

Medical Expert Training in Advanced Liver Surgery

Building laparoscopic liver experience

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The spread of minimally invasive surgery – **Scientific community**

2008

- ✓ Single lesion
- ✓ Segments 2-6
- ✓ Segmentary resections
- ✓ Left lateral sectionectomy
- ✓ Malignant and benign lesions
- ✓ “Major liver resections (ie, right or left hepatectomies) should be reserved to experienced surgeons already facile with more limited laparoscopic resections”

2014

- ✓ Indications to laparoscopy were broadened to encompass even major and complex liver resections

2017

- ✓ Guidelines regarding laparoscopic approach for liver resections have been discussed by experts

ORIGINAL ARTICLES

The International Position on Laparoscopic Liver Surgery
The Louisville Statement, 2008

Joseph F. Buell, MD, FACS, Daniel Cherqui, MD,† David A. Geller, MD,‡ Nicholas O'Rourke, MD,§ David Iannitti, MD,¶ Ibrahim Dagher, MD|| Alan J. Koffron, MD,** Mark Thomas, MD,†† Brice Gayet, MD,‡‡ Ho Seong Han, MD,§§ Go Wakabayashi, MD,¶¶ Giulio Belli, MD||| Hiromori Kaneko, MD,**** Chen-Guo Ker, MD,††† Olivier Scatton, MD,‡‡‡ Alexis Laurent, MD,† Eklle K. Abdalla, MD,§§§ Prasant Chaudhury, MD,¶¶¶ Erik Dussou, MD,||| Clark Gambin, MD,‡ Michael D'Angelica, MD,**** Derald Nigornny, MD,†††† Giuliano Testa, MD,‡‡‡‡ Daniel Labow, MD,§§§§ Derrick Manas, MD,¶¶¶¶ Ronnie T. Poon, MD,|||| Heidi Nelson, MD,†††† Robert Martin, MD,* Bryan Chary, MD,***** Wright C. Pinson, MD,††††† John Murtime, MD,* Jean-Nicolas Faucher, MD,§§§§ Robert Goldstein, MD,‡‡‡‡ Sasan Roxvari, MD,§§§§ David Barlet, MD,‡ Joseph Espar, MD,§§§§ Michael Abecassis, MD,¶¶¶¶ Myrddin Rees, MD,|||| Yuesun Fong, MD,**** Kelly M. McMaster, MD, PhD,* Christoph Brusch, MD,***** Ron Binnitt, MD,**** Jacques Belghiti, MD,††††† Steven Strzberg, MD,‡‡‡‡‡ and Ravi S. Chari, MD,§§§§*

Ann Surg, 2009

FEATURE

Recommendations for Laparoscopic Liver Resection
A Report From the Second International Consensus Conference Held in Morioka

Go Wakabayashi, MD, PhD, FACS, Daniel Cherqui, MD,† David A. Geller, MD,‡ Joseph F. Buell, MD, MBA, FACS,§ Hiromori Kaneko, MD,¶ Ho Seong Han, MD,|| Horacio Astua, MD,** Nicholas O'Rourke, MD,†† Minoru Tamabe, MD,‡‡ Alan J. Koffron, MD,§§ Allan Tsung, MD,¶¶ Olivier Soubrane, MD,||| Marcel Aunais Machado, MD,**** Brice Gayet, MD,††† Roberto J. Truini, MD,‡‡‡ Patrick Pessaux, MD,§§§ Ronald M. Van Dam, MD,¶¶¶ Olivier Scatton, MD,|||| Mohammad Abu Hlal, MD,***** Giulio Belli, MD,†††† Choon Hyuck David Kwon, MD,‡‡‡ Byern Edwin, MD,§§§§ Gi Hong Choi, MD,¶¶¶¶ Luca Antonio Aldrighetti, MD,||||| Tujun Cai, MD,***** Sean Cleary, MD,††††† Xiao-Jiao Chen, MD,††††† Michael H. Schön, MD,§§§§§ Atsushi Sugioka, MD,¶¶¶¶¶ Chung-Ngai Tang, MD,|||||| Paulo Herman, MD,***** Juan Polo, MD,††††† Xiao-Ping Chen, MD,||||||| Ibrahim Dagher, MD,§§§§§§ William Jarnagin, MD,¶¶¶¶¶ Masatake Tamamoto, MD,||||||| Russell Strong, MD,***** Palepu Jagannath, MD,††††††† Chung-Mau Lo, MD,|||||||††††† Pierre-Alain Clavien, MD,§§§§§§§ Norihiro Kokubo, MD,¶¶¶¶¶¶¶ Jeffrey Barkun, MD,||||||| and Steven M. Strasberg, MD,******

Ann Surg, 2014

ORIGINAL ARTICLE

The Southampton Consensus Guidelines for Laparoscopic Liver Surgery
From Indication to Implementation

*Mohammad Abu Hlal, PhD,† Lucie Aldrighetti, PhD,‡ Ibrahim Dagher, PhD,‡ Bjorn Edwin, PhD,§ Roberto Juan Truini, PhD,¶ Ravi S. Chari, PhD,|| Somaiah Anovi, PhD,†† Giulio Belli, PhD,‡‡ Marc Besselein, PhD,‡‡ Javier Briceño, PhD,§§ Brice Gayet, PhD,¶¶ Mathieu D'Hondt, PhD,||| Michael Lemarié, PhD,††† Kristina Meun, MS,†††† Peter Lodge, PhD,‡‡‡ Fernando Rotellar, PhD,§§§ John Santoro, PhD,¶¶¶ Olivier Scatton, PhD,||||| Olivier Soubrane, PhD,***** Robert Sutcliffe, MD,†††† Ronald Van Dam, PhD,‡‡‡† Siegfried Weiss, PhD,§§§§ Mark Christopher Hall, MBBS,††††† Federico Cuperios, MD,§§§ Marcel Van der Puij, MD,‡‡‡‡‡ Ruben Ciria, PhD,§§§ Leonid Barkhatov, MD,§§§ Yvone Govez-Laque, MD,§§§ Sara Ocana-Garcia, MD,§§§ Andrew Cook, MBBS,¶¶¶¶ Joseph Buell, MD,||||||| Pierre-Alain Clavien, PhD,***** Christian Dervents, PhD,††††† Giuseppe Fumai, MS,‡‡‡‡‡ David Geller, MD,§§§§§ Huike Long, MD,¶¶¶¶¶ John Pinnisse, PhD,† Mark Taylor, PhD,||||||| Thomas Van Gulik, PhD,‡‡‡‡‡ Go Wakabayashi, PhD,***** Horacio Astua, MD,††††† and Daniel Cherqui, PhD,|||||||*

Ann Surg, 2017

Impact of totally laparoscopic combined management of colorectal cancer with synchronous hepatic metastases on severity of complications: a propensity-score-based analysis

Francesca Ratti¹ · Marco Catena¹ · Saverio Di Palo² · Carlo Staudacher² · Luca Aldrighetti¹

Surg Endosc, 2016

Synchronous liver metastases

ORIGINAL ARTICLE

Updates Surg, 2015

Laparoscopic major hepatectomies: current trends and indications. A comparison with the open technique

Francesca Ratti¹ · Federica Cipriani¹ · Riccardo Ariotti¹ · Fabio Giannone¹ · Michele Paganelli¹ · Luca Aldrighetti¹

Major resections

Laparoscopic liver resections for hepatocellular carcinoma. Can we extend the surgical indication in cirrhotic patients?

Federica Cipriani^{1,2} · Corrado Fantini³ · Francesca Ratti² · Roberto Lauro⁴ · Hadrien Tranchart⁵ · Mark Halls¹ · Vincenzo Scuderi⁶ · Leonid Barkhatov⁷ · Bjorn Edwin^{7,8} · Roberto I. Troisi⁶ · Ibrahim Dagher⁵ · Paolo Reggiani⁴ · Giulio Belli³ · Luca Aldrighetti² · Mohammad Abu Hilal¹

Surg Endosc, 2017

HCC in cirrhosis

Safety and feasibility of laparoscopic liver resection with associated lymphadenectomy for intrahepatic cholangiocarcinoma: a propensity score-based case-matched analysis from a single institution

Francesca Ratti¹ · Federica Cipriani¹ · Riccardo Ariotti¹ · Annalisa Gagliano¹ · Michele Paganelli¹ · Marco Catena¹ · Luca Aldrighetti¹

Surg Endosc, 2015

Intrahepatic cholangiocarcinoma

Research

Jama Surgery, 2018

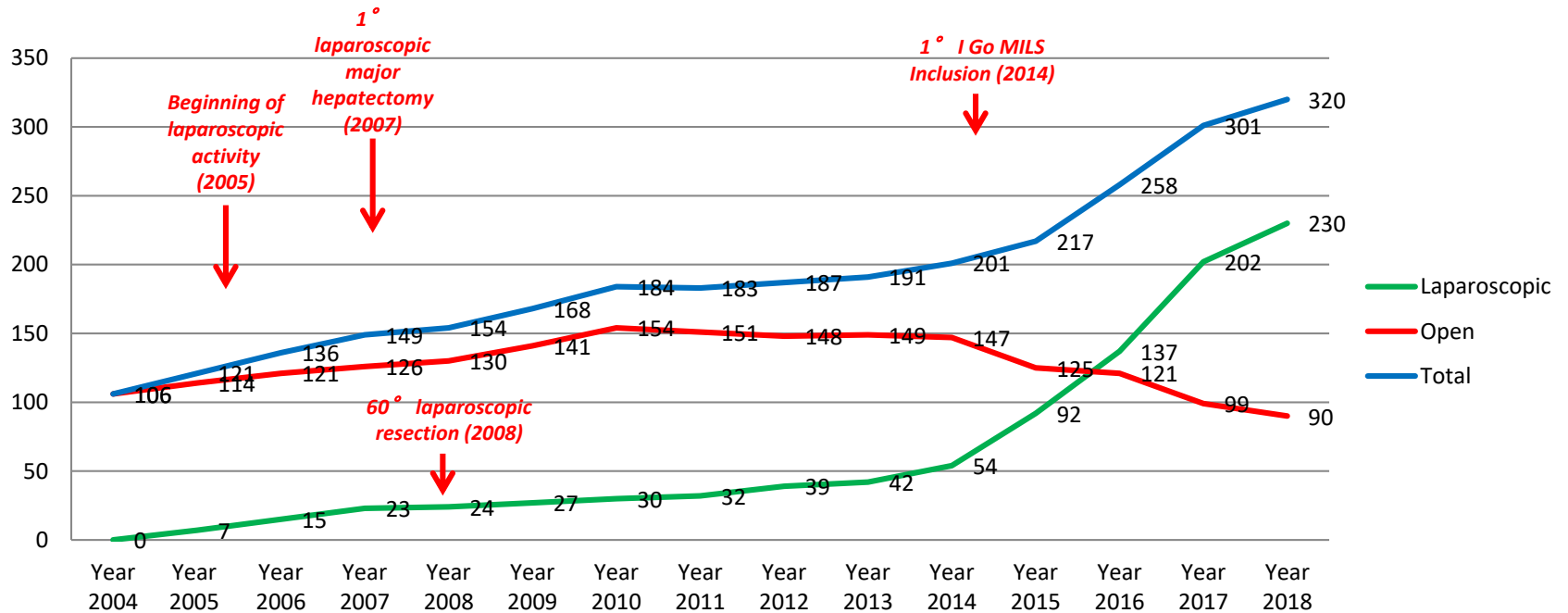
JAMA Surgery | Original Investigation

Laparoscopic vs Open Surgery for Colorectal Liver Metastases

Francesca Ratti, MD; Guido Fiorentini, MD; Federica Cipriani, MD; Marco Catena, MD, PhD; Michele Paganelli, MD; Luca Aldrighetti, MD, PhD

Colorectal Liver Metastases

Liver resection activity – Hepatobiliary Surgery Division San Raffaele Hospital, Milano (2004-2018)



2005: Ratio
MILS/Whole
series
5.8%

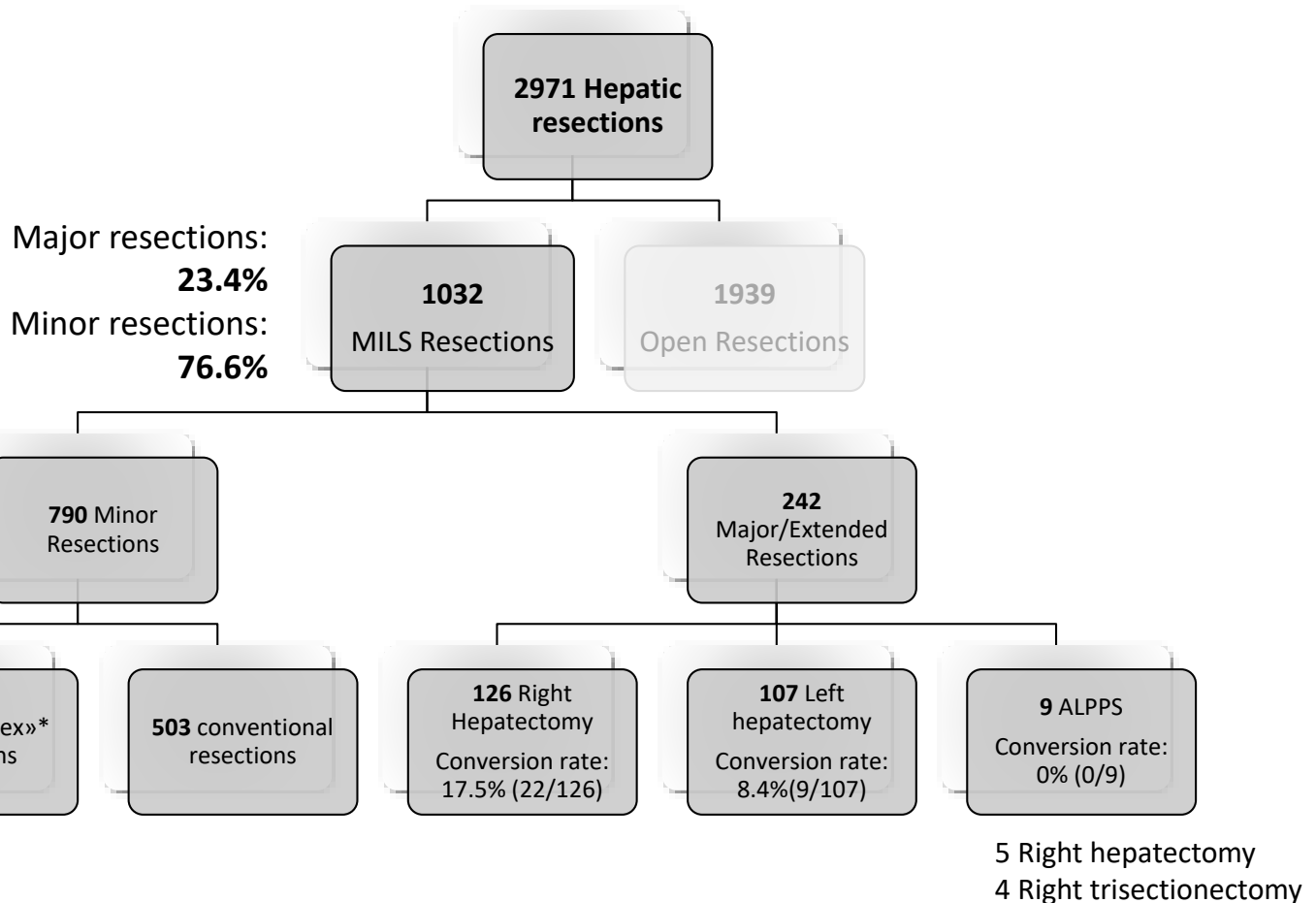
2010:
MILS/Whole
series
16.3%

2016:
MILS/Whole
series
53.1%

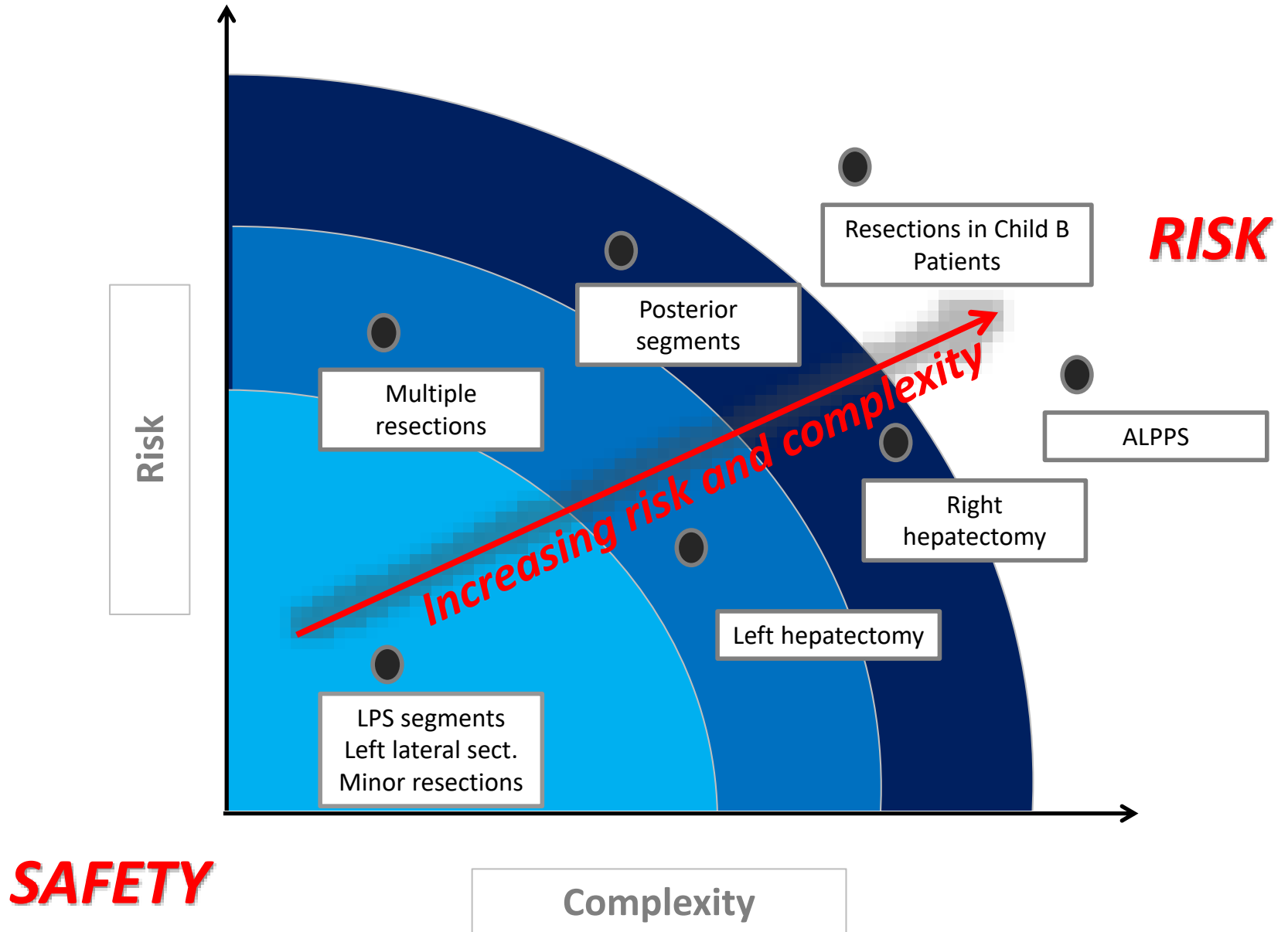
2018:
MILS/Whole
series
71.1%

Hepatobiliary Surgery Unit Ospedale San Raffaele - Milano

2971 Resections 01/01/2004 → 05/04/2019



* P-S segments, lesions close to vessels, redo surgery, cirrhosis

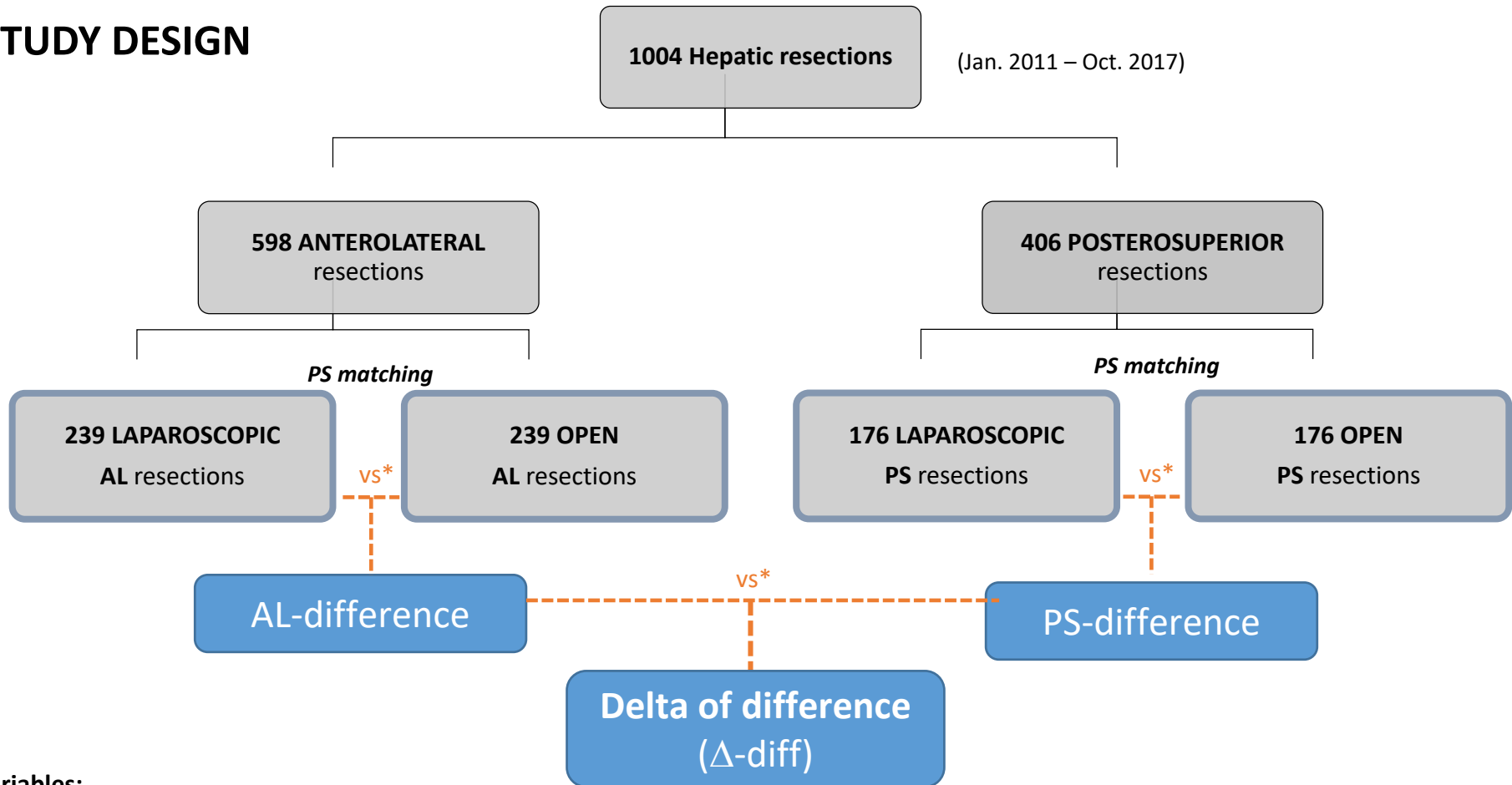


Laparoscopic or open approaches for posterosuperior and anterolateral liver resections? A propensity score based analysis of the degree of advantage

Cipriani F, Ratti F, Paganelli M, Reineke R, Catena M, Aldrighetti L

Lap vs Open

STUDY DESIGN



Variables:

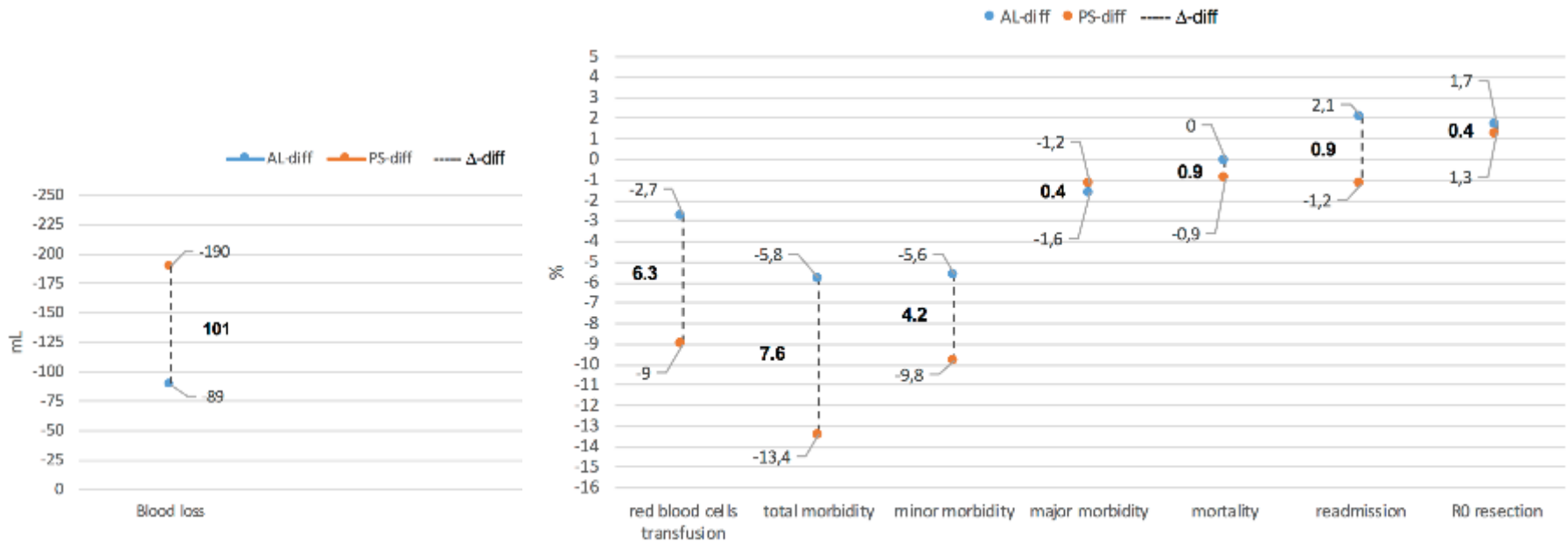
operative time; estimated blood loss; duration of Pringle manoeuvre; red blood cell transfusion rate; morbidity rate (total, minor and major); mortality rate; length of stay; time to orally-controlled postoperative pain; time to independent mobilization; time to tolerance of solid food; time for functional recovery; readmission rates; R0 rate.

ORIGINAL ARTICLE

Laparoscopic or open approaches for posterosuperior and anterolateral liver resections? A propensity score based analysis of the degree of advantage

Cipriani F, Ratti F, Paganelli M, Reineke R, Catena M, Aldrighetti L

Lap vs Open



While both resulting in benefit, the advantage of laparoscopy is greater for posterosuperior than anterolateral resections. Despite their technical difficulty, these should be considered among the most worthwhile laparoscopic liver resections.

ORIGINAL ARTICLE

The Southampton Consensus Guidelines for Laparoscopic Liver Surgery

From Indication to Implementation

Mohammad Abu Hilal, PhD, Luca Aldrighetti, PhD,† Ibrahim Dagher, PhD,‡ Bjorn Edwin, PhD,§ Roberto Ivan Troisi, PhD,¶ Ruslan Alikhanov, PhD,|| Somaiah Aroori, PhD,** Giulio Belli, PhD,†† Marc Besselink, PhD,‡‡ Javier Briceno, PhD,§§ Brice Gayet, PhD,¶¶ Mathieu D'Hondt, PhD,|||| Mickael Lesurtel, PhD,**** Krishna Menon, MS,††† Peter Lodge, PhD,‡‡‡ Fernando Rotellar, PhD,§§§ Julio Santoyo, PhD,¶¶¶ Olivier Scatton, PhD,||||| Olivier Soubrane, PhD,***** Robert Sutcliffe, MD,†††† Ronald Van Dam, PhD,‡‡‡‡ Steve White, PhD,§§§§ Mark Christopher Halls, MBBS,* Federica Cipriani, MD,† Marcel Van der Poel, MD,‡‡ Ruben Ciria, PhD,§§ Leonid Barkhatov, MD,§ Yrene Gomez-Luque, MD,§§ Sira Ocana-Garcia, MD,§§ Andrew Cook, MBBS,¶¶¶¶ Joseph Buell, MD,||||||| Pierre Alain Clavien, PhD,***** Christos Dervenis, PhD,††††† Giuseppe Fusai, MS,‡‡‡‡‡ David Geller, MD,§§§§§ Hauke Lang, MD,¶¶¶¶¶ John Primrose, PhD,* Mark Taylor, PhD,||||||| Thomas Van Gulik, PhD,‡‡ Go Wakabayashi, PhD,***** Horacio Asbun, MD,†††††† and Daniel Cherqui, PhD,‡‡‡‡‡‡*

Ann Surg, 2017

Training

- ✓ Laparoscopic liver resections should only be performed by surgeons with advanced laparoscopic skills and a wide experience of open liver surgery. Surgeons intending to start a laparoscopic liver practice should first pursue specific training through fellowships, courses, or proctoring programs. **Strong**
- ✓ Surgeons should develop their laparoscopic liver practice in a stepwise fashion. Proficiency should initially be gained by performing minor resections of lesions in the left lateral and anterior segments. Major resections should not be attempted before completing this first part of the learning curve. **Strong**



Contents lists available at [ScienceDirect](#)

Surgical Oncology

journal homepage: www.elsevier.com/locate/suronc



2018

Practical guidelines for performing laparoscopic liver resection based on the second international laparoscopic liver consensus conference



Jai Young Cho ^a, Ho-Seong Han ^{a,*}, Go Wakabayashi ^b, Olivier Soubrane ^c, David Geller ^d,
Nicholas O'Rourke ^e, Joseph Buell ^f, Daniel Cherqui ^g

Preoperative difficulty scoring systems allow the selection of cases appropriate for trainee surgeons and the allocation of lower risk cases to novice surgeons.

Such approaches may also provide a road map for trainees learning surgery, aiming to a step-by-step training system, and may help surgeons provide patients with more appropriate information regarding the predicted risks.

Ann Surg, 2017

ORIGINAL ARTICLE

Difficulty of Laparoscopic Liver Resection

Proposal for a New Classification

Yoshikuni Kawaguchi, MD, PhD,*† David Fuks, MD, PhD,*
Norihiro Kokudo, MD, PhD,† and Brice Gayet, MD, PhD*

TABLE 1. Operative Time, Estimated Blood Loss, and Conversion Rate, by Laparoscopic Liver Resection Procedure

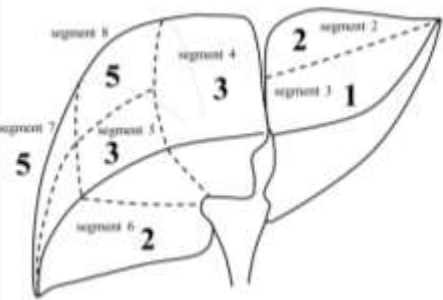
| | Wedge Ante | Wedge Post | Left Lateral | SegAnte | Left Hep | SegPost | Right Hep | Ex-right Hep | Right Posterior | Central Hep | Ex-left Hep | Total |
|---------------------|---------------|---------------|-----------------|----------|----------|----------|--------------|-----------------|--------------------|----------------|----------------|-----------|
| N | 94 | 59 | 38 | 49 | 26 | 31 | 98 | 27 | 7 | 11 | 12 | 452 |
| Operative time, min | | | | | | | | | | | | |
| Median | 120 | 172 | 135 | 200 | 210 | 198 | 240 | 285 | 300 | 205 | 300 | 190 |
| Range | 25–390 | 40–400 | 60–480 | 40–406 | 120–420 | 90–600 | 120–515 | 100–540 | 210–390 | 150–420 | 120–540 | 25–600 |
| Blood loss, mL | | | | | | | | | | | | |
| Median | 0 | 50 | 15 | 100 | 120 | 110 | 215 | 250 | 350 | 300 | 610 | 100 |
| Range | 0–1000 | 0–1000 | 0–100 | 0–800 | 0–1500 | 0–1300 | 0–4500 | 0–2000 | 0–1300 | 100–3000 | 0–1300 | 0–4500 |
| Conversion* | 0 (0%) | 1 (1.7%) | 0 (0%) | 1 (2.0%) | 1 (3.8%) | 2 (6.5%) | 5 (5.1%) | 3 (11.1%) | 1 (14.3%) | 2 (18.2%) | 3 (25.0%) | 19 (4.2%) |
| Scores† | 0 | 0 | 0 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | — |
| Group | I | | | II | | III | | | | | | |

*Conversion to laparotomy.

†One point was allocated as follows; either operative time (190 min and more), the amount of blood loss (100 mL and more), or conversion rate (4.2% and more).

Central Hep indicates central hepatectomy (resection of segments 5 and 8, or segments 4, 5, and 8); Ex-Left Hep, extended left hepatectomy (resection of segments 1, 2, 3, 4, 5, and 8); Ex-Right Hep, extended right hepatectomy (resection of segments 4, 5, 6, 7, and 8 ± 1); Left Hep, left hepatectomy (resection of segments 2, 3, and 4 ± 1); Left lateral, left lateral sectionectomy; Right Hep, right hepatectomy (resection of segments 5, 6, 7, and 8 ± 1); Right posterior, right posterior sectionectomy (resection of segments 6 and 7); SegAnte, anterolateral segmentectomy; SegPost, posterosuperior segmentectomy; WedgeAnte, wedge resection of anterolateral segment (segments 2, 3, 4b, 5, or 6); WedgePost, wedge resection of posterosuperior segment (segments 1, 4a, 7, or 8).

Tumor location 1



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

Extent of liver resection 2

| | Score |
|-------------------------------------|-------|
| Hr0 (partial resection) | 0 |
| Hr-LLR (left lateral sectionectomy) | 2 |
| Hr-S (segmentectomy) | 3 |
| Hr-1, 2 (sectionectomy and more) | 4 |

Tumor size 3

| | Score |
|-------|-------|
| <3 cm | 0 |
| ≥3 cm | 1 |

Proximity to major vessel 4

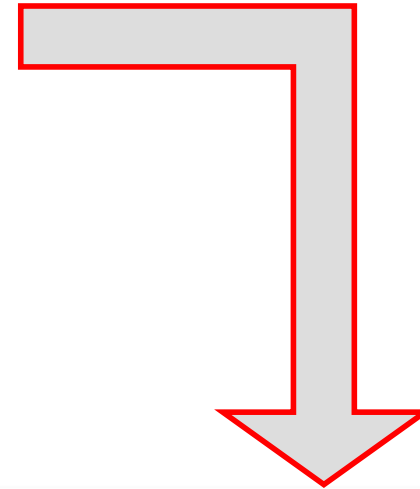
| Proximity to major vessel* | Score |
|----------------------------|-------|
| no | 0 |
| yes | 1 |

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

Liver function 5

| | Score |
|--------------|-------|
| Child Pugh A | 0 |
| Child Pugh B | 1 |

Score of Technical difficulty



A novel difficulty scoring system for laparoscopic liver resection

Ban D, Wakabayashi G. J HBP Sci 2015

From the perspective of **education** and **assessment** of MILS, a system to universally determine the difficulty level is essential

| Difficulty of laparoscopic liver resection | | | | | | | | | | | |
|--|--|---|---|--|---|---|---|--|---|----|--|
| 10-level index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| 3-level index | Low | | | Intermediate | | | | High | | | |
| Definition | <ul style="list-style-type: none"> For surgeons starting laparoscopic liver resection For surgeons with experience of <10 cases of laparoscopic liver resection | | | <ul style="list-style-type: none"> 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 | | | | <ul style="list-style-type: none"> 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 | | | | | | | |

Risk of intraoperative complications

Original article

Br J Surg, 2017

Development and validation of a difficulty score to predict intraoperative complications during laparoscopic liver resection

M. C. Halls¹, G. Berardi³, F. Cipriani^{1,5}, L. Barkhatov⁶, P. Lainas⁷, S. Harris², M. D'Hondt⁴, F. Rotellar⁸, I. Dagher⁷, L. Aldrighetti⁵, R. I. Troisi³, B. Edwin⁶ and M. Abu Hilal¹

¹Department of Hepato-Biliary and Pancreatic Surgery, University Hospital Southampton, and ²Department of Public Health Sciences and Medical Statistics, Faculty of Medicine, University of Southampton, Southampton, UK, ³Department of General and Hepatobiliary Surgery, Liver Transplantation, Ghent University Hospital Medical School, Ghent, and ⁴Department of Digestive and Hepatopancreatobiliary Surgery, Groeninge Hospital, Kortrijk, Belgium, ⁵Department of Hepatobiliary Surgery, San Raffaele Hospital, Milan, Italy, ⁶Intervention Centre and Department of Hepatopancreatobiliary Surgery, Oslo University Hospital, and Institute of Clinical Medicine, University of Oslo, Oslo, Norway, ⁷Department of Hepatobiliary Surgery, Antoine-Béclère Hospital, Paris, France, and ⁸Department of General Surgery, University of Navarra Hospital, Pamplona, Spain
 Correspondence to: Professor M. Abu Hilal, Department of Hepato-Biliary and Pancreatic Surgery, University Hospital Southampton NHS Foundation Trust, Tremona Road, Southampton SO16 2YD, UK (e-mail: abuhilal@gmail.com)

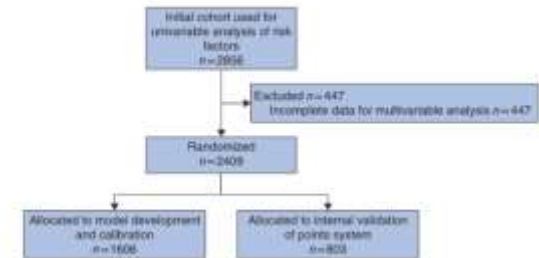


Table 4 Reference values with the reference base value for each predictor, the regression coefficient and points attributed to each factor

| Risk factor (,) | Risk factor category | Reference value | Regression coefficient (B _i) | Regression units (B _i (W _{ij} - W _{REF})) | Points assigned (B _i (W _{ij} - W _{REF})/B) |
|-------------------------------|----------------------|-------------------------|--|---|--|
| Neoadjuvant chemotherapy | No | 0 (W _{REF}) | 0.294 | 0 | 0 |
| | Yes | 1 (W _i) | | 0.294* | 1 |
| Previous open liver resection | No | 0 (W _{REF}) | 1.401 | 0 | 0 |
| | Yes | 1 (W _i) | | 1.401 | 5 |
| Lesion type | Benign | 0 (W _{REF}) | 0.659 | 0 | 0 |
| | Malignant | 1 (W _i) | | 0.659 | 2 |
| Lesion size (cm) | < 3 | 1.5 (W _{REF}) | 0.186 | 0 | 0 |
| | 3-5 | 4 (W _i) | | 0.465 | 2 |
| | > 5 | 6.5 (W _i) | | 0.930 | 3 |
| Classification of resection | Minor | 1 (W _{REF}) | 0.583 | 0 | 0 |
| | Technically major | 2 (W _i) | | 0.583 | 2 |
| | Anatomically major | 3 (W _i) | | 1.166 | 4 |

Factors

Points

| Total points scored | Post-calibration risk | Risk group |
|---------------------|-----------------------|----------------|
| 0 | 0.5 | Low |
| 1 | 3.0 | Low |
| 2 | 6.1 | Low |
| 3 | 9.9 | Moderate |
| 4 | 14.5 | Moderate |
| 5 | 20.0 | Moderate |
| 6 | 26.2 | High |
| 7 | 33.1 | High |
| 8 | 40.3 | High |
| 9 | 47.6 | High |
| 10 | 54.7 | Extremely high |
| 11 | 61.3 | Extremely high |
| 12 | 69.8 | Extremely high |
| 13 | 72.4 | Extremely high |
| 14 | 76.7 | Extremely high |
| 15 | 80.2 | Extremely high |

ORIGINAL ARTICLE

HPB, 2017

Are the current difficulty scores for laparoscopic liver surgery telling the whole story? An international survey and recommendations for the future

Mark C. Halls¹, Daniel Cherqui², Mark A. Taylor³, John N. Primrose¹, Mohammed Abu Hilal¹ & Collaborators of The Difficulty of Laparoscopic Liver Surgery Survey

¹University Hospital Southampton, Southampton, United Kingdom, ²Paul Brousse Hospital, Villejuif-Paris, France, and

³Mater Hospital, Belfast, Northern Ireland, United Kingdom

The difficulty of laparoscopic liver surgery is not fully assessed by the available difficulty scoring systems and prompts the development of a new difficulty score that incorporates all factors believed to increase difficulty.

Factors contributing to difficulty:

- BMI
- Neoadjuvant treatments
- Redo surgery
- Combined procedures

J Hepatobiliary Pancreat Sci (2016) 23:373–381
DOI: 10.1002/jbhp.390

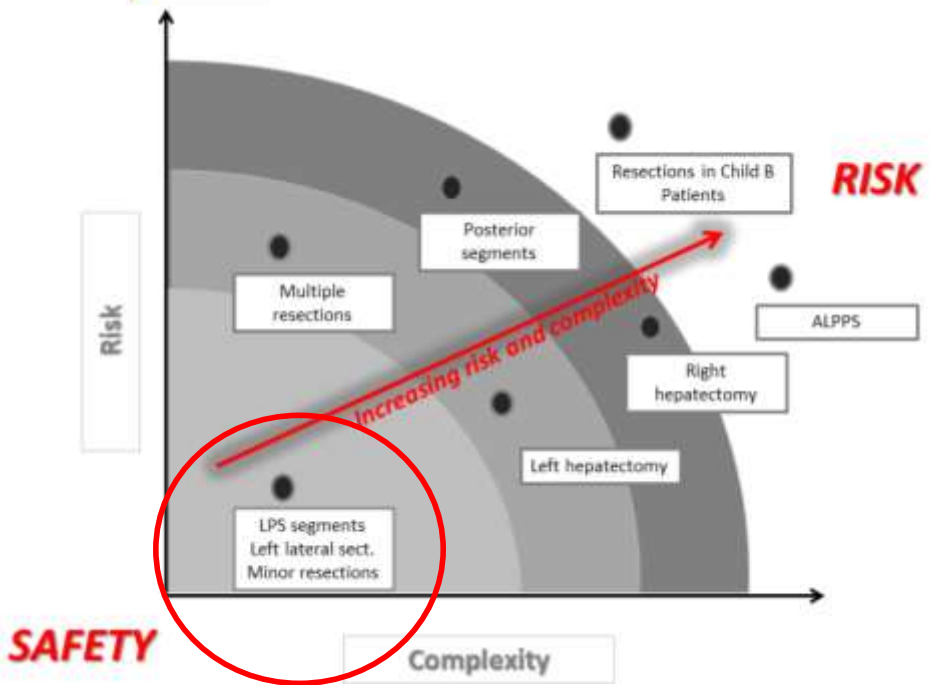
J HBP Sci, 2016

ORIGINAL ARTICLE

Influence of body habitus on feasibility and outcome of laparoscopic liver resections: a prospective study

Francesca Ratti · Valentina D'Alessandro ·
Federica Cipriani · Fabio Giannone · Marco Catena ·
Luca Aldrighetti

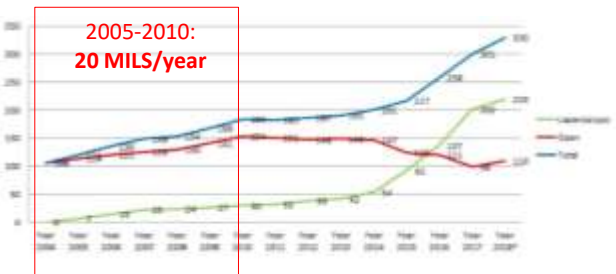
Skills acquisition: step 1



Beginners

J HBP Sci 2015

| Difficulty of laparoscopic liver resection | | | | | | | | | | |
|--|--|---|---|--|---|---|--|---|---|--|
| 10-level index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 3-level index | Low | | | Intermediate | | | High | | | |
| Definition | <ul style="list-style-type: none"> For surgeons starting laparoscopic liver resection For surgeons with experience of <10 cases of laparoscopic liver resection | | | <ul style="list-style-type: none"> 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 | | | <ul style="list-style-type: none"> 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 |



*Step 1 in details****Instruments:***

- Ultrasonic dissector, bipolar forceps, lap ultrasound, energy device

Skills:

- Patient and trocars position
- Parenchymal dissection
- Pringle maneuver
- Laparoscopic ultrasound
- Suturing for bleeding and bile leak
- Define standards

Procedures:

- Procedures for lesions in laparoscopic segments
- Left lateral sectionectomy

Case studies

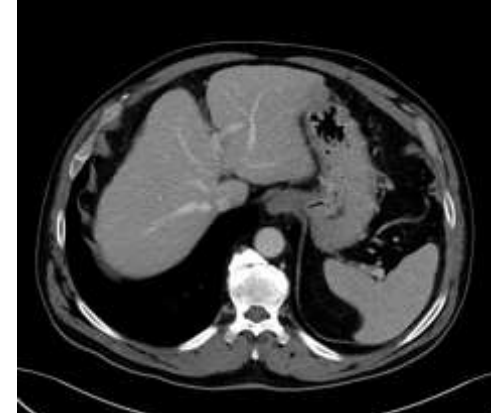
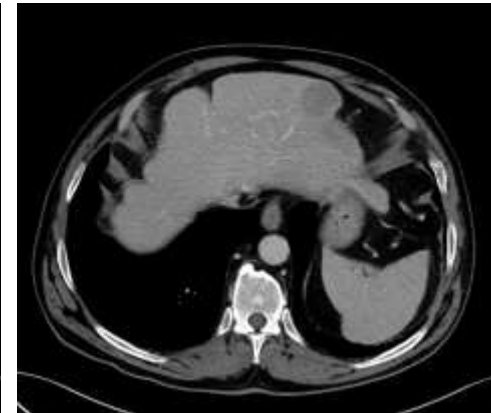
Score for technical difficulty

| Characteristics | Points |
|----------------------------|--------|
| Tumor location | 1 |
| Tumor size | 0 |
| Proximity to major vessels | 0 |
| Liver function | 0 |
| Extent of liver resection | 0 |
| <i>Total score</i> | 1 |

Score for risk of intraoperative complications

| Characteristics | Points |
|-----------------------------|--------|
| Neoadjuvant CT | 0 |
| Previous open liver surgery | 0 |
| Lesion type | 2 |
| Lesion size | 0 |
| Classification of resection | 0 |
| <i>Total score</i> | 2 |

Diagnosis: Colorectal metastases
Procedure: Wedge Sg3 resection



LOW

Case studies

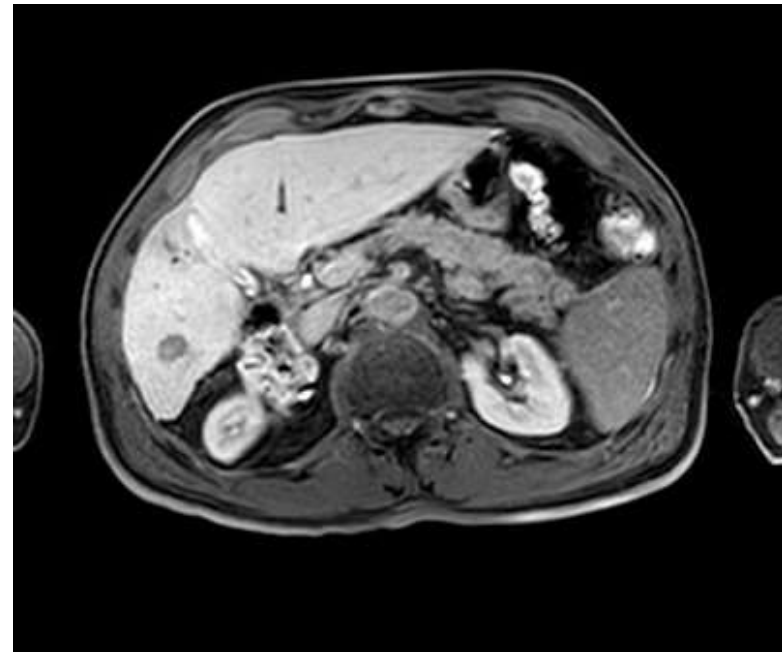
Score for technical difficulty

| Characteristics | Points |
|----------------------------|--------|
| Tumor location | 2 |
| Tumor size | 0 |
| Proximity to major vessels | 0 |
| Liver function | 0 |
| Extent of liver resection | 0 |
| <i>Total score</i> | 2 |

Score for risk of intraoperative complications

| Characteristics | Points |
|-----------------------------|--------|
| Neoadjuvant CT | 0 |
| Previous open liver surgery | 0 |
| Lesion type | 2 |
| Lesion size | 0 |
| Classification of resection | 0 |
| <i>Total score</i> | 2 |

Diagnosis: Colorectal liver metastases
 Procedure: Subsegmental Sg6 resection



LOW

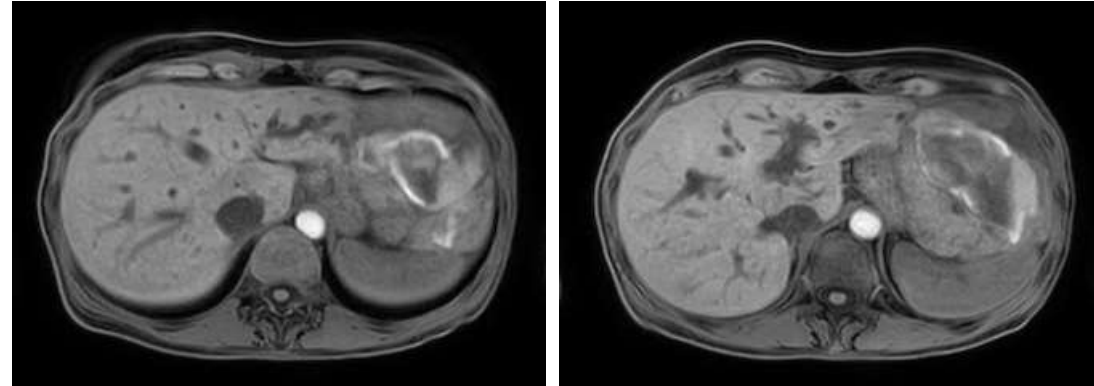
Case studies

Diagnosis: Adenoma

Procedure: Subsegmental Sg2 resection

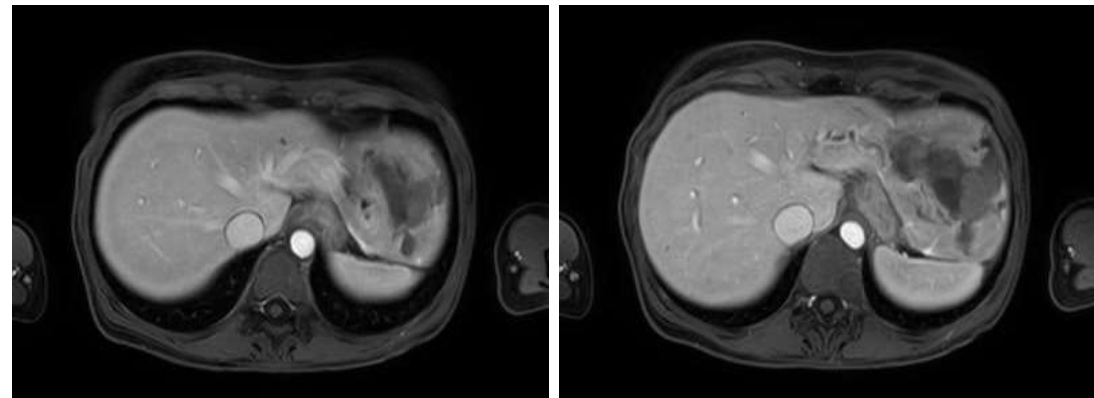
Score for technical difficulty

| Characteristics | Points |
|----------------------------|--------|
| Tumor location | 2 |
| Tumor size | 1 |
| Proximity to major vessels | 0 |
| Liver function | 0 |
| Extent of liver resection | 0 |
| <i>Total score</i> | 3 |



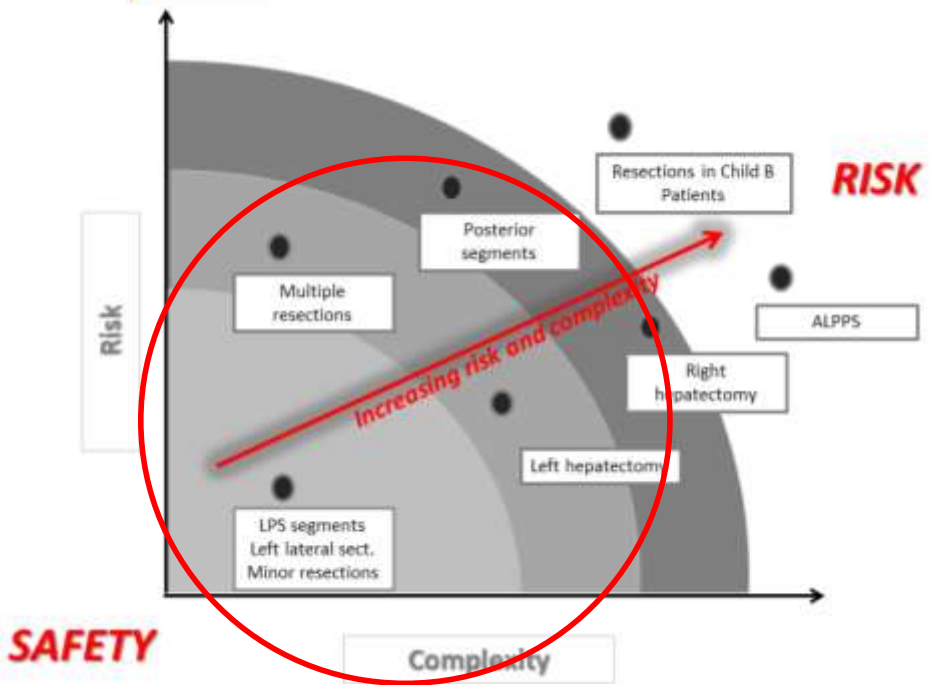
Score for risk of intraoperative complications

| Characteristics | Points |
|-----------------------------|--------|
| Neoadjuvant CT | 0 |
| Previous open liver surgery | 0 |
| Lesion type | 0 |
| Lesion size | 3 |
| Classification of resection | 0 |
| <i>Total score</i> | 3 |



LOW

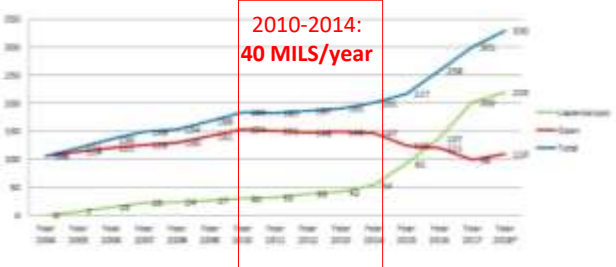
Skills acquisition: step 2



Intermediate

J HBP Sci 2015

| Difficulty of laparoscopic liver resection | | | | | | | | | | |
|--|--|---|---|--|---|---|--|---|---|--|
| 10-level index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 3-level index | Low | | | Intermediate | | | High | | | |
| Definition | <ul style="list-style-type: none"> For surgeons starting laparoscopic liver resection For surgeons with experience of <10 cases of laparoscopic liver resection | | | <ul style="list-style-type: none"> 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 | | | <ul style="list-style-type: none"> 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 |



Intermediate

Step 2 in details

Instruments:

- Atraumatic retractors, instruments for hilar dissection

Skills:

- Right liver full mobilization
- Vena cava exposure
- Approach to major pedicles
- Expertise in liver ultrasound guidance for liver resections

Procedures:

- Anatomical resections of laparoscopic segments
- Multiple resections in laparoscopic segments
- Left hepatectomy

Case studies

Diagnosis: Colorectal metastases

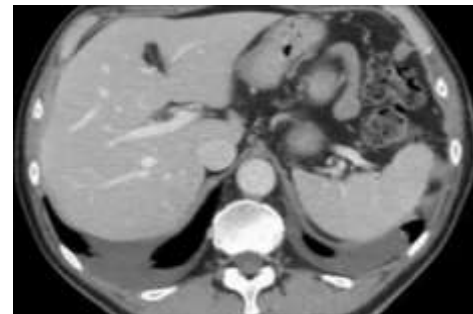
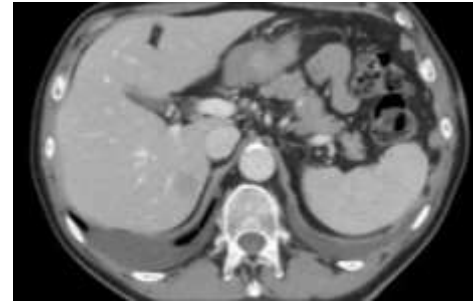
Procedure: Sg6 segmental resection

Score for technical difficulty

| Characteristics | Points |
|----------------------------|--------|
| Tumor location | 2 |
| Tumor size | 0 |
| Proximity to major vessels | 0 |
| Liver function | 0 |
| Extent of liver resection | 3 |
| <i>Total score</i> | 5 |

Score for risk of intraoperative complications

| Characteristics | Points |
|-----------------------------|--------|
| Neoadjuvant CT | 0 |
| Previous open liver surgery | 0 |
| Lesion type | 2 |
| Lesion size | 2 |
| Classification of resection | 2 |
| <i>Total score</i> | 6 |



INTERMEDIATE

Case studies

Diagnosis: Intrahepatic cholangiocarcinoma

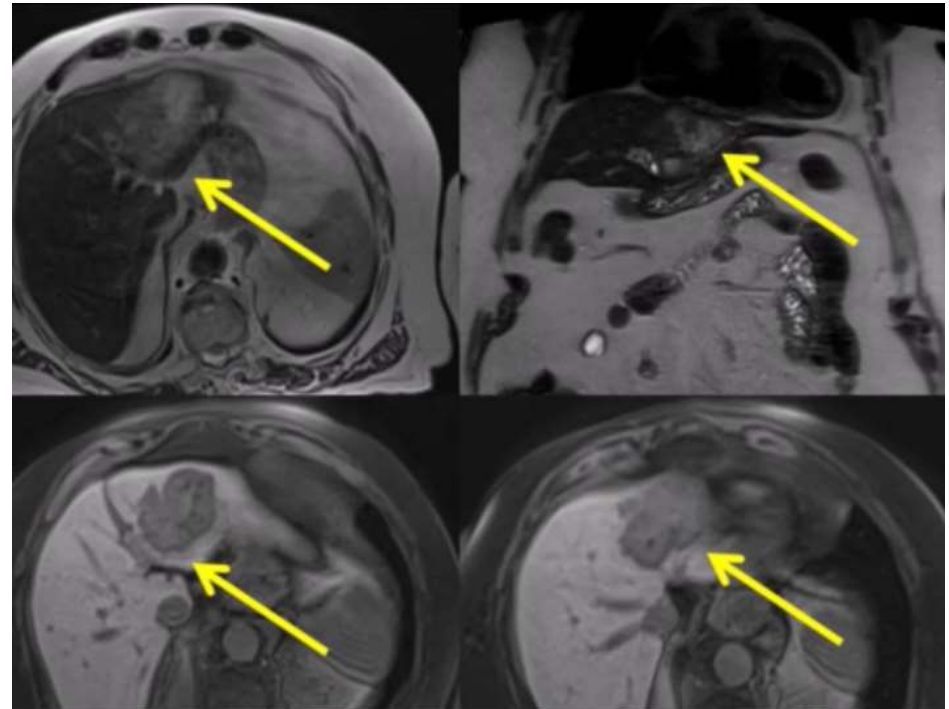
Procedure: Left hepatectomy

Score for technical difficulty

| Characteristics | Points |
|----------------------------|--------|
| Tumor location | 1 |
| Tumor size | 1 |
| Proximity to major vessels | 1 |
| Liver function | 0 |
| Extent of liver resection | 4 |
| <i>Total score</i> | 7 |

Score for risk of intraoperative complications

| Characteristics | Points |
|-----------------------------|--------|
| Neoadjuvant CT | 0 |
| Previous open liver surgery | 0 |
| Lesion type | 2 |
| Lesion size | 2 |
| Classification of resection | 4 |
| <i>Total score</i> | 8 |



INTERMEDIATE-HIGH

Case studies

Score for technical difficulty

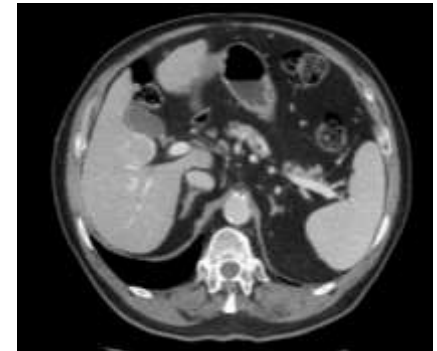
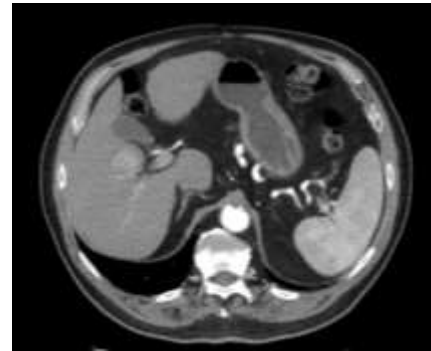
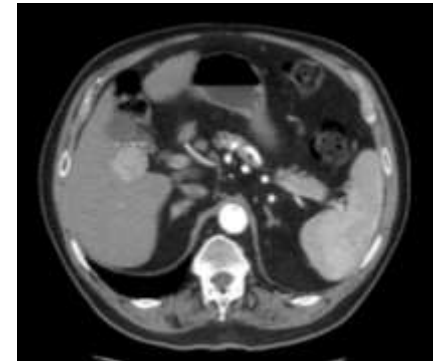
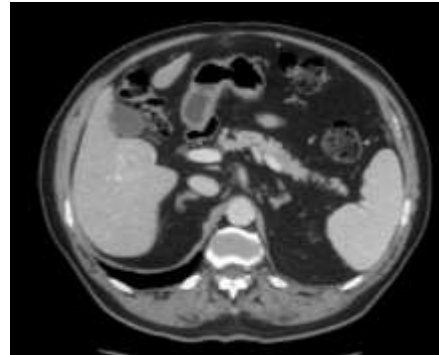
| Characteristics | Points |
|----------------------------|----------|
| Tumor location | 3 |
| Tumor size | 1 |
| Proximity to major vessels | 0 |
| Liver function | 0 |
| Extent of liver resection | 3 |
| <i>Total score</i> | <i>7</i> |

Score for risk of intraoperative complications

| Characteristics | Points |
|-----------------------------|----------|
| Neoadjuvant CT | 0 |
| Previous open liver surgery | 0 |
| Lesion type | 2 |
| Lesion size | 2 |
| Classification of resection | 0 |
| <i>Total score</i> | <i>4</i> |

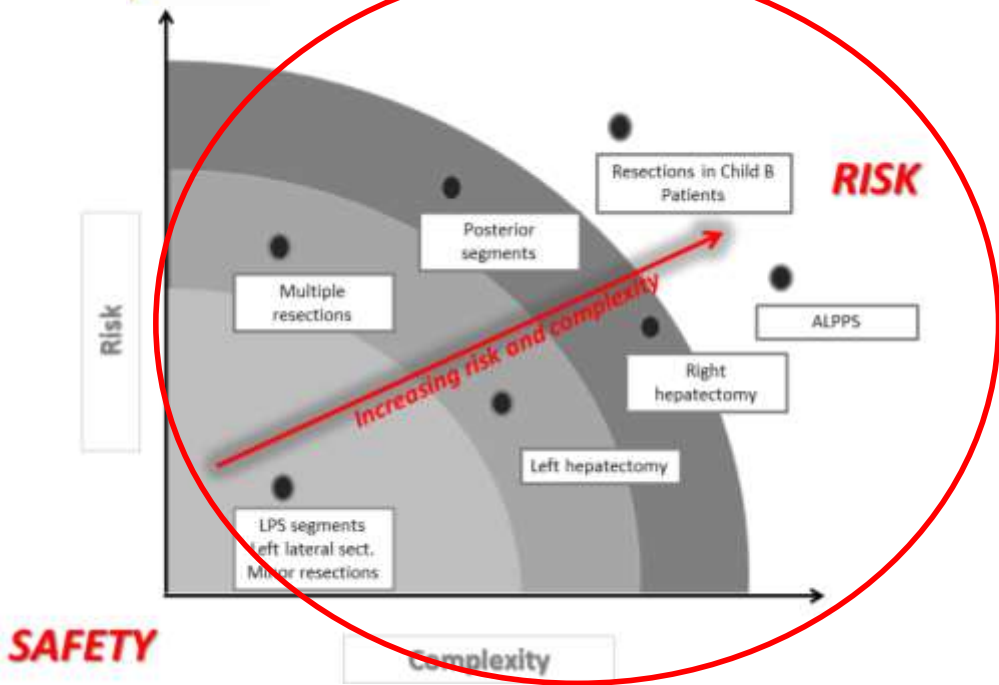
Diagnosis: HCC

Procedure: Sg5 segmental resection



INTERMEDIATE

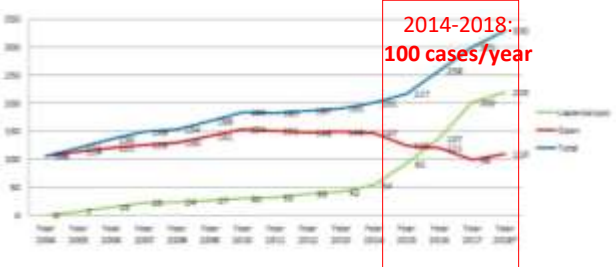
Skills acquisition: step 3



Experts

J HBP Sci 2015

| Difficulty of laparoscopic liver resection | | | | | | | | | | | |
|--|--|---|---|--|---|---|---|--|---|----|--|
| 10-level index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| 3-level index | Low | | | Intermediate | | | | High | | | |
| Definition | <ul style="list-style-type: none"> For surgeons starting laparoscopic liver resection For surgeons with experience of <10 cases of laparoscopic liver resection | | | <ul style="list-style-type: none"> 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 | | | | <ul style="list-style-type: none"> 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 | | | |



Experts

Instruments:

Step 3 in details

- Laparoscopic liver surgery operating room (advanced vision systems, integrated imaging systems, pre-defined sets of instruments for different type of resections)

Skills:

- Approach to hepatocaval confluence
- Laparoscopic hanging maneuver
- Laparoscopic lymphadenectomy
- Vascular sutures and biliary reconstructions

Procedures:

- Right hepatectomy/extended hemihepatectomies
- Resection of posterosuperior segments
- ALPPS procedures
- Advanced cirrhotic patients
- Living donor

Case studies

Diagnosis: Intrahepatic cholangiocarcinoma

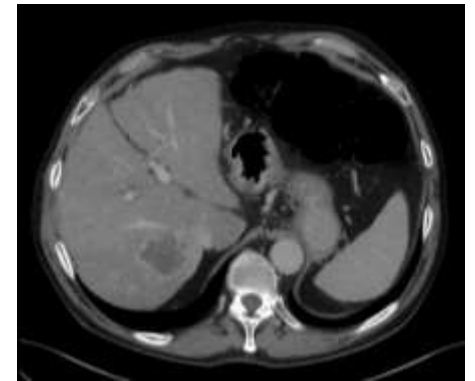
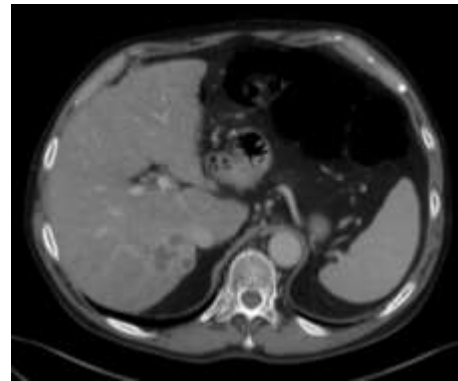
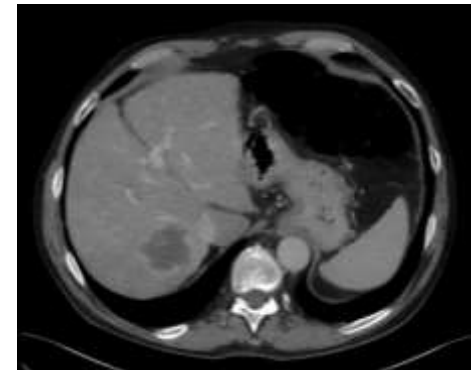
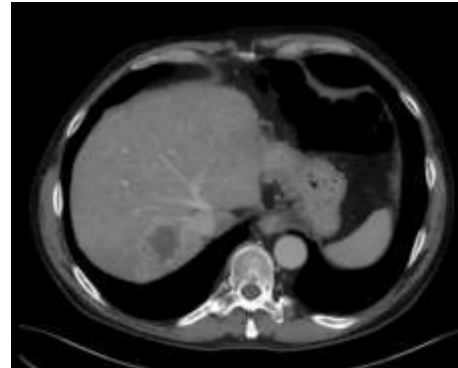
Procedure: Right posterior sectionectomy

Score for technical difficulty

| Characteristics | Points |
|----------------------------|---------------|
| Tumor location | 5 |
| Tumor size | 1 |
| Proximity to major vessels | 1 |
| Liver function | 0 |
| Extent of liver resection | 4 |
| <i>Total score</i> | <i>>10</i> |

Score for risk of intraoperative complications

| Characteristics | Points |
|-----------------------------|----------|
| Neoadjuvant CT | 0 |
| Previous open liver surgery | 0 |
| Lesion type | 2 |
| Lesion size | 3 |
| Classification of resection | 2 |
| <i>Total score</i> | <i>7</i> |



HIGH

Case studies

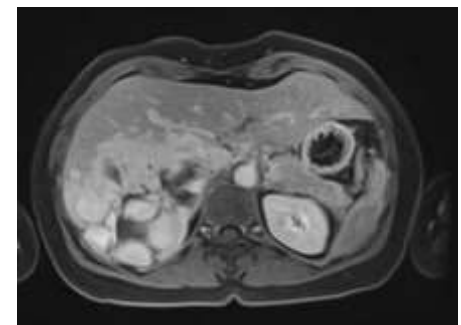
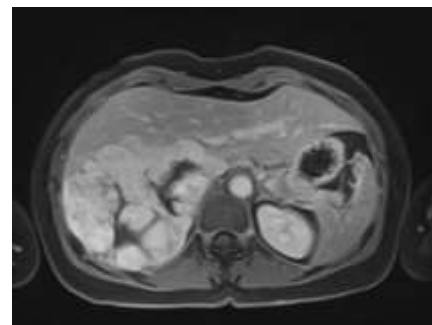
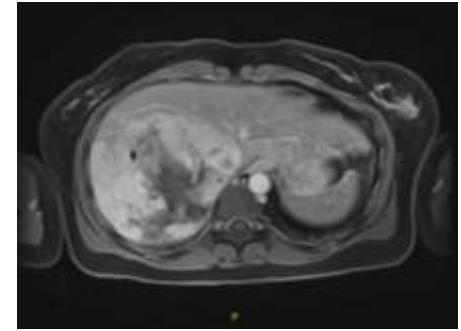
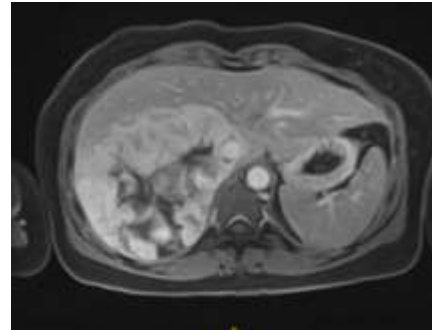
Score for technical difficulty

| Characteristics | Points |
|----------------------------|---------------|
| Tumor location | 5 |
| Tumor size | 1 |
| Proximity to major vessels | 1 |
| Liver function | 0 |
| Extent of liver resection | 4 |
| <i>Total score</i> | <i>>10</i> |

Score for risk of intraoperative complications

| Characteristics | Points |
|-----------------------------|----------|
| Neoadjuvant CT | 0 |
| Previous open liver surgery | 0 |
| Lesion type | 0 |
| Lesion size | 3 |
| Classification of resection | 4 |
| <i>Total score</i> | <i>7</i> |

Diagnosis: Giant haemangioma
Procedure: Right hepatectomy



HIGH

Case studies

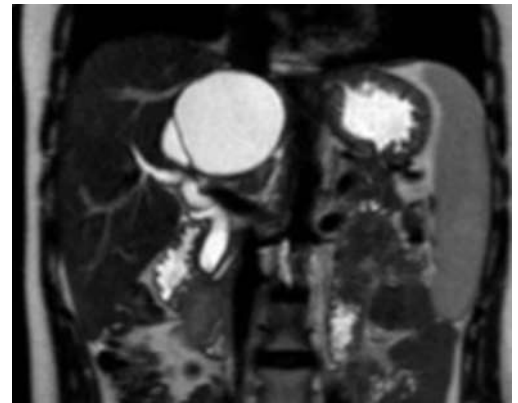
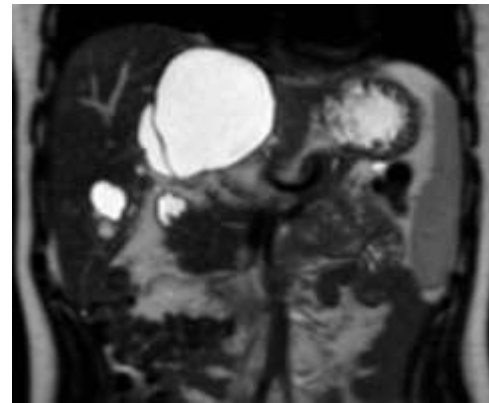
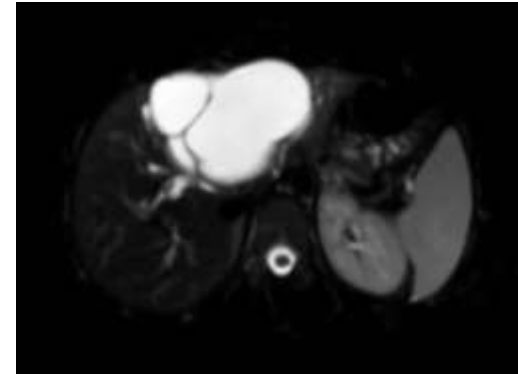
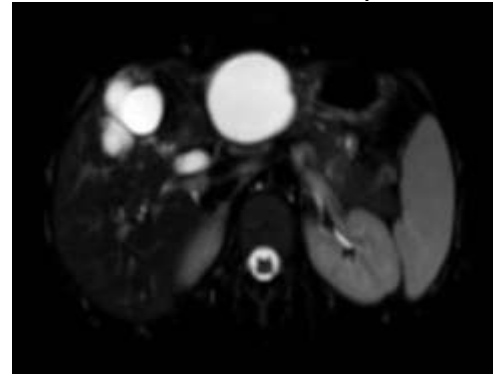
Score for technical difficulty

| Characteristics | Points |
|----------------------------|--------|
| Tumor location | 3 |
| Tumor size | 1 |
| Proximity to major vessels | 1 |
| Liver function | 0 |
| Extent of liver resection | 4 |
| <i>Total score</i> | 9 |

Score for risk of intraoperative complications

| Characteristics | Points |
|-----------------------------|--------|
| Neoadjuvant CT | 0 |
| Previous open liver surgery | 5 |
| Lesion type | 0 |
| Lesion size | 3 |
| Classification of resection | 4 |
| <i>Total score</i> | 12 |

Diagnosis: Biliary Cystadenoma
Procedure: Left hepatectomy



HIGH

Case studies

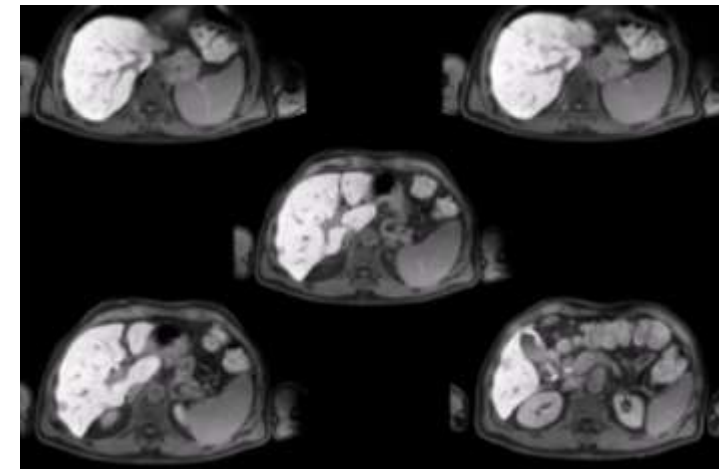
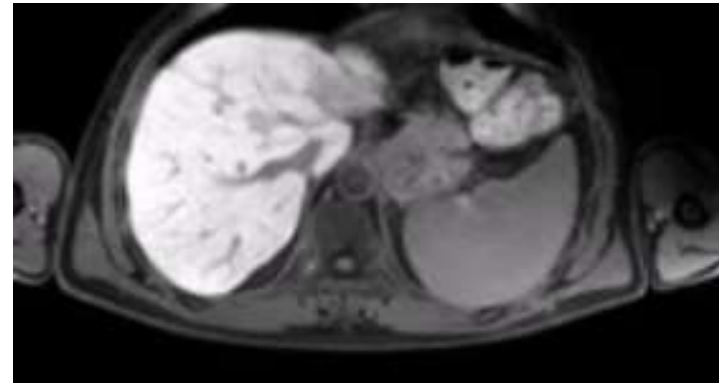
Score for technical difficulty

| Characteristics | Points |
|----------------------------|--------|
| Tumor location | 3 |
| Tumor size | 1 |
| Proximity to major vessels | 1 |
| Liver function | 0 |
| Extent of liver resection | 4 |
| <i>Total score</i> | 9 |

Score for risk of intraoperative complications

| Characteristics | Points |
|-----------------------------|--------|
| Neoadjuvant CT | 2 |
| Previous open liver surgery | 0 |
| Lesion type | 2 |
| Lesion size | 3 |
| Classification of resection | 4 |
| <i>Total score</i> | 11 |

Diagnosis: Colorectal liver metastases
 Procedure: Left hepatectomy + multiple right wedge resections and ablations



HIGH

Case studies

Diagnosis: Hepatocellular carcinoma

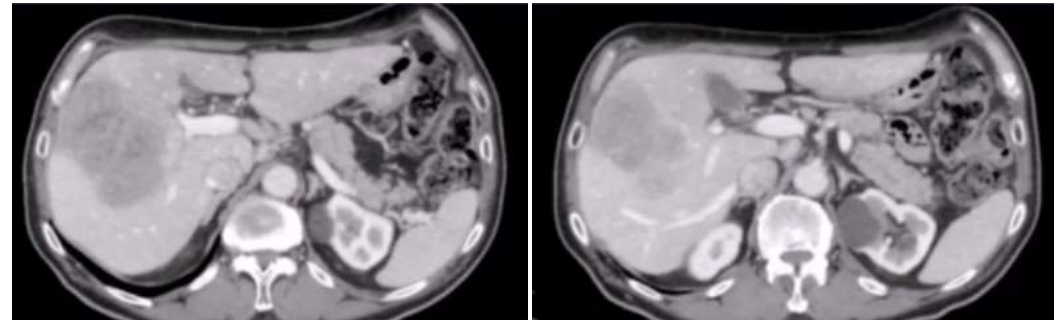
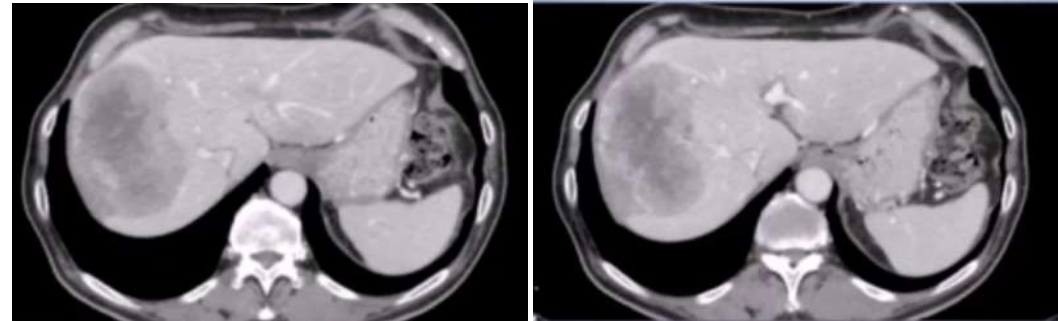
Procedure: Right hepatectomy

Score for technical difficulty

| Characteristics | Points |
|----------------------------|--------|
| Tumor location | 5 |
| Tumor size | 1 |
| Proximity to major vessels | 1 |
| Liver function | 0 |
| Extent of liver resection | 4 |
| <i>Total score</i> | >10 |

Score for risk of intraoperative complications

| Characteristics | Points |
|-----------------------------|--------|
| Neoadjuvant CT | 0 |
| Previous open liver surgery | 0 |
| Lesion type | 2 |
| Lesion size | 3 |
| Classification of resection | 4 |
| <i>Total score</i> | 9 |



VIDEO

Surg Endosc, 2016

Approach to hepatocaval confluence during laparoscopic right hepatectomy: three variations on a theme

Francesca Ratti¹ · Federica Cipriani¹ · Marco Catena¹ · Michele Paganelli¹ · Luca Aldrighetti¹

HIGH

Case studies

Diagnosis: Colorectal metastases with biliary thrombosis

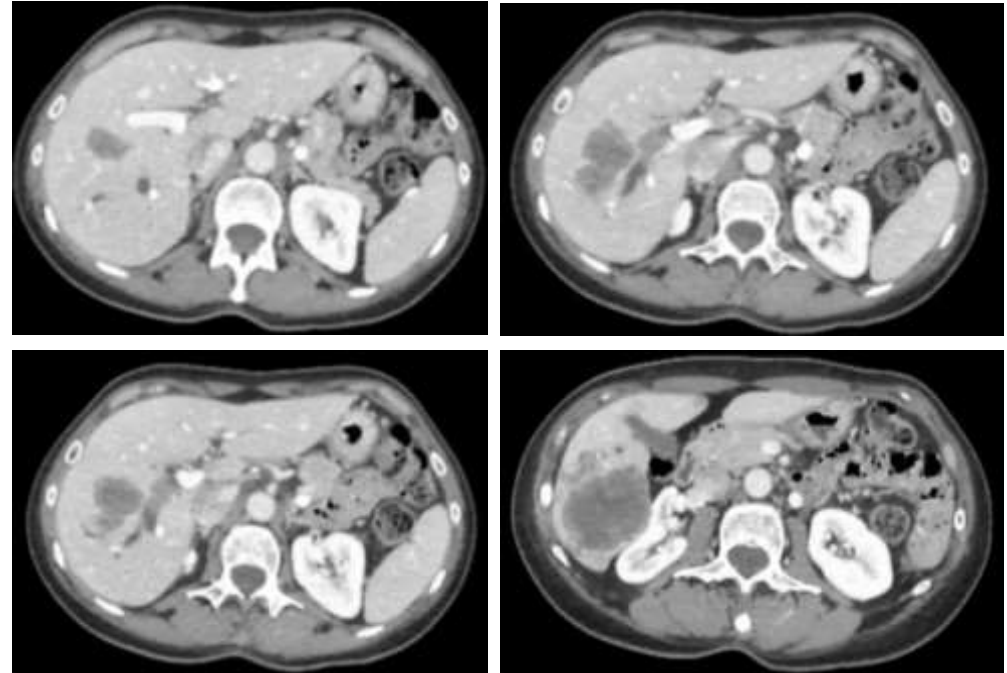
Procedure: Right hepatectomy

Score for technical difficulty

| Characteristics | Points |
|----------------------------|--------|
| Tumor location | 5 |
| Tumor size | 1 |
| Proximity to major vessels | 1 |
| Liver function | 0 |
| Extent of liver resection | 4 |
| <i>Total score</i> | >10 |

Score for risk of intraoperative complications

| Characteristics | Points |
|-----------------------------|--------|
| Neoadjuvant CT | 2 |
| Previous open liver surgery | 0 |
| Lesion type | 2 |
| Lesion size | 3 |
| Classification of resection | 4 |
| <i>Total score</i> | >10 |



HIGH

Case studies

Diagnosis: Colorectal metastases

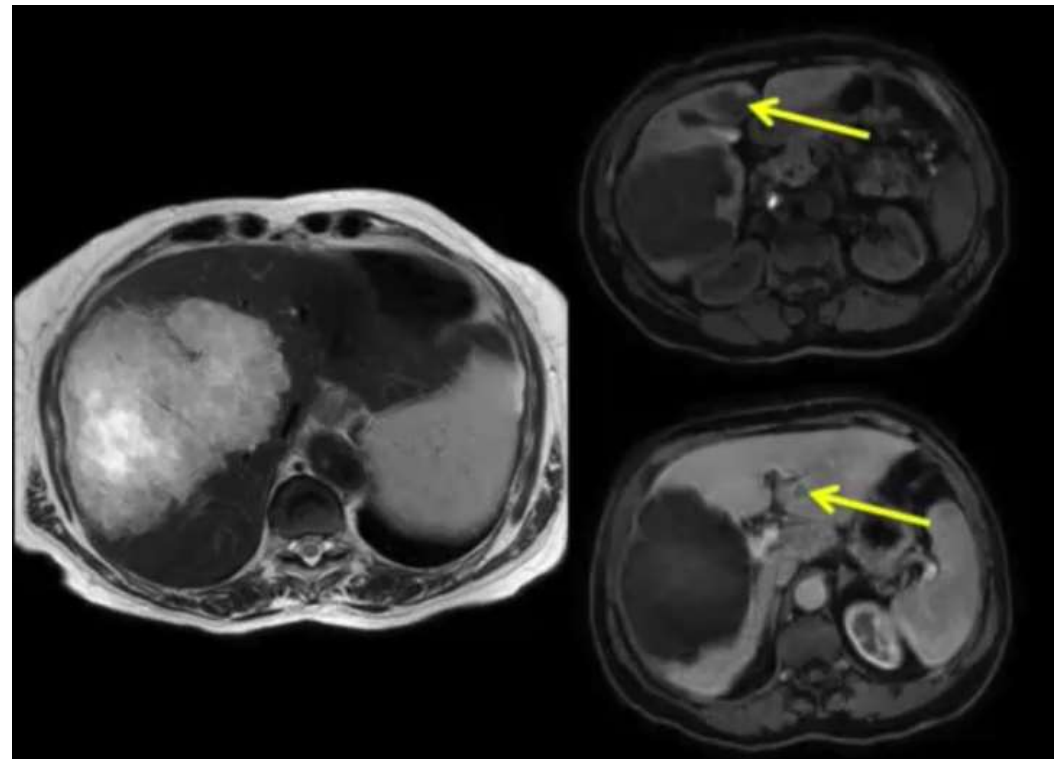
Procedure: ALPPS

Score for technical difficulty

| Characteristics | Points |
|----------------------------|--------|
| Tumor location | 5 |
| Tumor size | 1 |
| Proximity to major vessels | 1 |
| Liver function | 0 |
| Extent of liver resection | 4 |
| <i>Total score</i> | >10 |

Score for risk of intraoperative complications

| Characteristics | Points |
|-----------------------------|--------|
| Neoadjuvant CT | 2 |
| Previous open liver surgery | 0 |
| Lesion type | 2 |
| Lesion size | 3 |
| Classification of resection | 4 |
| <i>Total score</i> | >10 |



HIGH

What about the «numbers» of learning curve?

The Learning Curve in Laparoscopic Liver Resection

Improved Feasibility and Reproducibility

Luca Vigano, MD,* Alexis Laurent, MD, PhD,* Claude Tayar, MD,* Mariano Tomatis, MD,†
Antonio Ponti, MD,† and Daniel Cherqui, MD*

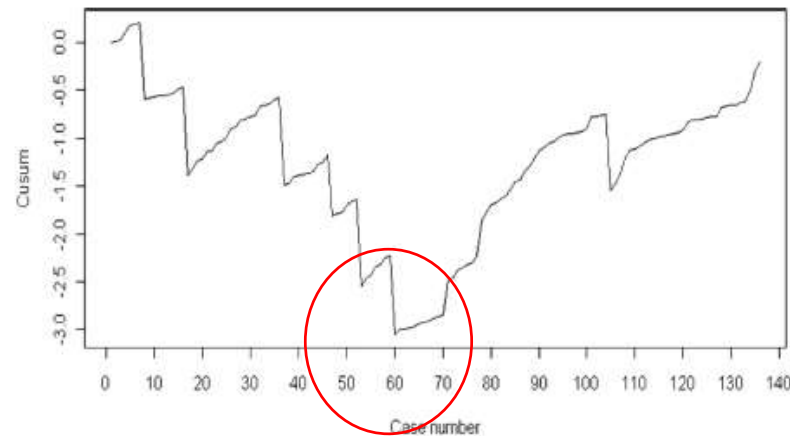


FIGURE 3. Risk-adjusted CUSUM chart of a series of 136 consecutive laparoscopic minor hepatectomies.

60 cases to complete the learning curve in minor MILS

...but...

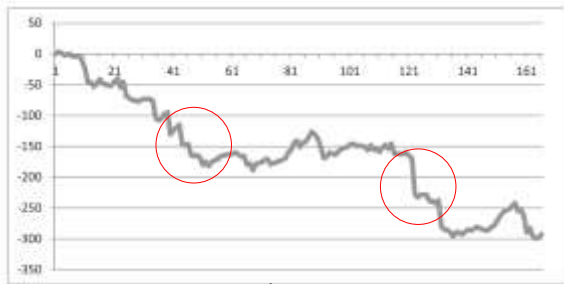
A Comparison of the Learning Curves of Laparoscopic Liver Surgeons in Differing Stages of the IDEAL Paradigm of Surgical Innovation

Standing on the Shoulders of Pioneers

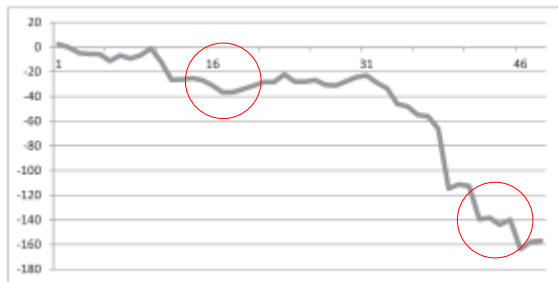
Mark Christopher Halls, MBBS,* Adnan Alseidi, MD,† Gianmauro Berardi, MD,‡ Federica Cipriani, MD,§ Marcel Van der Poel, MD,¶ Diego Davila, MD,|| Ruben Ciria, PhD,** Marc Besselink, PhD,‡‡ Mathieu D'Hondt, MD,†† Ibrahim Dagher, PhD,‡‡ Luca Aldrighetti, PhD,§ Roberto Ivan Troisi, PhD,‡‡§§ and Mohammad Abu Hilal, MD, PhD, DocEur, FRCS, FACS*

Learning curve of self-taught laparoscopic liver surgeons in left lateral sectionectomy: results from an international multi-institutional analysis on 245 cases

Francesca Ratti¹ · Leonid I. Barkhatov^{4,6} · Federico Tomassini² · Federica Cipriani^{1,3} · Airazat M. Kazaryan^{4,7} · Björn Edwin^{4,5,6} · Mohammad Abu Hilal³ · Roberto I. Troisi² · Luca Aldrighetti¹

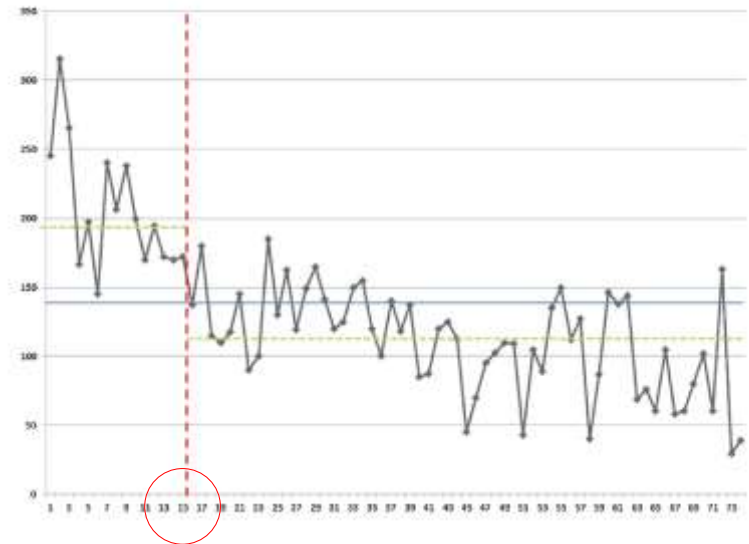


Pioneers



New generations

Risk-adjusted CUSUM analysis for in-hospital stay after MILS



Single procedure analyzed
Shorter learning curve

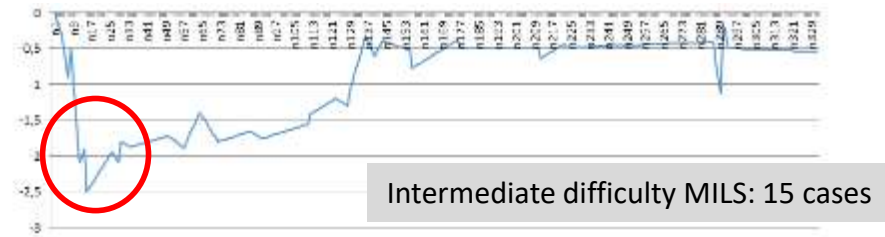
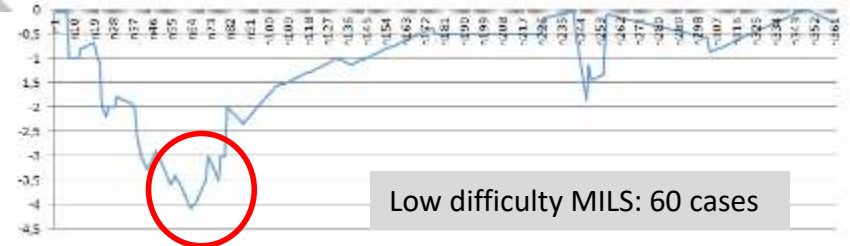
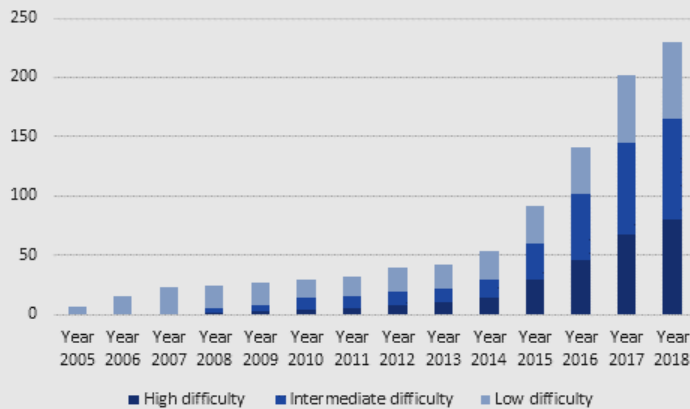
New generations vs pioneers
Shorter learning curve



A stepwise learning curve to define the standard for technical improvement in laparoscopic liver resections: complexity-based analysis in 1032 procedures

Aldrighetti Luca¹ · Federica Cipriani¹ · Guido Fiorentini¹ · Marco Catena¹ · Michele Paganelli¹ · Francesca Ratti¹

CUSUM analysis of learning curve



A **standard educational model—stepwise and progressive**—is mandatory to allow surgeons to define the technical and technological backgrounds to deal with a specific degree of difficulty, providing a help in the definition of indications to laparoscopic approach in each phase of training.

Conclusion

The stepwise approach in the development of the expertise in laparoscopic liver surgery depends on:

Obtaining scientific and technical background to define the level of difficulty based on preoperative imaging

Strict adherence to the progressive acquisition of technological knowledge and surgical skills

Identifying core-step procedures according to the difficulty score