ROBOTIC SURGERY FOR RENAL CELL CANCER

CLAYTON LAU, MD
CHIEF OF UROLOGY AND UROLOGIC ONCOLOGY
SEPT 2018
Disclosures

- Consultant and Speaker for “Intuitive Surgical” and “Covidien”
Epidemiology

- 62K–Estimated (NEW CASES)
- 13K – Kidney Cancer related deaths
- RCC accounts for 3% of adult malignancies
- Incidence rising 2% annually since 1975
- Lifetime risk of developing RCC -1/63(1.6%)
- Average age at diagnosis is 64
- Men:Female(1.6 : 1)
- Most are asymptomatic
- 40% of new tumors that are found Incidentally are SRM
- Classic Triad:
  #Hematuria
  #Flank Pain
  #Palpable Abdominal Mass

Hollingsworth J Natl Cancer Inst 2006
Cooperberg J Urol 2008
Treatment Options for Renal Cell Cancer

- Active Surveillance
- Ablation
  - Radiofrequency (RFA)
  - Cryoablation
- Radical Nephrectomy
- Partial Nephrectomy
History of Surgical Treatment for RCC

1869 – First planned nephrectomy for ureterovaginal fistula (Simon)
1878 – Anterior transperitoneal nephrectomy (Kocher)
1884 – Partial nephrectomy for perirenal fibrolipoma (Wells)
1887 – Partial nephrectomy for malignancy (Czerny)
1913 – Nephrectomy with caval thrombectomy (Berg)
Early - mid 1900’s – retroperitoneal flank approach preferred due to risk of peritonitis and abdominal complications
1963 – radical nephrectomy described with survival benefit (Robson)

Contemporary era:
- increased utilization of open partial nephrectomy for localized tumors
- emergence of laparoscopy and robotics
- ablative techniques applied for nephron preservation
Robson’s Radical Nephrectomy

Early ligation of the renal artery and vein

• removal of the kidney outside Gerota's fascia

• removal of the ipsilateral adrenal gland

• ± regional lymphadenectomy

Nephron Sparing Surgery

• Possible Benign lesion
• Similar Oncologic outcomes in those tumors >4 cm and possibly 7cm
• Morbidity/Mortality of Chronic Kidney Disease and Dialysis
  – Increasing rates of CKD
  – Interplay of CKD and Cardiovascular Disease
  – Acknowledgment that RN is a major cause of CKD in elderly Patients or those with pre-existing CKD
  – Up 50% yearly mortality in elderly pts on HD

Das J Urol 2006;
Huang Lanc Onc 2006,
Go NEJM 2004
Kidney Cancer NCCN 2017

Kidney Cancer, Version 2.2017

INITIAL WORKUP

- H&P
- CBC, comprehensive metabolic panel
- Urinalysis
- Abdominal ± pelvic CT or abdominal MRI
- Chest x-ray
- If clinically indicated
  - Bone scan
  - Brain MRI
  - Chest CT
  - Consider needle biopsy
- If urothelial carcinoma suspected (eg, central mass)
  - Consider urine cytology, ureteroscopy

Suspicous mass

STAGE

- Stage I (pT1a)
- Stage I (pT1b)
- Stage II, III

PRIMARY TREATMENT

- Partial nephrectomy (preferred) or Radical nephrectomy (if partial not feasible or central location)
- Active surveillance in selected patients or Ablative techniques in selected patients

FOLLOW-UP (category 2B)

- Follow-up (See KID-B) Relapse
  - See First-Line Therapy (KID-3)

Management

Partial Nephrectomy (PN) and Nephron-Sparing Approaches

14. Physicians should prioritize PN for the management of the cT1a renal mass when intervention is indicated. In this setting, PN minimizes the risk of CKD or CKD progression and is associated with favorable oncologic outcomes, including excellent local control. (Moderate Recommendation; Evidence Level: Grade B)

15. Physicians should prioritize nephron-sparing approaches for patients with solid or Bosniak 3/4 complex cystic renal masses and an anatomic or functionally solitary kidney, bilateral tumors, known familial RCC, preexisting CKD, or proteinuria. (Moderate Recommendation; Evidence Level: Grade C)

16. Physicians should consider nephron-sparing approaches for patients with solid or Bosniak 3/4 complex cystic renal masses who are young, have multifocal masses, or comorbidities that are likely to impact renal function in the future, such as moderate to severe hypertension, diabetes mellitus, recurrent urolithiasis, or morbid obesity. (Conditional Recommendation; Evidence Level: Grade C)

17. In patients who elect PN, physicians should prioritize preservation of renal function through efforts to optimize nephron mass preservation and avoidance of prolonged warm ischemia. (Expert Opinion)

18. For patients undergoing PN, negative surgical margins should be a priority. The extent of normal parenchyma removed should be determined by surgeon discretion taking into account the clinical situation, tumor characteristics including growth pattern, and interface with normal tissue. Tumor enucleation should be considered in patients with familial RCC, multifocal disease, or severe CKD to optimize parenchymal mass preservation. (Expert Opinion)

Radical Nephrectomy (RN)

19. Physicians should consider RN for patients with a solid or Bosniak 3/4 complex cystic renal mass where increased oncologic potential is suggested by tumor size, RMB, and/or imaging characteristics and in whom active treatment is planned. (Conditional Recommendation; Evidence Level: Grade B) In this setting, RN is preferred if all of the following criteria are met: 1) high tumor complexity and PN would be challenging even in experienced hands; 2) no preexisting CKD or proteinuria; and 3) normal contralateral kidney and new baseline eGFR will likely be greater than 45 ml/min/1.73m². (Expert Opinion)
Open Partial Nephrectomy

Variety of techniques (CCF):  
- early vascular control vs off clamp partial  
- minimize ischemic damage  
  - mannitol diuresis  
  - regional hypothermia  
- complete tumor excision with free margins  
- closure of collecting system and renal defect
Minimally Invasive Surgery

- Large Shift towards Minimally Invasive Urologic Oncologic Surgery
- Comparable short-intermediate term oncologic control
- Acceptable complication rates
- Improved QOL Variables
  - Pain
  - LOS
  - Convalescence
  - Return to Work
  - Cosmesis
Renal MIS Timeline

- LRN
- LPN
- RRN
- RPN

Clayman J Urol 1990
Winfield J Urol 1993
Guilloneau J Urol 2001
Gettman 2004 Urology
Laparoscopy and Robotics

Perioperative Complications of Robot-assisted Partial Nephrectomy: Analysis of 886 Patients at 5 United States Centers

Youssef S. Tanagho, Jihad H. Kaouk, Mohamad E. Allaf, Craig G. Rogers, Michael D. Stifelman, Bartosz F. Kaczmarek, Shahab P. Hillyer, Jeffrey K. Mullins, Yichun Chiu, and Sam B. Bhayani
• EBL (mean) = 206ml (10-2200)
• WIT = 20.3 mins (0-83)
• OP Time = 183.6 mins (59-472)
• Nephrotomy Scores = 6.9
• Complications
  – Overall 15.6%  
    • Hemorrhage Intraop 9 (0.2%)
    • Hemorrhage Postop 41 (4.6%)
    • Urinary Leakage 10 (0.11%)
    • Lymphatic Leak 10 (0.11%)
    • Embolization rate 1.1%

No reoperations or deaths within 90 days

Tanagho et al Urology 2013
Single Institutional Cost Analysis of 325 Robotic, Laparoscopic, and Open Partial Nephrectomies

Humberto Laydner, Wahib Isac, Riccardo Autorino, Ahmad Kassab, Rachid Yakoubi, Shahab Hillyer, Ali Khalifeh, Steven C. Campbell, Amr Fergany, Matthew Simmons, and Jihad H. Kaouk
<table>
<thead>
<tr>
<th>Variables</th>
<th>RPN (n = 145)</th>
<th>LPN (n = 47)</th>
<th>OPN (n = 133)</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>59 (30-86)</td>
<td>59 (39-84)</td>
<td>61 (18-83)</td>
<td>.73</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>83 (57)</td>
<td>29 (62)</td>
<td>96 (72)</td>
<td>.03</td>
</tr>
<tr>
<td>Female</td>
<td>62 (43)</td>
<td>18 (38)</td>
<td>37 (28)</td>
<td></td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td>30 (20-60)</td>
<td>29 (18-47)</td>
<td>28 (19-46)</td>
<td>.56</td>
</tr>
<tr>
<td>ASA score</td>
<td>3 (1-4)</td>
<td>3 (1-4)</td>
<td>3 (2-4)</td>
<td>.02</td>
</tr>
<tr>
<td>Side</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>72 (50)</td>
<td>22 (47)</td>
<td>72 (54)</td>
<td>.69</td>
</tr>
<tr>
<td>Left</td>
<td>73 (50)</td>
<td>25 (53)</td>
<td>61 (46)</td>
<td></td>
</tr>
<tr>
<td>Tumor size, cm</td>
<td>2.6 (1-8.3)</td>
<td>2.8 (0.5-7.5)</td>
<td>4 (1-12.6)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>RNS</td>
<td>7 (4-11)</td>
<td>6 (4-11)</td>
<td>8 (4-12)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Pre-op eGFR, ml/min/1.73 m²</td>
<td>84 (20-139)</td>
<td>77 (20-136)</td>
<td>77 (37-156)</td>
<td>.052</td>
</tr>
<tr>
<td>Length of stay, days</td>
<td>3 (2-14)</td>
<td>3 (2-6)</td>
<td>5 (3-59)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td><strong>Costs, $</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room and board</td>
<td>1160 (11-3,430)</td>
<td>1348 (686-3429)</td>
<td>1934 (12-7097)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>OR and supplies</td>
<td>5324 (2614-11,116)</td>
<td>3773 (2258-5957)</td>
<td>3228 (1684-18,320)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Anesthesia</td>
<td>503 (152-1893)</td>
<td>508 (333-1577)</td>
<td>546 (204-4399)</td>
<td>.002</td>
</tr>
<tr>
<td>Pharmacy</td>
<td>349 (94-2369)</td>
<td>358 (119-1480)</td>
<td>365 (94-15,990)</td>
<td>.08</td>
</tr>
<tr>
<td>Professional fees</td>
<td>2958 (1487-10,708)</td>
<td>3295 (2258-5464)</td>
<td>3569 (2196-80,654)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Labs and pathology</td>
<td>152 (41-1039)</td>
<td>153 (41-595)</td>
<td>297 (86-6813)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Blood bank</td>
<td>0 (0-4066)</td>
<td>0 (0-674)</td>
<td>0 (0-4371)</td>
<td>.48</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>10,556 (6543-22,711)</td>
<td>9924 (7129-13,755)</td>
<td>10,237 (4789-129,611)</td>
<td>.019</td>
</tr>
</tbody>
</table>
Costs of PN

<table>
<thead>
<tr>
<th>Costs, $</th>
<th>RPN</th>
<th>LPN</th>
<th>OPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Room and board</td>
<td>1160 (11-3,430)</td>
<td>1348 (686-3429)</td>
<td>1934 (12-7097)</td>
</tr>
<tr>
<td>OR and supplies</td>
<td>5324 (2614-11,116)</td>
<td>3773 (2258-5957)</td>
<td>3228 (1684-18,320)</td>
</tr>
<tr>
<td>Anesthesia</td>
<td>503 (152-1893)</td>
<td>508 (333-1577)</td>
<td>546 (204-4399)</td>
</tr>
<tr>
<td>Pharmacy</td>
<td>349 (94-2369)</td>
<td>358 (119-1480)</td>
<td>365 (94-15,990)</td>
</tr>
<tr>
<td>Professional fees</td>
<td>2958 (1487-10,708)</td>
<td>3295 (2258-5464)</td>
<td>3569 (2196-80,654)</td>
</tr>
<tr>
<td>Labs and pathology</td>
<td>152 (41-1039)</td>
<td>153 (41-595)</td>
<td>297 (86-6813)</td>
</tr>
<tr>
<td>Blood bank</td>
<td>0 (0-4066)</td>
<td>0 (0-674)</td>
<td>0 (0-4371)</td>
</tr>
<tr>
<td>Total</td>
<td>10,556 (6543-22,711)</td>
<td>9924 (7129-13,755)</td>
<td>10,237 (4789-129,611)</td>
</tr>
</tbody>
</table>

*The operating room costs were $1900 more for the RPN vs the OPN

*However the overall costs were similar at discharge
**1st Case series of Robotic Partial Nephrectomy**

**ROBOTIC-ASSISTED LAPAROSCOPIC PARTIAL NEPHRECTOMY: TECHNIQUE AND INITIAL CLINICAL EXPERIENCE WITH DAVINCI ROBOTIC SYSTEM**

MATTHEW T. GETTMAN, MICHAEL L. BLUTE, GEORGE K. CHOW, RICHARD NEURURER, GEORG BARTSCH, AND REINHARD PESCHEL

**N=13**
11/2002 to 8/03

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>13</td>
</tr>
<tr>
<td>Diameter</td>
<td>3.5cm</td>
</tr>
<tr>
<td>WIT</td>
<td>22 mins</td>
</tr>
<tr>
<td>O Prep time</td>
<td>215 mins</td>
</tr>
<tr>
<td>LOS</td>
<td>4.3</td>
</tr>
</tbody>
</table>

Gettman, et al. Urology 2004
Surgery in Motion

Robotic Partial Nephrectomy for Complex Renal Tumors: Surgical Technique

Craig G. Rogers**, Amar Singh, Adam M. Blatt, W. Marston Linehan, Peter A. Pinto*

Urologic Oncology Branch, National Cancer Institute, National Institutes of Health, Bethesda, MD, USA
## COH Robotic Urologic Oncology Surgery

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Cases Completed 2003 to 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robotic Prostatectomy</td>
<td>7318</td>
</tr>
<tr>
<td>Robotic Radical Cystectomy</td>
<td>552</td>
</tr>
<tr>
<td>Robotic Nephrectomy</td>
<td>704</td>
</tr>
<tr>
<td>#360 Partial Nephrectomy</td>
<td></td>
</tr>
</tbody>
</table>
Robotic Renal Surgery

- Robotic Radical Nephrectomy
- Robotic Partial Nephrectomy
- Robotic Nephroureterectomy
- Robotic Radical Nephrectomy with caval Thrombectomy
- Robotic Metastectomy for Renal cell Cancer recurrence
EVOLUTION OF MIS TECHNOLOGY

**1999**
- da Vinci®
  - Eliminates lap compromises
  - Simple instruments

**2006**
- da Vinci® S™
  - 3D HD Vision (720p)
  - Cross-quadrant access
  - Streamlined set-up

**2009**
- da Vinci® Si™
  - Dual Console option
  - Enhanced HD Vision (1080i)
  - Upgradable architecture

**2014**
- da Vinci® Xi™
  - Multi-quadrant access
  - Crystal clear 3D HD vision
  - Platform for future technologies

**Coming Soon**
- da Vinci® SP™
  - Single Port
  - Multi-quadrant access
  - Crystal clear 3D HD vision

- XI SKILLS SIMULATOR™
- INTEGRATED ENERGY
- VESSEL SEALER
- STAPLER 45 & 30 CURVED TIP (WHITE, BLUE, GREEN)
- FUTURE INNOVATION SINGLE PORT SURGERY PATIENT CART
Robot Assisted Partial Nx
Integrating robotic partial nephrectomy to an existing robotic surgery program

Bertram Yuh, MD, Shantel Muldrew, Anita Menchaca, Wesley Yip, Clayton Lau, MD, Timothy Wilson, MD, David Josephson, MD
City of Hope National Cancer Center, Duarte, California, USA

Yuh et al 2012
## COH Robotic Partial Nephrectomy

<table>
<thead>
<tr>
<th>Yuh et al 2012 (n = 92) Single institution</th>
<th>Benway et al 2010(^{29}) (n = 183) Multi-institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>61.6</td>
</tr>
<tr>
<td>Body mass index (kg/m(^2))</td>
<td>28.3</td>
</tr>
<tr>
<td>Tumor size (cm)</td>
<td>2.7</td>
</tr>
<tr>
<td>Operative time (min)</td>
<td>212</td>
</tr>
<tr>
<td>Warm ischemia time (min)</td>
<td>24.0</td>
</tr>
<tr>
<td>Estimated blood loss (mL)</td>
<td>150</td>
</tr>
<tr>
<td>% malignant</td>
<td>77%</td>
</tr>
<tr>
<td><strong>Positive margin rate</strong></td>
<td><strong>1.1%</strong></td>
</tr>
<tr>
<td>Conversion rate</td>
<td>2.2%</td>
</tr>
<tr>
<td>Hospital stay (days)</td>
<td>3</td>
</tr>
<tr>
<td>Renal nephrometry scores</td>
<td></td>
</tr>
<tr>
<td>Low complexity (4-6)</td>
<td>26 (28%)</td>
</tr>
<tr>
<td>Moderate complexity (7-9)</td>
<td>51 (55%)</td>
</tr>
<tr>
<td>High complexity (10-12)</td>
<td>10 (11%)</td>
</tr>
<tr>
<td>Multiple tumors</td>
<td>5 (5%)</td>
</tr>
</tbody>
</table>
TABLE 4. Clinical and operative parameters representing the learning curve

<table>
<thead>
<tr>
<th>Sequential cases</th>
<th>Total</th>
<th>First 30</th>
<th>Second 30</th>
<th>Final 32</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, median (range)</td>
<td>62 (31-86)</td>
<td>56 (36-86)</td>
<td>62 (31-80)</td>
<td>66 (35-83)</td>
<td>0.31</td>
</tr>
<tr>
<td>ASA, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>34 (37%)</td>
<td>11 (37%)</td>
<td>15 (50%)</td>
<td>8 (25%)</td>
<td>0.07</td>
</tr>
<tr>
<td>III-IV</td>
<td>58 (63%)</td>
<td>19 (63%)</td>
<td>15 (50%)</td>
<td>24 (75%)</td>
<td></td>
</tr>
<tr>
<td>Operative time (min)</td>
<td>212 (132-403)</td>
<td>235 (164-403)</td>
<td>202 (132-339)</td>
<td>199 (139-399)</td>
<td>0.03</td>
</tr>
<tr>
<td>Previous abdominal surgery, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.03</td>
</tr>
<tr>
<td>Yes</td>
<td>19 (21%)</td>
<td>5 (17%)</td>
<td>3 (10%)</td>
<td>11 (34%)</td>
<td>0.03</td>
</tr>
<tr>
<td>No</td>
<td>73 (79%)</td>
<td>25 (83%)</td>
<td>27 (90%)</td>
<td>21 (66%)</td>
<td></td>
</tr>
<tr>
<td>Renal nephrometry score, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>Low (4-6)</td>
<td>26 (28%)</td>
<td>11 (36%)</td>
<td>8 (27%)</td>
<td>7 (22%)</td>
<td>0.01</td>
</tr>
<tr>
<td>Moderate (7-9)</td>
<td>51 (55%)</td>
<td>18 (60.0%)</td>
<td>19 (63%)</td>
<td>14 (44%)</td>
<td></td>
</tr>
<tr>
<td>High (10-12)</td>
<td>10 (11%)</td>
<td>1 (3%)</td>
<td>3 (10%)</td>
<td>6 (19%)</td>
<td></td>
</tr>
<tr>
<td>Multiple tumors</td>
<td>5 (5%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>5 (16%)</td>
<td></td>
</tr>
</tbody>
</table>
COH Partial Nephrectomy Setup

- Kidney Surgery Positioning
- Intubated
- No OG/NGT/Bowel Prep
- 16 french foley
- IV access-
- A line not routine
- No central line/TAP block
- Chlorhexideine/Alcohol Prep
Renal Surgery Positioning

- Flank position (80-90 degrees)
- Maximal Flexion
- No Bean bag/Krause Arm (Airplane) Support
- Orthopedic Hip Jelly Positioners and Rolled Blankets
- Arm Protector from The Pink Pad-Pigazzzi Pink Pad (Medline)
- Cloth Tape 3 inch across chest and hips
DICE 5
Left sided renal surgery
STRAIGHT LINE

Right Renal Surgery
steps
Robotic Partial Nephrectomy
Steps for success: Initial dissection and hilar approach

1. Mobilize bowel (*leave 4th arm undocked*)
   - Right side: Kocherize duodenum till IVC exposed
   - Left side: dissect spleno-renal attachments

2. Lift ureter off psoas mx (*leave 4th arm undocked*)
   - Right: Lift ureter up leaving gonadal vein on IVC
     - Right: “gonadal is not your friend”
   - Left: Retract gonadal vein upwards w/ureter
     - Left: “gonadal is your friend”

3. Only at this point: Dock 4th arm w/robotic Graptor
   - Approach hilum w/Graptor providing lateral traction on hilum
     - Hilar vessel dissection safer when on stretch!!!
Hilar retraction using 4th arm Grasping Retractor
Key points for Setup/Mobilization

- Dissect The Renal hilum off as proximal as possible (IVC/Aorta)
- Mobilize the kidney outside of Gerota’s fascia first
- Defat the Perirenal fat at least 2 cm from edge of tumor
- For deeper tumors, cut till you get to renal sinus fat and/or collecting system
Tumor Resection and Renorrhaphy

• When cutting the tumor out, use blunt dissection to efficiently remove the mass.

• Don’t work in a hole.

• Take your time, but be efficient and exact in securing arteries/arterioles and collecting system.

• When clamp comes off and repair is done. Pack it with minilap if it is still oozing. May need additional interrupted sutures.
**EUN RENORRHAPHY:**

**Double-armed suture**

**INNER LAYER:**
- 6” 3-0 VLOC on CV 23 needle
- Running baseball stitch
- Closes open vessels and collecting system
- Early unclamping

**OUTER LAYER:**
- 12” 0 VLOC on GS21 needle
- Running horizontal mattress
- Laproclip on all needle exits from capsule
- Slide Laproclip to close defect and compress parenchyma/capsule
Video big partial
Expanding Indications

- Big Tumors
- Hilar Tumors
- Solitary Kidney
- Multiple Tumors
- Transplant Alografts
- Vein Thrombus
Video Horsoeshoe
ICG uses
Final Thoughts

• Expanding Indications

• Radical nephrectomy still overutilized

• Easily teachable

• Advanced technology may help
  – ICG
  – Vessel Sealer
  – Suction Irrigator
Thank you

Questions:
Cllau@coh.org