Partial Nephrectomy Planning:
Everybody’s doing it, you can too

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Objectives

• Review the current recommendations for treating small renal tumors and the indications for partial nephrectomy

• Review the surgical planning needs for nephron sparing surgery

• Learn imaging techniques and tips to provide surgical planning information

• Nephron sparing surgery includes
  • Open and laparoscopic partial nephrectomy
  • Laparoscopic and percutaneous ablation techniques
RCC Facts...

- 3% of all visceral malignancies
- Risk factors - smoking, obesity
- 2008
  - 54,000 new cases
  - 4% bilateral
  - 13,000 deaths/yr
  - 33% present with locally advanced or metastatic disease
- 10-yr survival rate (2000)
  - T1 - 91%
  - T2 - 70%
  - T3a - 53%
  - T3b,c - 42-43%
RCC treatment

- **Treatment**
  - Surgery remains best curative treatment option
  - Medical therapies and radiation therapy poor
    - IFN-α, IL2, vaccines all have had limited success
    - Response rates < 30%
- **Recent advances**
  - Surgical options have expanded - NSS, cryoablation, RF
  - Cellular receptor targeted therapy for metastatic disease
    - VEG-F & PDGF-α inhibitors showing promise
      - Sutent (sunitinib malate) & Sorafenib
Trend towards MIS and NSS
(Part 1: “Everybody’s doing it”)

- More institutions and more Urologists are performing open and laparoscopic NSS
- More radiologists performing percutaneous NSS

- Washington University study
  - 1999-2003 showed an increase in NSS - 33/yr to 91/yr
  - Laparoscopic pNx went from 3% to 56% of all pNx
    - Bhayani et al, Urology 2006;68:732
CC Urologic Surgical Procedures
Cleveland Clinic Glickman Urological Institute data

- NSS procedures more than doubled in an 8-year period
- Laparoscopic procedures have had the biggest growth
Revised Staging Criteria 1997 / 2003

- **Tumor (T)**
  - T1 $\leq 7$ cm, confined to the kidney (previously 2.5 cm)
    - T1a $\leq 4$ cm
    - T1b $> 4$ cm
  - T2 $> 7$ cm, confined to the kidney
  - **T3** - Venous invasion, adrenal or perinephric fat
    - T3a - adrenal gland, w/i Gerota’s fascia
    - T3b - renal vein / vena cava below diaphragm
    - T3c - vena cava or wall above diaphragm (former T4b)
  - **T4** - Beyond Gerota’s fascia (no a or b)

Note: changes in 1997 highlighted in yellow
Renal central sinus invasion and urothelial invasion

- Occurs in less than 10% of patients but
- Invasion of the central sinus fat may have significant prognostic indications
  - similar to extension outside the renal capsule
- Patients with T2 tumors with urothelial invasion did worse than those without urothelial invasion
  - suggested as an added criterion for staging
- Patients with ‘central’ tumors more likely to need collecting system repair at surgery
“Imperative” indications for NSS for Renal Neoplasms

- Bilateral renal tumors (approx 4% at diagnosis)
- Solitary kidney (prior Nx, renal agenesis)
- Functionally solitary kidney
  - chronic obstruction, infection, renal vascular disease
- Underlying disease predisposing to CKD
  - Calculus, infection, diabetes mellitus, SLE, HTN

- Why? - avoid dialysis whenever possible....
Treatment recommendations for cT1 tumors

- Open partial nephrectomy is considered the standard of care by the AUA for clinical T1 renal mass - particularly if renal function is compromised or potentially compromised regardless of the presence of a normal contralateral kidney.

- Despite dissemination of pNx techniques, radical nephrectomy remains over utilized.
  - Estimated that less than 50% of T1 tumors are treated by partial nephrectomy.

- … therefore the number of partial nephrectomies for small renal tumors will be increasing …
Why nephron sparing surgery?

#1 - Success with imperative indications

#2 - Increase in incidentally detected renal masses

#3 - More benign tumors are resected as smaller tumors discovered and treated

#4 - Better outcomes for patients, particularly with better long-term renal function
**Reason #1 - Good treatment success**

- First and foremost this is a cancer operation

<table>
<thead>
<tr>
<th>No. of patients in study*</th>
<th>Recurrence rate</th>
<th>Local tumor survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>121</td>
<td>4.1%</td>
<td>90%</td>
</tr>
<tr>
<td>185</td>
<td>5.9%</td>
<td>89%</td>
</tr>
<tr>
<td>146</td>
<td>2.7%</td>
<td>93%</td>
</tr>
<tr>
<td>485</td>
<td>3.2%</td>
<td>92%</td>
</tr>
<tr>
<td>146</td>
<td>2.7%</td>
<td>93%</td>
</tr>
</tbody>
</table>

*Table adapted from Novick AC. Ann Rev Med 2002*
Reason #2 - the incidental renal mass

- Approximately 60-65% of RCC are incidentally detected
  - Classic triad of fever, flank pain, hematuria is rare

- Abdominal imaging trends (all modalities)
  - 1996 - 451.8 per 1000 Medicare patients
  - 2005 - 564.5 per 1000 Medicare patients
  - … 25% increase

- CT/CTA: +141% increase 99.4 to 239.3/1000
- MR/MRA: +365% increase 2 to 9.3/1000
Reason #2 - the incidental renal mass

- More incidental renal masses are low stage
  - 64% - 78% incidental RCC are stage T1 or T2
  - 36% - 57% symptomatic RCC are stage T1 or T2
- Incidental tumors are smaller
  - 5.9 cm v. 7.5 - 8.7 cm
- Smaller tumors are less aggressive
  - (Remzi et al J Urol 2006)
    - 4/168 (2.4%) of 3 cm or less v. 10/119 (8.4%) of 3.1-4 cm with distant metastases

... therefore they are more suitable for NSS!
Reason #3 - Benign Findings at Surgery

- Frank et al J Urol 2003 – 2935 tumors in 2770 adults all specimens

<table>
<thead>
<tr>
<th>Size (cm)</th>
<th>&lt;1.0 cm</th>
<th>1-1.9 cm</th>
<th>2-2.9 cm</th>
<th>3-3.9 cm</th>
<th>4-4.9 cm</th>
<th>5-5.9 cm</th>
<th>6-6.9 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>% benign</td>
<td>46.3%</td>
<td>22.4%</td>
<td>22.0%</td>
<td>19.9%</td>
<td>9.9%</td>
<td>13%</td>
<td>4.5%</td>
</tr>
<tr>
<td>% malignant</td>
<td>53.8%</td>
<td>77.7%</td>
<td>78.0%</td>
<td>80.1%</td>
<td>90.1%</td>
<td>87.0%</td>
<td>95.5%</td>
</tr>
</tbody>
</table>

- Kutikov et al Urol 2006 – 143 tumors in 143 adults with suspected RCC

<table>
<thead>
<tr>
<th>Size (cm)</th>
<th>&lt;2.0 cm</th>
<th>2.0-4.0 cm</th>
<th>&gt;4.0 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>% benign</td>
<td>15.9%</td>
<td>16.5%</td>
<td>14.3%</td>
</tr>
<tr>
<td>% malignant</td>
<td>84.1%</td>
<td>83.5%</td>
<td>85.7%</td>
</tr>
</tbody>
</table>
Reason #4 - Outcomes

- Radical versus partial nephrectomy
  - 50% more Rad Nx pts with proteinuria (55% v. 34.5%)
  - Nearly 2x as many Rad NX pts with CKD (22.4% v. 11.6%)
- 3-yr probability of CKD
  - 65% after RNx v. 20% after PNx
- Survival in patients with pT1a tumors
  - Radical Nx (290) versus partial Nx (358)
  - Higher relative risk of death w/ Rad Nx - 2.16 (age < 65)
Planning for NSS
(Part 2: “You can do it to”)

- Complications
  - Hemorrhage
  - Renal infarction / loss
  - Urinary leak or fistula
  - Abscess

- Rates
  - Lap PNx - 9%
  - Open PNx - 6.3%
  - RFA - 6%
  - Lap RNx - 3.4%
  - Open RNx - 1.3%
Planning info for NSS - avoid complications!

- Renal arterial and venous anatomy
- Vena Cava variants
- Kidney position
- Tumor location and depth
- Collecting system involvement
- Number, course of ureter(s)
Three-phase MDCT scan

- **1) Unenhanced**
  - 20 cc timing bolus (scan q1 sec from 20-45 s) or contrast preload
  
  … *wait 2 minutes to opacify the collecting system …*

- **2) Vascular or corticomedullary phase**
  - Timing bolus or automated tracking (abd aorta trigger)
  - Add + 5 seconds or auto-tracking
  - Aim for both arterial and venous enhancement

- **3) Nephrographic or parenchymal phase**
  - 120 seconds from start of contrast injection
    - Earlier for younger patients, later for older, fast scans
    - Ensures nephrographic phase
Three-phase renal CT

- **16 slice / detector MDCT & up**
  - 0.6, 0.625 or 0.75 mm slice collimation
  - 3-5 mm slice thickness / 3 mm interval for diagnostic interpretation
  - 1 mm slice thickness x 0.8 mm for MPR, VR reconstructions

- **Obese patients**
  - Use thicker collimator - 1.2, 1.25, 1.5

- **We use dose modulation algorithms (both x-y and z directions)**
MR protocols

- Coils 1.5 T & 3T phased array body coils
- Pre contrast –
  - Axial T1 in/out - 5-6 mm slices.
  - Axial & Coronal HASTE - No fat sat - 5-6mm slices
  - Axial VIBE – 1.5 mm effective slice thickness
  - Coronal 3D FLASH - Try to get effective thickness 2mm
MR protocols (cont.)

- **Post contrast** —
  - Timing Run - axial thru kidneys –
    contrast at 2cc/sec followed by 20 cc
    saline at 2cc/sec
  - Standard timing formula
    - TP + inject-time/2 – time-to-center
  - Coronal 3D FLASH
  - Axial & coronal VIBEs
    - 0, 30, 60, 90, 180 secs
  - Subtraction
Image creation

- MIPs and MPRs
  - Coronal oblique MIPs of arterial system ≈ aorta
  - MPRs oblique coronal and sagittal MPRs ≈ long axis of the kidney
Image creation

- **Volume rendering**
  - Opacity settings to preference
    - Mine – approx 50%
  - Or use presets …
Tumor position

- Four renal segments, based on vascular territories

![Diagram of renal segments: anterior, apical, basilar, posterior]
Tumor depth of extension - terminology

• **Central** – extends into the central sinus fat or abuts the central sinus
  • Higher likelihood of collecting system “entry”

• **Peripheral** – no central extension
  • Surgically simpler

• **Exophytic** – identifiable on surface

• **Intrarenal** – may require IOUS
Anterior, central, exophytic

axial

MPR

VR
Posterior, central, exophytic
Apical, peripheral, exophytic
Basilar, exophytic, central
Central, intrarenal
Tumor position
Venous anatomy

Retroaortic left renal vein

Circumaortic left renal vein
### Billing

**Table 1: 2007 Medicare Reimbursement for 3D Rendering Procedures**
(Reflects National Rates, Unadjusted For Locality)

<table>
<thead>
<tr>
<th>CPT Code</th>
<th>Reimbursement Component</th>
<th>Hospital Inpatient Department</th>
<th>Hospital Outpatient Department</th>
<th>IDTF and Physician Office</th>
</tr>
</thead>
</table>
| **CPT 76376**
3D rendering with interpretation and reporting of computed tomography, magnetic resonance imaging, ultrasound, or other tomographic modality; not requiring image postprocessing on an independent workstation | Technical | Included in DRG | $37.51 | $37.51 |
| | Professional | $10.23 | $10.23 | $10.23 |
| | Total | DRG + $10.23 | $47.74 | $47.74 |
| **CPT 76377**
3D rendering with interpretation and reporting of computed tomography, magnetic resonance imaging, ultrasound, or other tomographic modality; requiring image postprocessing on an independent workstation | Technical | Included in DRG | $94.53 | $94.53 |
| | Professional | $39.79 | $39.79 | $39.79 |
| | Total | DRG + $39.79 | $134.32 | $134.32 |

- 2007 reimbursement rates (from the web)
What’s next? Segmentation and tumor volume

- Studies looking at relationship of tumor and renal parenchymal volume to NSS and outcome
- Segmentation results from software
  - Volume
  - Mean density & std. dev.
  - Recist diameters
Summary

• Open pNx is now recommended treatment for small renal mass
• More Urologists will be doing more NSS for SRM
  • Least experienced will need the most operative guidance!
• Images to provide
  • Arterial / Venous anatomy
    • Number, location, branching
    • Anomalies
  • Tumor
    • Location anterior/posterior/apical/basilar
    • Location - exophytic / depth / involvement of calices
  • Ureter(s)
• Bill as 3D when requested by the surgeon
References

- Bhayani et al. Urology 2006;68:732
- Lau et al, Mayo Clinic Proceedings, 2000;75:1236-1242
- Thompson et al J Urol 2008;179:468-473