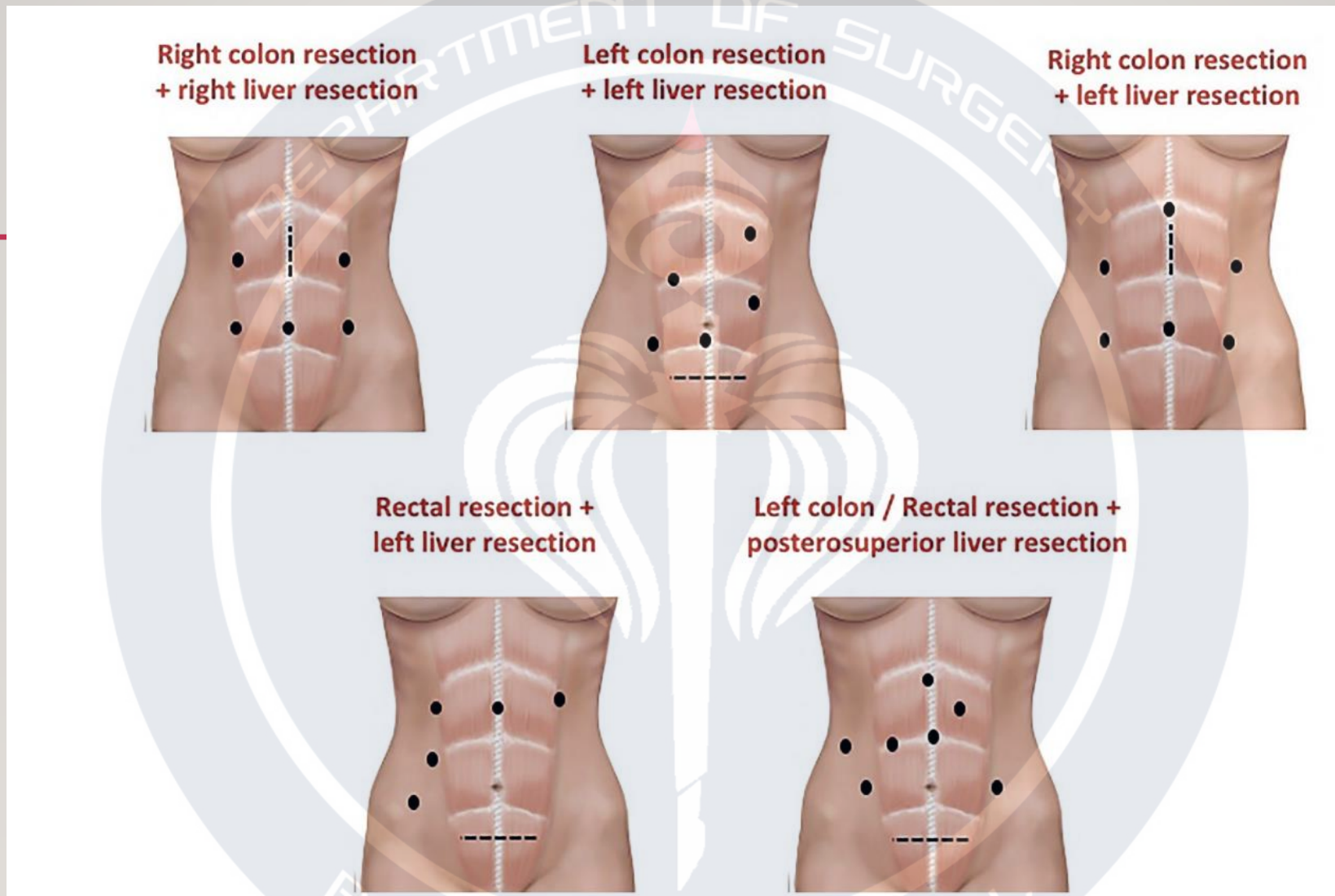

Fig. 1 Example of trocar placement to perform a combined resection

TAKE HOME MESSAGE

- LLS is feasible for CRLM, HCC, Benign liver lesion same as OLS
- LLS surgical outcome better than OLS (LOS, TFR, Pain control)
- LLS oncologic outcome same as OLS
- LLS has difficulty from low to expert level that need learning curve for 10-50 cases for each level