Uro-Assiut 2015
Robotic Nephron Sparing Surgery

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Outline

• What is NSS? PNx
• Why? Renal Tumors - size of the problem
• Evolution of Renal surgery into Robotics
• Why Robotic
• Quick how to / tips tricks
Age Adjusted Incidence & Mortality Rates For Kidney Cancer By Gender

![Graph showing age-adjusted incidence and mortality rates for kidney cancer by gender across different regions.](graph)

**World Health Organization**

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**GLOBOCAN 2008 (IARC) (17.6.2011)**
Age-adjusted Annual kidney Ca Incidence & Annual Renal Surgeries Stratified By Tumor Size


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Clinical T1 (<7cm) Renal Mass (RM)
Gustav Simon (1824 to 1876)
1st planned nephrectomy - 1869
1st PN 1870

Vincenz Czerny (1842 - 1915)
1st PN for renal tumor 1887

CJ Robson 1968
1st Radical Nx - RCC
• outside Gerota’s
• Extensive RPLND
• Adrenalectomy

The Journal of Urology 2005 173, 705-708DOI: (10.1097/01.ju.0000146270.65101.1d)
Copyright © 2005 American Urological Association, Inc.
Lap Radical Nephrectomy: The Great Seductress!
Open Partial Nephrectomy For T1a

- 1981: elective NSS
- Debated for 2 decades
- Several studies with long f/u showed excellent survival and v. low risk of local recurrence comparable to RN
- Widely accepted early 2000s

Herr, Hx of PNx J Urol 2005
Renal Function Outcomes: Radical vs. Partial Nephrectomy

- \( n=2000 \), Kidney Ca surgery @ MSKCC
- 662 selected
  - Normal s-cr
  - 2 healthy kidneys
  - Single tumor ≤ 4 cm
- 26% : pre-existing renal dysfunction (GFR<60)

<table>
<thead>
<tr>
<th>3 yr probability</th>
<th>Partial Nx</th>
<th>Radical Nx</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GFR &lt; 60</td>
<td>20%</td>
<td>65%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>GFR &lt; 45</td>
<td>5%</td>
<td>36%</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Huang & Russo *Lancet Oncol* 2006
**CKD, Risks Of Death, CV morbidity & Hospitalization**

- \( n = 1,120,295 \)
- Median f/u 2.8 yr
- Large community-based population

<table>
<thead>
<tr>
<th>e-GFR</th>
<th>Death</th>
<th>CVS events</th>
<th>Hospitalization</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adjusted Hazard Ratios</td>
<td>45-60</td>
<td>30-45</td>
</tr>
<tr>
<td>Death</td>
<td>1.2</td>
<td>1.8</td>
<td>3.2</td>
</tr>
<tr>
<td>CVS events</td>
<td>1.4</td>
<td>2.0</td>
<td>2.8</td>
</tr>
<tr>
<td>Hospitalization</td>
<td>1.1</td>
<td>1.5</td>
<td>2.1</td>
</tr>
</tbody>
</table>

*NEJM 2004*
Algorithm for Management

**Patient with clinical T1 renal mass**

**Evaluation**
- High-quality cross-sectional imaging study (CT or MRI) with and without contrast (in the presence of adequate renal function) to assess contrast enhancement, exclude angiomylipoma, assess for locally invasive features, define the relevant anatomy and evaluate the status of the contralateral kidney.
- Percutaneous renal mass core biopsy with or without FNA for patients in whom it might impact management, particularly patients with clinical or radiographic findings suggestive of lymphoma, abscess or metastasis.

**Counseling**
- Review the current understanding of the natural history of clinical T1 renal masses, the relative risks of benign vs. malignant pathology and the potential role of AS.
- Review the available treatment options and the attendant benefits and risks, including oncologic considerations, renal functional considerations and potential morbidities.
- Discuss the potential advantages of a nephron-sparing treatment approach in the imperative and effective settings, including the avoidance of dialysis and reduced risk of CKD with its attendant morbidity and mortality.

**Index Patient 1:** Healthy, Clinical T1a

**Standard—PN:** Complete surgical excision by PN is a standard of care and should be strongly considered.

**Standard—RN:** Should be discussed as alternate standard of care if PN is not technically feasible as determined by the urologic surgeon.

**Option—TA:** Cryoablation or RFA should be discussed as less-invasive treatment options, but local tumor recurrence is more likely, measures of success are not well defined, and surgical salvage may be difficult.

**Option—AS:** AS with delayed intervention should be discussed as an option for patients wishing to avoid treatment and willing to assume oncologic risk.

**Index Patient 2:** Major comorbidities, Increased surgical risk; Clinical T1a

**Standard—PN:** Complete surgical excision by PN is a standard of care and should be strongly considered.

**Standard—RN:** Should be discussed as standard of care with increased risk of CKD and surgical complications in this patient.

**Recommendation—TA:** Cryoablation or RFA should be discussed as less-invasive treatment options which may be advantageous in this high surgical risk patient, acknowledging the increased risk of local tumor recurrence compared to surgical excision.

**Recommendation—AS:** Should be offered as an acceptable approach which can delay or avoid the need for intervention in this high-risk patient.

**Index Patient 3:** Healthy, Clinical T1b

**Standard—RN:** Should be discussed as standard of care for patients with a normal contralateral kidney.

**Standard—PN:** Complete surgical excision by PN should be discussed as an alternative standard of care, particularly when there is a need to preserve renal function.

**Option—TA:** Cryoablation or RFA can be discussed as a treatment option which is less effective due to an increased risk of local recurrence. TA may represent suboptimal management for this healthy patient.

**Option—AS:** AS with delayed intervention may be discussed as an option in patients who want to avoid surgery and are willing to accept an increased risk of tumor progression compared to RN or PN. AS may represent suboptimal management for this healthy patient.

**Index Patient 4:** Major comorbidities, Increased surgical risk; Clinical T1b

**Standard—RN:** Should be discussed as standard of care for patients with a normal contralateral kidney, although it can be associated with surgical morbidity and an increased risk of CKD in this patient.

**Recommendation—PN:** Complete surgical excision by PN should be discussed as a recommended modality when there is a need to preserve renal function, although it can be associated with increased urologic morbidity in this patient.

**Recommendation—AS:** AS should be discussed with patients who want to avoid surgery or who are considered high risk for surgical therapy.

**Option—TA:** Cryoablation or RFA can be discussed as a treatment option which is less effective due to an increased risk of local recurrence.

**Guideline Statement Key**
1. Standard: A guideline statement is a standard if (1) the health outcomes of the alternative interventions are sufficiently well known to permit meaningful decisions, and (2) there is virtual unanimity about which intervention is preferred.
2. Recommendation: A guideline statement is a recommendation if (1) the health outcomes of the alternative interventions are sufficiently well known to permit meaningful decisions, and (2) an appreciable, but not unanimous majority agrees on which intervention is preferred.
3. Option: A guideline statement is an option if: (1) the health outcomes of the interventions are not sufficiently well known to permit meaningful decisions, or (2) preferences are unknown or equivocal.
<table>
<thead>
<tr>
<th>Stage</th>
<th>Surgery</th>
<th>Surgical Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Nephron-sparing surgery</td>
<td>Open</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Laparoscopic/Robot-assisted</td>
</tr>
<tr>
<td></td>
<td>Radical nephrectomy</td>
<td>Laparoscopic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Open</td>
</tr>
<tr>
<td>T2</td>
<td>Radical nephrectomy</td>
<td>Laparoscopic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Open</td>
</tr>
<tr>
<td></td>
<td>Nephron-sparing surgery</td>
<td>Open</td>
</tr>
<tr>
<td>T3,T4</td>
<td>Radical nephrectomy</td>
<td>Open</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Laparoscopic</td>
</tr>
</tbody>
</table>
### Conclusions on RRN and RPN

<table>
<thead>
<tr>
<th>Conclusion</th>
<th>LE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conclusive long-term data are not available. RRN and RPN are technically feasible.</td>
<td>–</td>
</tr>
<tr>
<td>No comparable long-term data on oncologic, safety, and functional outcomes are available. However, based on short-term data and guidelines panel expertise, no significant differences are expected.</td>
<td>4</td>
</tr>
<tr>
<td>In ablative surgery, robotics will produce no better outcomes compared with laparoscopy.</td>
<td>–</td>
</tr>
<tr>
<td>Possible benefit exists in reconstructive surgery (i.e., partial nephrectomy/pyeloplasty).</td>
<td>–</td>
</tr>
</tbody>
</table>

### Recommendations

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>GR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use laparoscopy for simple or radical nephrectomy.</td>
<td>C</td>
</tr>
<tr>
<td>Use robot-assisted or laparoscopic surgery for partial or reconstructive renal surgery if technically feasible.</td>
<td>C</td>
</tr>
<tr>
<td>Use of minimal invasive techniques should not compromise nephron-sparing surgery.</td>
<td>C</td>
</tr>
</tbody>
</table>

**GR** = grade of recommendation; **LE** = level of evidence; **RPN** = robot-assisted partial nephrectomy; **RRN** = robot-assisted radical nephrectomy.
Management Renal Mass: Overriding Principles

• Oncologic control is top priority
  – 20% potentially aggressive
  – Local salvage can be difficult
  – Systemic salvage is impossible

• Nephron-sparing whenever possible

• Minimize morbidity: MIS when possible
Lap Partial Nx: NSS & MIT

- Winfield 1993
- Small incisions
- Better visibility
- Less blood loss
- Low risk of infection, hernia, & wound complications
- Shorter hospital stay

Disadvantages of Standard Laparoscopy

- Remote instrument operation-fulcrum effect
- 2–dimensional image
- Rigid instruments limits the movement & precision
- Operator fatigue especially in complicated surgeries as PN

Advantages of Robotic Surgery

- Same as Lap/MIS
- Better ergonomics & surgeon’s comfort
- High Definition, 3D stereoscopic vision
- The Endowrist: 6 degrees of freedom

**Disadvantage:** Cost & Learning curve

Gettman & Blute Urol 2004
Robotic NSS: Keys To Surgical Success

- Patient & Mass selection
- Imaging & Pre-operative planning
- Anesthetic considerations
- Patient & port positioning
- Adequate dissection & preparation
- Intraop US
- Pre-clamp Checklist
- Renorrhaphy
Early Experience - Patient Selection

- Radical or pyeloplasty 1st
- Left side
- not a Re-do, no COPD
- RENAL score 4-6
- Female, Low BMI, non-smokers (friendly fat)
Ideal Tumor

- Small
- Anterior
- Non hilar
- Exophytic
- Not involving collecting system
- Simple blood supply
Challenging Tumor

- Larger
- Endophytic component,
- Polar
- Posterior
- Hilar
- Involving collecting system
- Complex blood supply
Many Variables Determine Complexity!

- Prompted search & validation of **instruments** to determine level of difficulty in elective partial nephrectomy
## R.E.N.A.L. Nephrometry Scoring System

<table>
<thead>
<tr>
<th></th>
<th>1pt</th>
<th>2pts</th>
<th>3 pts</th>
</tr>
</thead>
<tbody>
<tr>
<td>(R)adius (maximal diameter in cm)</td>
<td>≤4</td>
<td>&gt;4 but &lt; 7</td>
<td>≥7</td>
</tr>
<tr>
<td>(E)xophytic/endophytic properties</td>
<td>≥50%</td>
<td>&lt;50%</td>
<td>Entirely endophytic</td>
</tr>
<tr>
<td>(N)earness of the tumor to the collecting system or sinus (mm)</td>
<td>≥7</td>
<td>&gt;4 but &lt; 7</td>
<td>≤4</td>
</tr>
<tr>
<td>(A)nterior/Posterior</td>
<td>No points given. Mass assigned a descriptor of a, p, or x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(L)ocation relative to the polar lines*</td>
<td>Entirely above the upper or below the lower polar line</td>
<td>Lesion crosses polar line</td>
<td>&gt;50% of mass is across polar line (a) or mass crosses the axial renal midline (b) or mass is entirely between the polar lines (c)</td>
</tr>
</tbody>
</table>

* suffix “h” assigned if the tumor touches the main renal artery or vein

![Images of kidneys with different tumor locations](images)
PADUA Classification Of Renal Tumors

- Upper & Lower sinus lines
- Floor Localization: Density difference between calyx & parenchyma
R.E.N.A.L vs PADUA

Coronal scans needed?

R.E.N.A.L.
Always !

PADUA
Not always !

Advantage ?
Patient Positioning

- Modified Flank
  60-70 degrees

- Full Flank
  90 degrees
Port Placement & Docking
4th Arm Docking
Hilar Management

• Vascular Clamping
  – Artery(ies) vs. Art & Vein
  – Bulldog vs Satinsky
  – Confirmation (ICG, US, Doppler)

• “Robotic” Vascular Clamps
  – Surgeon in control
  – Different angles, full articulation
  – Klein Surgical or Scanlan International
Minimizing Warm Ischmia

• Expose the kidney & mass(es) → facing you: lap pad, 4\textsuperscript{th} arm, 2\textsuperscript{nd} assistant port
• Skilled assistant: swap sutures, suction & US use
• Pre-clamp checklist
• Selective Clamping: dissect hilum & dist. Vess.
• Encleo-resection when indicated: facilitate excision & renorrhaphy
• Demand Ischemia: clamp when bleeding impairs vision
• Early unclamping: after deep layer repair
• Off clamp: usually unnecessary, careful case selection, consider cold ischemia
Minimizing Ischemia Time: “Every Minute Counts”?

Limit WIT < 25 min to minimize risk of CKD & ARF

Table 2 - Univariate and multivariable associations of warm ischemia time (continuous) with clinical end points

<table>
<thead>
<tr>
<th>Feature</th>
<th>Univariate</th>
<th></th>
<th>Multivariable</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95% CI)</td>
<td>p value</td>
<td>OR (95% CI)</td>
<td>p value</td>
</tr>
<tr>
<td>Warm ischemia time (1-min increase)</td>
<td>1.05 (1.02–1.08)</td>
<td>&lt;0.001</td>
<td>1.06 (1.03–1.10)</td>
<td>0.001</td>
</tr>
<tr>
<td>Preoperative GFR (10-unit increase)</td>
<td>0.67 (0.58–0.79)</td>
<td>&lt;0.001</td>
<td>0.66 (0.56–0.78)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Tumor size (1-cm increase)</td>
<td>1.12 (1.02–1.24)</td>
<td>0.023</td>
<td>1.06 (0.94–1.19)</td>
<td>0.369</td>
</tr>
<tr>
<td>Laparoscopic vs open</td>
<td>0.39 (0.14–1.14)</td>
<td>0.080</td>
<td>0.32 (0.10–1.05)</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Acute-onset GFR <15

<table>
<thead>
<tr>
<th></th>
<th>Univariate</th>
<th></th>
<th>Multivariable</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95% CI)</td>
<td>p value</td>
<td>OR (95% CI)</td>
<td>p value</td>
</tr>
<tr>
<td>Warm ischemia time (1-min increase)</td>
<td>1.06 (1.02–1.09)</td>
<td>&lt;0.001</td>
<td>1.07 (1.03–1.11)</td>
<td>0.001</td>
</tr>
<tr>
<td>Preoperative GFR (10-unit increase)</td>
<td>0.65 (0.55–0.78)</td>
<td>&lt;0.001</td>
<td>0.63 (0.52–0.76)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Tumor size (1-cm increase)</td>
<td>1.13 (1.01–1.26)</td>
<td>0.027</td>
<td>1.05 (0.93–1.19)</td>
<td>0.446</td>
</tr>
<tr>
<td>Laparoscopic vs open</td>
<td>0.53 (0.18–1.55)</td>
<td>0.246</td>
<td>0.42 (0.13–1.37)</td>
<td>0.149</td>
</tr>
</tbody>
</table>

Fig. 1  Risk of developing new-onset stage IV chronic kidney disease for patients treated with >25 min versus ≤25 min of warm ischemia. GFR=glomerular filtration rate.
Every Min Does **NOT** Count In Normal Kidney After Accounting For Volume Loss

- Late GFR ↓ determined by vol loss if WIT < 25 m
- WIT weak correlate of post op GFR, & only for prolonged WIT & preop renal insufficiency
- Strongest predictors of GFR ↓ are % parenchyma preserved & pre op GFR
- Minimal WIT or Cold ischemia may be beneficial in patients with pre op renal insufficiency

Lane, et al. J Urol 11
Mir et al. Urol 2013
Minimizing WIT: Summary

- Exposure
- Efficiency of surgeon & assistant
- Pre-clamp check list
- Selective clamp, enucleation, demand ischemia, early unclamp, off clamp
- Quality, Quantity > quickness
Assistance Tips

• Consider additional assistance port to facilitate access/retraction when on clamp
• Traction/counter-traction
• Anticipate surgeons next move, always 1 step ahead
• Facilitate communication between surgeon, anesthesia, & circulator
• Efficiency: 1 suture in, 1 suture out (or replace)
• Optimize visualization of the surgical field (If you can’t see, neither can the surgeon)
Techniques To Preserve Renal Function During RPN

- On Demand Ischemia (Bollens et al. Eur Urol 07)
- Early unclamping (Nguyen, J Urol 08)
- Off clamp resection (Gill, J Urol 12)
- **Intracorporeal hypothermia** (Arai, Urol 11; Rogers Eur Urol 13)
- Barbed suture renorrhaphy (Sammon, J Endo 11)
- Enucleation (Minervini, Eur Urol 11)
Pre-Clamp Check List

• All sutures & hemostatic agents ready & visually confirmed
• Adequate CO2/insuflation
• Clean Cam & instruments, test needle dr.
• Hydration & Mannitol
• Bulldogs, Satinsky, GIA stapler, Open tray
• No breaks during clamp time (lockdown)
Renorrhaphy

- Sliding clip offers tightest closure
- Deep suture: 2/0 Vicryl - SH or V-Lock
- Outer stitch: 0 vicryl on CT-1
- Running or interrupted
- Hemostatic agents only if needed
- Edges should come together
- Test with Valsalva breath, MAP > 90 & pneumo down +/- IV indigo
TRANSPERITONEAL APPROACH

ICE PORT
Thank you!