"Minimally Invasive Approaches In Gastrointestinal Cancer: The Role of Robotic and Laparoscopic Surgery"

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Disclosures

- No financial disclosures.
Outline

- Overview of current data regarding use of Laparoscopic/Robotic Surgery:
  - Colorectal Cancer
  - Liver Cancer
  - Pancreas cancer
- Technical Aspects of Robotic Surgery - Case Presentation
- National trends and Future directions of MIS and Robotic Surgery.

Current Trend In Surgical Oncology

Proven Benefits of Minimally Invasive Surgery

- Decreased surgical trauma.
- Decreased need of pain medication
- Less blood loss
- Faster recovery
- Less wound complications
Robotic Surgery

**Advantages**
- 3-D Magnification 20–30x
- Stereotactic binocular visualization
- Near 540° range of motion in instruments
- Elimination of tremor/improved dexterity
- Improved surgeon comfort

**Disadvantages**
- Learning curve
- Cost
- Lack of tactile feedback

Laparoscopic Surgery

Robotic Surgery
Minimally Invasive Surgery In GI Malignancies

Colorectal Cancer

Laparoscopic Approach Significantly Reduces Surgical Site Infections after Colorectal Surgery:

NSQIP
10,979 colorectal surgeries (LAP 31.1%, open 68.9%)

<table>
<thead>
<tr>
<th>Table 5. Operative and Postoperative Factors</th>
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<tbody>
<tr>
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<tr>
<td>--------------</td>
</tr>
<tr>
<td>Operation time (min, mean [IQR])</td>
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<tr>
<td>Operation time (&gt; 100 min, n, %)</td>
</tr>
<tr>
<td>Postoperative complications, n (%)</td>
</tr>
<tr>
<td>Superficial infection</td>
</tr>
<tr>
<td>Deep infection</td>
</tr>
<tr>
<td>Organ space infection</td>
</tr>
<tr>
<td>Wound dehiscence</td>
</tr>
<tr>
<td>10/11, transplant coverage</td>
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</tbody>
</table>

Laparoscopic Colectomy Decreases the Time to Administration of Chemotherapy Compared with Open Colectomy

![Graph showing time to chemotherapy administration between open and MIS colectomy](image)

**FIG. 1** Time between surgery and initiation of chemotherapy in the MIS and open groups. MIS minimally invasive surgery

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**Randomized Trials: Laparoscopic versus Open Colectomy for Colon Cancer**

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Design</strong></td>
<td>Random. 1:1</td>
<td>Random. 1:1 Non-Inferiority</td>
<td>Random. 1:1</td>
<td>Random. 2:1</td>
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<tr>
<td><strong># Patients</strong></td>
<td>208 pts</td>
<td>1735 pts</td>
<td>1248 pts</td>
<td>794 pts</td>
</tr>
<tr>
<td><strong>Centers</strong></td>
<td>Single Center</td>
<td>48 centers (US &amp; Canada)</td>
<td>29 centers (Europe)</td>
<td>27 centers (UK)</td>
</tr>
<tr>
<td><strong>Outcomes</strong></td>
<td>Improved cancer related survival in Lap group</td>
<td>Similar recurrence rate</td>
<td>No difference in DFS and OS (3-5 year)</td>
<td>No difference in DFS and OS (5-year)</td>
</tr>
</tbody>
</table>

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**COLOR II**

Lap vs Open Resection for Rectal CA
Randomized phase 3 trial

- 30 centers, 8 countries (2004-2010).
- 1044 pts (699 Lap vs 345 open)
- Results, Laparoscopic group had significantly:
  - Less blood loss
  - Longer OR time
  - Sooner bowel function and shorter LOS
- Similar morbidity and mortality
- Similar rates of recurrence, disease free survival and overall survival.

*Van der Pas et al. Lancet Oncol 2013; 14: 210-18*
“Laparoscopic and open colectomy achieve equivalent oncological outcomes for localized colon cancer. The use of the laparoscopic approach should be based on the surgeon’s documented experience in laparoscopic surgery as well as on patient- and tumor-specific factors”.
Grade of Recommendation: 1A

Long-term Oncologic Outcomes of Robotic Low Anterior Resection for Rectal Cancer: A Comparative Study With Laparoscopic Surgery

133 Rob vs 84 Lap cases

- Less conversion rate and decreased LOS in Rob group.
- No difference in Local Recurrence in Lap (2.3%) vs Rob (1.2%) \( p=0.649 \).
- No difference in Disease Free Survival or Overall Survival.
- The cost of robotic surgery was approximately 2.34 times higher than that of laparoscopic surgery.


Outcomes of Robotic-Assisted Colorectal Surgery Compared with Laparoscopic and Open Surgery: a Systematic Review

- 69 publications:
  - 29 comparative studies
  - 1 RCT

Conclusions about Robotic Colorectal Surgery:
- Is safe and feasible option.
- Comparable short-term and oncologic outcomes to Lap and Open Surgery.
- Less blood loss and less rate of conversion
- Limitations of robotic surgery: longer OR times and higher costs.

Case 1:
59 yo male, T3N1M0 Rectal Cancer at 8cm from anal verge s/p Neoadjuvant therapy

Robotic Low Anterior Resection

Minimally Invasive Surgery In GI Malignancies

Liver Cancer
World Review of Laparoscopic Liver Resection – 2,804 Patients

Kevin Tri Nguyen, MD, PhD, Thomas Clark Gamblin, MD, MS, and David A. Geller, MD
University of Pittsburgh Medical Center

- Review of 142 published papers lap. liver resection
- 2,804 actual patients
- Mortality 0.3% (9/2,804 cases)
- 50% of resections were for malignancy

LLR had:
- Equivalent OR time
- Less blood loss (15 studies)
- Less pRBC transfusions (5 studies)
- Less pain & narcotic use (8 studies)
- Faster oral intake (8 studies)
- Less overall morbidity (7 studies)
- Shorter LOS (24 studies)
- No oncological disadvantages

Laparoscopic vs Open Liver Resection for Metastatic Colorectal Cancer: A meta-analysis of 610 patients

SC Schiffman, et al

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Journal</th>
<th>Total Patients</th>
<th>Patients</th>
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<tbody>
<tr>
<td>Cannon</td>
<td>2012</td>
<td>Surgery</td>
<td>175</td>
<td>35</td>
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<td>Castaing</td>
<td>2009</td>
<td>Ann Surg</td>
<td>120</td>
<td>60</td>
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<tr>
<td>Guerron</td>
<td>2012</td>
<td>Surg Endosc</td>
<td>80</td>
<td>40</td>
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<td>Qiu</td>
<td>2013</td>
<td>Plos One</td>
<td>60</td>
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<td>Nguyen</td>
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<td>Arch Surg</td>
<td>49</td>
<td>24</td>
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<tr>
<td>Topal</td>
<td>2012</td>
<td>Surg Endosc</td>
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<td>20</td>
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<tr>
<td>Hu</td>
<td>2012</td>
<td>Surg Laparosc Perc Tech</td>
<td>26</td>
<td>13</td>
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<tr>
<td>Total</td>
<td></td>
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<td>610</td>
<td>242</td>
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</table>
Laparoscopic vs Open Liver Resection for Metastatic Colorectal Cancer: A meta-analysis of 610 patients
SC Schiffman, et al.

Lap Liver Resection for Colorectal Cancer offers:
- Decreased blood loss,
- Decreased LOS
- Less overall complication rates
- Comparable 1,3 and 5-year OS and DFS.

Surgery. 2015 Feb;157(2):211-22

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

The jury concluded that MINOR LLRs had become standard practice and that MAJOR liver resections were still innovative procedures in the exploration phase.

Annals of Surgery Volume 261, Number 4, April 2015

Robotic Versus Laparoscopic Hepatectomy
A Matched Comparison

- 57 Robotic vs 114 Laparoscopic resections
  (21 Major Rob. vs 52 Major Lap. resections)

Conclusions:
- Similar safety and feasibility.
- A greater proportion of robotic cases were completed in a totally minimally invasive manner.
- No significant benefits over laparoscopic techniques in operative outcomes.

Case 2
65 yo male patient, Hepatitis C – Child A cirrhosis with splenomegaly, thrombocytopenia, elevated AFP. MRI 1.3 cm lesion highly suggestive HCC

Robotic US Guided Segment 3 Liver resection
Case 3
72 yo male patient with NASH-Child A cirrhosis
MRI: cirrhosis, portal hypertension and a 4 x 3 cm in the left lateral segment

Robotic Left Lateral Sectionectomy

Minimally Invasive Surgery In GI Malignancies

Pancreatic Cancer
Surgery for Pancreatic Tumors

Distal pancreatectomy
Pancreatectoduodenectomy
Whipple Procedure
Enucleation

Laparoscopic Distal Pancreatectomy Is Associated With Significantly Less Overall Morbidity Compared to the Open Technique
A Systematic Review and Meta-Analysis

18 good quality studies, 1814 patients
(43% laparoscopic, 57% open)

LDP
• Lower blood loss
• Reduced length of hospital stay
• Lower risk of overall postoperative complications
• No substantial increase in the operative time
• Similar rate of negative margins


Robot-Assisted Distal Pancreatectomy (RADP) Is Superior to the Laparoscopic Technique

30 Robotic vs 94 Laparoscopic

Conclusions:
• Similar: LOS, fistula rates, blood transfusion, and readmission rates.
• RADP group did not require conversion to open surgery unlike the Lap. group (16%, P < 0.05)
• RAPD higher rates of margin negative resection and improved lymph node harvest.

Case 4
58 yo male, 2.5 cm pancreatic tail mass, EUS biopsy: pancreatic adenocarcinoma

Robotic Distal Pancreatectomy

OR Set Up

Trocar placement
Laparoscopic Pancreaticoduodenectomy

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Patients</th>
<th>Operative Time (min)</th>
<th>EBL (mL)</th>
<th>Conversion (%)</th>
<th>PF Rate (%)</th>
<th>Mortality (%)</th>
<th>R0 Resection (%)</th>
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<tbody>
<tr>
<td>Palanivelu et al</td>
<td>2009</td>
<td>75</td>
<td>357</td>
<td>74</td>
<td>0</td>
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<tr>
<td>Kendrick et al</td>
<td>2010</td>
<td>65</td>
<td>368</td>
<td>240</td>
<td>4.6</td>
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<td>Zureikat et al</td>
<td>2011</td>
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<td>36</td>
<td>7</td>
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<tr>
<td>Kim et al</td>
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<tr>
<td>Asbun et al</td>
<td>2012</td>
<td>53</td>
<td>541</td>
<td>195</td>
<td>22.6*</td>
<td>16.7</td>
<td>5.7</td>
<td>95</td>
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<tr>
<td>Corcione et al</td>
<td>2013</td>
<td>22</td>
<td>392</td>
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<td>9.1</td>
<td>27.2</td>
<td>4.5</td>
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<tr>
<td>Total (Weighted Average)</td>
<td>329</td>
<td>431</td>
<td>108</td>
<td>7.3</td>
<td>18.8</td>
<td>2.4</td>
<td>96.4</td>
<td></td>
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</tbody>
</table>

* Includes 3 patients requiring hand-assist port

Matched Case-Control Analysis Comparing Laparoscopic and Open Pylorus-Preserving Pancreaticoduodenectomy in Patients With Periampullary Tumors

- Lap group had: less pain, shorter LOS, quicker recovery, longer OR time (p<0.001)
- No difference in oncologic outcomes

Ann Surg 2015:00:1–10

Total Laparoscopic Pancreaticoduodenectomy for Pancreatic Ductal Adenocarcinoma

Oncologic Advantages Over Open Approaches?

- less EBL
- Less delayed gastric emptying
- Quicker recovery and faster initiation of adjuvant therapy
- Improved Progression Free Survival
- No difference in Overall Survival

• Largest reported single institution RPD = 200 cases
  • Last 120 cases:
    - Operative time Mean (SD), min : 417 (78)
    - EBL Median (IQR) ml : 250 (150-400)
    - Grade B/C pancreatic fistula: 6.9%
    - 90-day Mortality: 3.3 %
    - LOS, median (IQR): 9 (7-14) days
    - LN harvest, median (IQR) : 26 (19-32)

JAMA Surg, March 11, 2015

Robotic-assisted versus laparoscopic pancreaticoduodenectomy: oncological outcomes

Surg Endosc. 2017 Dec 26

Conclusion: No Survival Difference

Assessment of Quality Outcomes for Robotic Pancreticoduodenectomy Identification of the Learning Curve

JAMA Surg, 2015

• 200 Robotic PD
  • Learning Curve:
    - OR time: 80 cases
    - Conversion: 20 cases
    - Fistula rate: 40 cases
    - LN harvest: 80 cases
**National Trends of MIS HPB Surgery**

“A comparison of open and minimally invasive surgery for hepatic and pancreatic resections using the nationwide inpatient sample”

Period 2000-2011 65,033 resections

- MIS increased from 2.3% in 2000 to 7.5% in 2011.
- MIS patients were older and had more comorbidities.
- MIS group had:
  - Less complications
  - Shorter LOS
  - Less in-hospital mortality

Pawlik et al, Surgery 2014;156:538-47
Future of MIS and Robotic Surgery

- The future of complex MIS surgery relies on Robotic technology.
- Robotic technology advances: haptics, "augmented reality", near infrared technology, smaller and smarter instruments, tele-surgery, among others.
- New robotic platforms/companies:
  - Amadeus Composer™ Titan Medical (Canada).
  - TELELAP Alf-X® system, SOFAR (Italy)
  - AVRA Surgical Robotics (New York, USA)
- Drop in costs of robotic surgery.

The Future of MIS and Robotic Surgery


Conclusions

- MIS in GI surgical oncology has shown equivalent oncologic outcomes to open surgery with improved operative outcomes.
- The use of laparoscopic techniques in colorectal resections, minor liver resections and laparoscopic distal pancreatectomies should be considered standard practice.
- Robotic approach for rectal, liver and pancreatic resections are safe, feasible and may allow completion of more complex cases with less rate of conversions.
- Longer OR times, higher cost and steep learning curves remain the main limitations of robotic surgical procedures.
“It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is most adaptable to change.”

Charles Darwin

THANK YOU