The Evolution of Laparoscopic Liver Surgery

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Paul Brousse Hopital – Université Paris Sud
Villejuif, France
No disclosures
Evolution of laparoscopic liver resection

D. Cherqui

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BJS 2016; 103: 1405–1407
Contents

- Changes over the last decade
- Current indications (and contraindications)
- Evolving techniques
- Future
Changes over the last decade

- Two consensus and one guidelines meetings
- Recognized short term advantages and oncologic non inferiority
- Large retrospective reviews and meta-analyses and one RCT
- Dissemination of minor resections
- Development of major resections
- Development of complex anatomical hepatectomies
The International Position on Laparoscopic Liver Surgery

The Louisville Statement, 2008

Expert Consensus - Feasibility and Safety

Buell et al. Ann Surg 2017
Louisville statement – Expert Consensus

- **Safe indications**
  
  Minor resection, Solitary Tumors < 5 cm – Peripheral segments

- **Efficacy and Safety of Major Resection**
  
  Only in expert hands

- **Conversion**
  
  Safe and not a failure
  
  Efforts at lap bleeding control rather than urgent conversion

- **Benign lesions**
  
  No widened indications

- **Cancer**
  
  CRLM: concerns about margins and missed lesions
  
  HCC: good indication in solitary lesions – improved outcomes in cirrhotics

- **Live Donor**
  
  Controversial
1. SHORT TERM OUTCOMES
   - **MINOR LLR:** standard practice
     - IDEAL 3: adopted by an increasing proportion of surgeons
     - Recognized benefits: reduced morbidity and hospital stay
   - **MAJOR LLR:** remains an innovative procedure
     - Still in an exploration or learning phase (IDEAL 2b)
     - Incompletely defined risks
     - It should continue to be introduced cautiously

2. LONG TERM ONCOLOGIC OUTCOMES
   - **NON INFERIOR**

3. REQUIRED IMPROVEMENTS
   - Quality of studies
   - Registries
   - Education – Training - Credentialing
Adoption of new surgical technology

Charles B Wilson

Surgeons and patients seeking improved treatment often forget that a new technique is not necessarily a better one.

S-curve showing the five stages in adoption of innovations²
**Recommendations**

### Session 5 – IMPLEMENTATION

**Topic 13: SURGEON / CENTRE / TRAINING**

<table>
<thead>
<tr>
<th>CQ24: What training and preparation should surgeons pursue before performing minor, major and complex liver resections?</th>
<th>R24.1 - 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. 4</th>
<th>Strong (Upgraded from conditional)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R24.2 - Surgeons should develop their laparoscopic liver practice in a step-wise fashion. Proficiency should initially be gained by performing minor resections of lesions in the left lateral and anterior segments. Major resections should not be</td>
<td>3</td>
<td>Strong (Upgraded from conditional)</td>
</tr>
</tbody>
</table>

| CQ26: Should LLR become adopted in all liver surgical centres? | R26 - LLR should be an available option in all liver centers as part of the multidisciplinary management of liver cancer. Ideally, each centre should have two or more surgeons with competency in laparoscopic liver surgery. | 4 | Recommended best practice based on the clinical experience of the guideline development group |
Randomized Controlled Trial

Laparoscopic Versus Open Resection for Colorectal Liver Metastases

The OSLO-COMET Randomized Controlled Trial

Ásmund Avedem 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 Flamark, MD, PhD,¶§
Eline Aas, MPhil, PhD,††† and Bjørn Edwin, MD, PhD*†‡ on behalf of the Oslo-CoMet study group

Annals of Surgery ● Volume XX, Number XX, Month 2017
Contents

- Changes over the last decade
- Current indications (and contraindications)
- Evolving techniques
- Future
Not for all patients

Proportion varies among centers and surgeons

- Range: 25 – 95%
- Personal: 40%

58% HCC
20% other indications
Current indications

- By procedure
  - Minor
  - Major
  - Complex

- By pathology
  - HCC
  - Colorectal mets
  - Benign

- Limitations and contra-indications

<table>
<thead>
<tr>
<th>Procedure</th>
<th>N</th>
<th>%</th>
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<tr>
<td>Minor (≤ 2 segments)</td>
<td>6707</td>
<td>70</td>
</tr>
<tr>
<td>Major (≥ 3 segments)</td>
<td>2305</td>
<td>24</td>
</tr>
<tr>
<td>Complex</td>
<td>62</td>
<td>6</td>
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</table>
Need for a new classification

✓ Major 3 segments or more

- Amount of parenchyma: liver failure and mortality
- Future liver remnant
- Quality of underlying parenchyma

✓ Complexity of resection

- Difficult locations: postero-superior (7, 8, 4b)
- Anatomical segmentectomies and sectionectomies
IWATE Criteria

<table>
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<tr>
<th>Difficulty index</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<th>10</th>
<th>11</th>
<th>12</th>
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<td>Difficulty level</td>
<td>Low</td>
<td>Intermediate</td>
<td>Advanced</td>
<td>Expert</td>
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<td></td>
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<td></td>
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<tr>
<td>Index surgery</td>
<td>Left lateral sectionectomy</td>
<td>Right or left hepatectomy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Simple and small partial hepatectomy in segment III</td>
<td>Posterior sectionectomy for segment VII tumor ≥ 3 cm</td>
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**Scoring system**

**Tumor location (Couinaud segment)**

<table>
<thead>
<tr>
<th>Segment</th>
<th>Score</th>
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<tr>
<td>S1</td>
<td>4</td>
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<tr>
<td>S2</td>
<td>2</td>
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<tr>
<td>S3</td>
<td>1</td>
</tr>
<tr>
<td>S4a</td>
<td>4</td>
</tr>
<tr>
<td>S4b</td>
<td>3</td>
</tr>
<tr>
<td>S5</td>
<td>3</td>
</tr>
<tr>
<td>S6</td>
<td>2</td>
</tr>
<tr>
<td>S7</td>
<td>5</td>
</tr>
<tr>
<td>S8</td>
<td>5</td>
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**Tumor size**

<table>
<thead>
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<tr>
<td>&lt;3 cm</td>
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<tr>
<td>≥3 cm</td>
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**Proximity to major vessel**

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>no</td>
</tr>
<tr>
<td>yes</td>
</tr>
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</table>

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

**Extent of liver resection**

<table>
<thead>
<tr>
<th>Score</th>
<th>HALS/ Hybrid</th>
<th>Liver function</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>no</td>
<td>Child Pugh A 0</td>
</tr>
<tr>
<td>2</td>
<td>yes</td>
<td>Child Pugh B 1</td>
</tr>
<tr>
<td>3</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>yes</td>
<td></td>
</tr>
</tbody>
</table>

**Difficulty score:** Ban, Tanabe, Wakabayashi
Laparoscopic Liver Resections: A Feasibility Study in 30 Patients

Daniel Cherqui, MD,* Emmanuel Husson, MD,* Renaud Hammoud, MD,* Benoît Malassagne, MD,* François Stéphan, MD,† Said Bensaid, MD, † Nelly Rotman, MD,* and Pierre-Louis Fagniez, MD*
Laparoscopic Major Hepatectomy
An Evolution in Standard of Care

Ibrahim Dagher, MD, PhD,* Nicholas O’Rourke, MD,† David A. Geller, MD, FACS,‡ Daniel Cherqui, MD,§ Giulio Belli, MD,¶ T. Clark Gamblin, MD, MS,‡ Panagiotis Lainas, MD,* Alexis Laurent, MD, PhD,§ Kevin Tri Nguyen, MD, PhD,‡ Michael R. Marvin, MD,|| Mark Thomas, MD,|| Kadyalia Ravindra, MD,|| George Fielding, MD,** Dominique Franco, MD,* and Joseph F. Buell, MD||


Laparoscopic Liver Resection—Understanding its Role in Current Practice

Richard Bryant, MD, Alexis Laurent, MD, PhD, Claude Tayar, MD, and Daniel Cherqui, MD

<table>
<thead>
<tr>
<th>Type of Resection</th>
<th>HCC</th>
<th>CLM</th>
<th>Other Malignancy</th>
<th>Benign</th>
<th>Totals</th>
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<tr>
<td>Limited resection (&lt;3 segments)</td>
<td>58</td>
<td>13</td>
<td>9</td>
<td>55</td>
<td>135*</td>
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<tr>
<td>Left lateral sectionectomy</td>
<td>22</td>
<td>6</td>
<td>4</td>
<td>24</td>
<td>56</td>
</tr>
<tr>
<td>Segmentectomy¹/tumorectomy²</td>
<td>36</td>
<td>7</td>
<td>5</td>
<td>31</td>
<td>79</td>
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<tr>
<td>Major resection (≥3 segments)</td>
<td>6</td>
<td>9</td>
<td>5</td>
<td>11</td>
<td>31*</td>
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<tr>
<td>Right hepatectomy</td>
<td>2</td>
<td>8</td>
<td>4</td>
<td>5</td>
<td>19</td>
</tr>
<tr>
<td>Left hepatectomy</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>Central hepatectomy</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>64</td>
<td>22</td>
<td>14</td>
<td>66</td>
<td>166</td>
</tr>
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</table>
Right Hepatectomy

Left Hepatectomy
Total laparoscopic liver resection for hepatocellular carcinoma located in all segments of the liver

Yoo-Seok Yoon · Ho-Seong Han · Jai Yo · Keun Soo Ahn


Laparoscopic Segmentectomy of the Liver

From Segment I to VIII

Takeaki Ishizawa, MD, PhD,*† Andrew A. Gambs, MD,‡ Norihiro Kokudo, MD, PhD,† and Brice Gayet, MD, PhD*

Ann Surg 2012;256: 959–964
Living donor hepatectomy

Left Lateral 2001
Cherqui et al. Lancet 2002
Kim et al. BJS 2011

Full Left-Full Right 2012

Left:
Samstein, Cherqui et al. AJT 2013
Troisi et al AJT 2013

Right:
Soubrane et al. AJT 2013
Rotellar et al. AJT 2015
Kwon et al. Seoul
Kim et al. Seoul
Suh et al. Seoul
Pure or Lap-Assisted used in all donor hepatectomies
Current indications

- By procedure
  - Minor
  - Major
  - Complex

- By pathology
  - HCC
  - Colorectal mets
  - Others: cholangio, benign disease

- Limitations and contra-indications
Laparoscopic Liver Resection: Evolution of Indications

Courtesy of Han HS presented at the Morioka Consensus October 2014
# Lap Liver: HCC vs CRLM

<table>
<thead>
<tr>
<th>HCC</th>
<th>CR Mets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solitary early tumors (surveillance)</td>
<td>Often Multiple and Bilobar</td>
</tr>
<tr>
<td>No primary tumor</td>
<td>Management of primary</td>
</tr>
<tr>
<td>Usually upfront surgery</td>
<td>Neoadjuvant chemo and downstaging: missing mets</td>
</tr>
<tr>
<td>Advantages in Cirrhosis</td>
<td>No proven advantages</td>
</tr>
</tbody>
</table>
Laparoscopic liver resection for HCC
Laparoscopic versus open liver resection for hepatocellular carcinoma: Case-matched study with propensity score matching

Ho-Seong Han¹, Ahmed Shehata², Soyeon Ahn³, Yoo-Seok Yoon¹, Jai Young Cho¹, Young-Rok Choi¹

¹Department of Surgery, Seoul National University Bundang Hospital, Seoul National University, Republic of Korea; ²Gastroenterology Surgical Center, College of Medicine, Mansoura University, Egypt; ³Medical Research Collaborating Center, Seoul National University Bundang Hospital, Seoul National University, Republic of Korea

<table>
<thead>
<tr>
<th></th>
<th>LLR (n = 88)</th>
<th>OLR (n = 88)</th>
<th>p value</th>
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<tbody>
<tr>
<td>Complications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>11 (12.5%)</td>
<td>18 (20.4%)</td>
<td>0.042</td>
</tr>
<tr>
<td>Complication type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>1 (1.1%)</td>
<td>0</td>
<td>0.185</td>
</tr>
<tr>
<td>Surgical</td>
<td>5 (5.7%)</td>
<td>6 (6.8%)</td>
<td></td>
</tr>
<tr>
<td>Liver related</td>
<td>2 (2.3%)</td>
<td>5 (5.7%)</td>
<td></td>
</tr>
<tr>
<td>Mixed</td>
<td>3 (3.4%)</td>
<td>7 (8%)</td>
<td></td>
</tr>
<tr>
<td>Clavien-Dindo grade</td>
<td></td>
<td></td>
<td>0.642</td>
</tr>
<tr>
<td>I</td>
<td>3 (3.4%)</td>
<td>5 (5.7%)</td>
<td></td>
</tr>
<tr>
<td>IIa</td>
<td>6 (6.8%)</td>
<td>9 (10.2%)</td>
<td></td>
</tr>
<tr>
<td>IIb</td>
<td>1 (1.1%)</td>
<td>3 (3.4%)</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>1 (1.1%)</td>
<td>1 (1.1%)</td>
<td></td>
</tr>
<tr>
<td>General complications</td>
<td></td>
<td></td>
<td>0.213</td>
</tr>
<tr>
<td>Respiratory</td>
<td>4 (4.6%)</td>
<td>6 (6.8%)</td>
<td></td>
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<tr>
<td>Renal</td>
<td>1 (1.1%)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>DU bleeding</td>
<td>1 (1.1%)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Surgical related</td>
<td></td>
<td></td>
<td>0.038</td>
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<tr>
<td>Wound complications</td>
<td>1 (1.1%)</td>
<td>5 (5.7%)</td>
<td></td>
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<tr>
<td>Internal hemorrhage</td>
<td>1 (1.1%)</td>
<td>2 (2.3%)</td>
<td>1</td>
</tr>
<tr>
<td>Fluid collections</td>
<td>5 (5.7%)</td>
<td>7 (8%)</td>
<td>0.916</td>
</tr>
<tr>
<td>Liver related</td>
<td></td>
<td></td>
<td>0.041</td>
</tr>
<tr>
<td>Bile leakage</td>
<td>2 (2.3%)</td>
<td>2 (2.3%)</td>
<td></td>
</tr>
<tr>
<td>Transient liver failure</td>
<td>3 (3.4%)</td>
<td>8 (8.9%)</td>
<td></td>
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</table>
Long-term and perioperative outcomes of laparoscopic versus open liver resection for hepatocellular carcinoma with propensity score matching: a multi-institutional Japanese study


Takeshi Takahara · Go Wakabayashi · Toru Beppu · Arihiro Aihara · Kiyoshi Hasegawa · Naoto Gotohda ·

<table>
<thead>
<tr>
<th></th>
<th>Matched–LLR (n = 387)</th>
<th>Matched–OLR (n = 387)</th>
<th>P</th>
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<tbody>
<tr>
<td>Blood loss (ml)</td>
<td>158 (50, 450%)</td>
<td>400 (170, 675%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>RCC transfusion</td>
<td>28 (7.24%)</td>
<td>38 (9.82%)</td>
<td>0.198</td>
</tr>
<tr>
<td>FFP transfusion</td>
<td>17 (4.44%)</td>
<td>30 (7.85%)</td>
<td>0.049</td>
</tr>
<tr>
<td>Operation time (min)</td>
<td>294.4 ± 158.8</td>
<td>271.0 ± 130.0</td>
<td>0.025</td>
</tr>
<tr>
<td>Hospital stay (days)</td>
<td>13 (9, 18)</td>
<td>16 (11, 25)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Conversion</td>
<td></td>
<td></td>
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<tr>
<td>Pure → Hybrid or HALS</td>
<td>7 (1.81%)</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Pure → Open</td>
<td>7 (1.81%)</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Hybrid or HALS → Open</td>
<td>11 (2.84%)</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Accident</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bleeding</td>
<td>9 (2.33%)</td>
<td>14 (3.79%)</td>
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</tr>
<tr>
<td>Injury of other organs</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Others</td>
<td>1 (0.26%)</td>
<td>0</td>
<td>0.313</td>
</tr>
<tr>
<td>Complications</td>
<td>26 (6.72%)</td>
<td>50 (12.99%)</td>
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<tr>
<td>Ascites</td>
<td>7</td>
<td>12</td>
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<tr>
<td>Intraperitoneal abscess</td>
<td>4</td>
<td>4</td>
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<tr>
<td>Pleural effusion</td>
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<td>5</td>
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<tr>
<td>Bile leak</td>
<td>5</td>
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</tr>
<tr>
<td>Liver failure</td>
<td>2</td>
<td>7</td>
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<tr>
<td>Wound infection</td>
<td>1</td>
<td>4</td>
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<tr>
<td>Bleeding</td>
<td>1</td>
<td>1</td>
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<td>Others</td>
<td>4</td>
<td>8</td>
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<tr>
<td>30 days mortality</td>
<td>0</td>
<td>1 (0.26%)</td>
<td>0.317</td>
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<tr>
<td>90 days mortality</td>
<td>1 (0.26%)</td>
<td>4 (1.03%)</td>
<td>0.178</td>
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Pure Laparoscopic Versus Open Right Hepatectomy for Hepatocellular Carcinoma in Patients With Cirrhosis

A Propensity Score Matched Analysis

Young-In Yoon, MD, PhD,* † Ki-Hun Kim, MD, PhD,* Sung-Hwa Kang, MD, ‡ Wan-Joon Kim, MD,* Min-Ho Shin, MD,* ‡ Sang-Kyung Lee, RN,* Dong-Hwan Jung, MD, PhD,* Gil-Chun Park, MD, PhD,* Chul-Soo Ahn, MD, PhD,* Deok-Bog Moon, MD, PhD,* Tae-Yong Ha, MD, PhD,* Gi-Won Song, MD, PhD,* Shin Hwang, MD, PhD,* and Sung-Gyu Lee, MD, PhD*

Reduced morbidity (CCI) and hospital stay
Laparoscopic liver resection for CRLM
Laparoscopic Versus Open Resection for Colorectal Liver Metastases

The OSLO-COMET Randomized Controlled Trial

- Single Center Open vs laparoscopic parenchymal sparing non anatomical (major excluded) resection for CRLM
  - 280 patients in each group
  - Primary End Point achieved! **Reduced Morbidity 31% vs 19%**
  - Reduced Hospital Stay
  - Identical R1 rate
  - Cost effective (67% probability)

- More to come
  - Tumor location
  - Adjuvant chemotherapy
  - Survival

Fretland… Edwin et al.  
Ann Surg in press
Role of laparoscopic approach in colorectal liver metastasis
An international multi-center data analysis using LiverMetSurvey
Eveno C., Cailliez-Delvart V., R. Adam, Cherqui D. ILLS 2017
LiverMetSurvey International Registry Working Group.

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<table>
<thead>
<tr>
<th>Total</th>
<th>1 yr</th>
<th>2 yrs</th>
<th>3 yrs</th>
<th>4 yrs</th>
<th>5 yrs</th>
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<th>7 yrs</th>
<th>8 yrs</th>
<th>9 yrs</th>
<th>10 yrs</th>
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<tbody>
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<td>1171</td>
<td>651</td>
<td>398</td>
<td>216</td>
<td>104</td>
<td>57</td>
<td>40</td>
<td>21</td>
<td>9</td>
<td>3</td>
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<tr>
<td>584</td>
<td>333</td>
<td>192</td>
<td>115</td>
<td>65</td>
<td>35</td>
<td>16</td>
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Lap  Open

OS DFS
Enhanced access to adjuvant chemotherapy with lap for pancreatic adenocarcinoma

Laparoscopic liver resection for colorectal liver metastasis patients enables to start adjuvant chemotherapy without delay

*Takayuki Kawai, Claire Goumard, Florence Jeune, Olivier Scatton (France)*

ILLS 2017
Contra-indications

- my word of caution
  - Safety
  - Oncologic soundness
  - Futility
Large Tumors

Lap OK

Caution

No lap
Benign symptomatic lesions in young women

No Lap
Harmless asymptomatic lesions

NO SURGERY
Complex vascular connections
Bilobar disease
Biliary or Vascular reconstruction
Contents

- Changes over the last decade
- Current indications (and contraindications)

- **Evolving techniques**
  - Improved technology
  - Precision surgery
  - Robotics

- Future
Energy Devices
Ultrasonic Aspirators

Linear staplers

Coagulators
Precision Surgery
Single Incision
Single Incision
Robotic surgery seems to overcome the limitations of laparoscopy and expands the role of minimally invasive approaches

PG Giulianotti, 2011
Robotic Versus Laparoscopic Hepatectomy

A Matched Comparison

57 Robot vs 114 Lap
- Identical short term outcomes and R0 margins
- Longer operative and OR times
- Increased pure lap major hepatectomies: only advantage

Increased costs in most studies
Changes over the last decade

Current indications (and contraindications)

Evolving techniques
- Improved technology
- Precision surgery
- Robotics

Future
Present

- LLR has gained a significant and irreversible place in hepatic surgery as a result of recognized short- and long-term advantages.

- Minor resections in peripheral segments are now performed laparoscopically by the vast majority of HPB teams.

- The diffusion of major and/or complex resections is increasing annually.
Future

- Principles of liver surgery must be transmitted and adapted to laparoscopy
- The new generation will bring LLS to the next level
- New technologies will continue to enhance our possibilities
- Organization
  - Regular dedicated meetings
  - Registries: continued evaluation and clinical research
  - Education and training
  - Collaboration with industry for specific needs

All for meaningful improvement of patient care
Future

- Our responsibility: transmission of generic indications and techniques of liver surgery, regardless of incision
- The new generation will bring LLS to the next level