GU Trauma Part Deux: Renal & Ureteral Trauma

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Grand Rounds
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December 20th, 2006
Location of GU Trauma

Kidney 67%
Ureter 1%
Bladder 22%
Urethra 3%
External Genitalia 7%

Part Deux

Overview

• Renal
  – Imaging
  – Mx
  – Cx
• Ureteral
  – Penetrating
  – Blunt
  – Iatrogenic
    • Mx
• BJU Intl GU Trauma Concensus Guidelines 2004
• EAU Guidelines 2003
• Urol Clinics NA Feb 2006
Renal Trauma

Epidemiology

- Incidence: 1.4 - 3.25%
- Age: 20-30 yo
- Males
- Assoc injuries common: 20-94%
Mechanism of Injury

- **Blunt**
  - Majority: 81-95%
  - Canada: 93% (Baverstock R, McLoughlin M. Can J Urol 2001)
  - MVC, Falls

- **Penetrating**
  - 18% (4.6-87%)
  - More likely severe renal injuries
    - Penetrating 27-68% vs Blunt 4-25% (Santucci 2001)
  - Likelihood renal injury: GSW > stab
  - GSW injury: High vs Low velocity

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Classification: AAST

<table>
<thead>
<tr>
<th>Grade</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Contusion</td>
<td>Microscopic or gross haematuria, urological studies normal</td>
</tr>
<tr>
<td>II</td>
<td>Haematoma</td>
<td>Subcapsular, not expanding with no parenchymal laceration</td>
</tr>
<tr>
<td>III</td>
<td>Laceration</td>
<td>Not expanding perirenal haematoma confirmed to renal retroperitoneum</td>
</tr>
<tr>
<td>IV</td>
<td>Laceration</td>
<td>&lt;1.0 cm parenchymal depth of renal cortex with no urinary extravasation</td>
</tr>
<tr>
<td>V</td>
<td>Laceration</td>
<td>&gt;1.0 cm parenchymal depth of renal cortex with no collecting system rupture or urinary extravasation</td>
</tr>
<tr>
<td></td>
<td>Vascular</td>
<td>Main renal artery or vein injury with contained haemorrhage</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>Completely shattered kidney</td>
</tr>
<tr>
<td></td>
<td>Vascular</td>
<td>Avulsion of renal hilum which devascularizes kidney</td>
</tr>
</tbody>
</table>

*Advance one grade for bilateral injuries up to grade III. Accessible online at [http://www.aast.org/injury.html](http://www.aast.org/injury.html).*
Classification: AAST

- Validated:
  - ↑ grade assoc w/ serious negative outcomes

- AAST: Most important predictive variable
  - Predict need for kidney repair/ removal

Santucci et al. J Trauma 2001. n=2467. LOE=3
AAST

- **Gr 4:**
  - Segmental infarction w/o laceration
    - Thrombosis or laceration segmental a.
- **Gr 5:**
  - UPJ Avulsion
    - No contrast distal ureter


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**Dx: Hx & PE (EAU Guidelines)**

- ? HDN stability
- Circumstances of incident
- PMHx: ? Renal abn, ? Renal Sx
- PE: Chest, abdo, flanks & back
  - Hematuria, flank abrasions/pain
  - Fractured ribs
  - Abdo distension, mass, pain
Risk Factors

- Renal abn
  - ↑ vulnerability in blunt renal trauma
  - Consider if injury out of proportion to trauma
  - Incidence 6% (1-19%) (Morey JU 1996)
  - Higher %age in children (12.6-35%)
  - Hydro, Cysts, Tumors, Abnormal renal position

Dx: Lab Investigations

- Urine Analysis (LOE: 3)
  - Most important lab study
  - Urine dipstick reliable (EAU 2003)
    - False negative 2.5-10%
- Serial Hb
- Serum Cr
  - Often reflects pre-trauma renal fxn
**Hematuria**

- Present in 80-94% renal trauma
- May be absent in:
  - Pedicle injuries (18-36%)
  - UPJ avulsion
  - Penetrating
- **Blunt: Gross vs micro**
  - Predictive value for major injury

**Dx: Imaging Indications**

- Penetrating
- Gross hematuria
- Microhematuria & sBP < 90 mm Hg
- Pediatric: > 50 rbc/hpf
- **Mechanism of Injury:**
  - Flank impact
  - Deceleration injury (eg. fall from great height)

Imaging: Indications

• Penetrating:
  – ½ have grade 3, 4 or 5
  – High index of suspicion if wounds to chest, flanks or abdomen
  – LOE: 3


Imaging: Indications

• Adult Blunt: Degree of Hematuria & sBP (LOE: 2)
  – Gross Hematuria or Micro + sBP< 90 mm Hg
    • 12.5% major injury
  – Microhematuria + sBP > 90 mm Hg
    • 0.2%

(Mee et al. JU 1989, Miller & McAninch JU 1995. N= 1588 total)
Imaging: Indications

- Pediatric: Blunt
  - BP not reliable criterion for imaging
  - 50 rbc/hpf threshold
  - No prospective studies
  - LOE: 3

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>[28] 1983</td>
<td>140</td>
<td>0</td>
</tr>
<tr>
<td>[27] 1988</td>
<td>47</td>
<td>0</td>
</tr>
<tr>
<td>[77] 1989</td>
<td>23</td>
<td>0</td>
</tr>
<tr>
<td>[70] 1991</td>
<td>155</td>
<td>2</td>
</tr>
<tr>
<td>[70] 1993</td>
<td>47</td>
<td>0</td>
</tr>
<tr>
<td>[108] 1995</td>
<td>26</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>548</td>
<td>11 (8%)</td>
</tr>
</tbody>
</table>

Imaging: CT Abdo/Pelvis

- Gold standard
- Assess other intra-abdo injury
- Arteriovenous phase
- Delayed scan @ 10-20 min
  - ? Omit if ‘Normal Kidneys’ w/ no perinephric, RP, or pelvic fluid (LOE: 5)

**Imaging: CT**

- Immediate laparotomy
- 2 cc/kg IV contrast bolus
- AXR @ 10 min
- **Confirm contralat fxn, r/o life-threatening injury**
- Safely avoided renal exploration in 32%

Morey et al. JU 1999.

**Imaging: Intra-op IVP**

- Immediate laparotomy
- 2 cc/kg IV contrast bolus
- AXR @ 10 min
- **Confirm contralat fxn, r/o life-threatening injury**
- Safely avoided renal exploration in 32%
Imaging: Alternatives

- **IVP**
  - 65-95% accuracy (CT)
  - 70% sensitivity urine leak (Al-Qudah Urol Clin NA 2006)
  - GSW: Not recommended
  - LOE: 4

- **U/S**
  - Resolution inferior
  - May be useful in:
    - Post-op f/u fluid collections
    - Conservatively Mx
    - Hydro
  - Lack prospective studies

Imaging: Alternatives

- **Renal Arteriography**
  - Indications:
    - Suspect RA thrombosis
    - Suspect segmental arterial injuries
  - Renal venous injuries
    - Test of choice (EAU 2003)

- **Retrograde pyelogram**
  - Limited use
  - Consider if CT cannot r/o collecting system injury

- **MRI**
  - Limited use in acute setting
Imaging: F/U

- Indications:
  - Unexplained fever
  - Flank pain/mass
  - Bleeding
- Repeat CT @ 36-48 hr for Grade IV/V
  - Reassess extrav, hemorrhage
  - Resolution of Grade IV Extrav:
    - ? Image only if ↓ pt condition (LOE:5)


Mx: EAU 2003 Guidelines

- Indications for surgical management include:
  1. Haemodynamic instability
  2. Exploration for associated injuries
  3. Expanding or pulsatile perirenal haematoma identified during laparotomy
  4. A grade V injury
  5. Incidental finding of pre-existing renal pathology requiring surgical therapy

- Blunt: Gr I-IV Conservative Mx
- Penetrating: Gr I-III Conservative Mx
Mx: Operative Absolute Indications

<table>
<thead>
<tr>
<th>Indication</th>
<th>Description</th>
<th>Level of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Persistent, life-threatening haemorrhage believed to stem from renal injury</td>
<td>(4)</td>
</tr>
<tr>
<td>2</td>
<td>Renal pedicle avulsion (grade 5 injury)</td>
<td>(4)</td>
</tr>
<tr>
<td>3</td>
<td>Expanding, pulsatile or uncontained retroperitoneal haematoma (thought to indicate renal pedicle avulsion)</td>
<td>(4)</td>
</tr>
</tbody>
</table>

Remember to assess contralateral kidney!

Mx: Operative Relative Indications
**Mx: Operative Relative Indications**

<table>
<thead>
<tr>
<th>Relative</th>
<th>Indication</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A large laceration of the renal pelvis, or avulsion of the PUJ</td>
<td>(3)</td>
</tr>
<tr>
<td>2</td>
<td>Coexisting bowel or pancreatic injuries</td>
<td>(3)</td>
</tr>
<tr>
<td>3</td>
<td>Persistent urinary leakage, postinjury urinoma or perinephric abscess with failed percutaneous or endoscopic management</td>
<td>(3)</td>
</tr>
<tr>
<td>4</td>
<td>Abnormal intraoperative one-shot MU</td>
<td>(3)</td>
</tr>
<tr>
<td>5</td>
<td>Devitalized parenchymal segment with associated urine leak</td>
<td>(3)</td>
</tr>
<tr>
<td>6</td>
<td>Complete renal artery thrombosis of both kidneys, or of a solitary kidney, or when renal perfusion appears to be preserved</td>
<td>(4)</td>
</tr>
<tr>
<td>7</td>
<td>Renal vascular injuries after failed angiographic management</td>
<td>(3)</td>
</tr>
<tr>
<td>8</td>
<td>Renovascular hypertension</td>
<td>(4)</td>
</tr>
</tbody>
</table>

- Urine extrav resolves spontaneously 76-87%
- GSW: Lower threshold to explore
- Large renal pelvis lac
  - Unlikely to resolve w/ ureteric stent alone

**Mx: Operative Relative Indications**

**<2% renal trauma**

**Controversial Mx**

<table>
<thead>
<tr>
<th>#</th>
<th>Condition</th>
<th>LOE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Coexisting bowel or pancreatic injuries</td>
<td>3</td>
</tr>
</tbody>
</table>

- Increased incidence of major complications (LOE: 3)
  - Extensive renal injury
  - Urinary extravasation
  - Devitalized renal segments
  - Not seen in more modern series

**Technique:**
- Tissue interposition
- Drain


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**Mx: Operative Relative Indications**

**> 20%**

**Conservative Mx:**
- Stents ± percutaneous for persistent leak
- Angiography if delayed bleed

<table>
<thead>
<tr>
<th>#</th>
<th>Condition</th>
<th>LOE</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Devitalized parenchymal segment with associated urine leak</td>
<td>3</td>
</tr>
</tbody>
</table>

**Higher incidence of Major Cx (LOE:3)**
- Bleeding
- Urinoma
- Abscess

**Devitalized segments:**
- No increase in renovascular HTN
  
  (Husmann JU 1990)

Husmann JU 1993; Moudouni et al. BJUI 2001
Mx: Operative Relative Indications

Options:

- Nephrectomy
- Reconstruction
- Radiological/Angio

7 Renal vascular injuries after failed angiographic management

Mx: Renovascular Injuries

Avulsed/ lacerated vessels:
- Often Explore

<table>
<thead>
<tr>
<th>Ref</th>
<th>N</th>
<th>Bunt/penetrating</th>
<th>Associated injuries, %</th>
<th>Vascular injury, %</th>
<th>Nephrectomy rate, %</th>
<th>Mortality rate, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>[94]</td>
<td>96</td>
<td>10/64</td>
<td>95</td>
<td>24 A, 43 V, 33 C</td>
<td>49</td>
<td>21</td>
</tr>
<tr>
<td>[123]</td>
<td>94</td>
<td>32/68</td>
<td>95</td>
<td>17 A, 48 V, 35 C</td>
<td>44</td>
<td>37</td>
</tr>
<tr>
<td>[112]</td>
<td>41</td>
<td>26/24</td>
<td>100</td>
<td>49 A, 21 V, 15 C, 15 S</td>
<td>39</td>
<td>44</td>
</tr>
<tr>
<td>[114]</td>
<td>15</td>
<td>40/60</td>
<td>100</td>
<td>69 A, 27 V, 13 C</td>
<td>60</td>
<td>33</td>
</tr>
<tr>
<td>[84]</td>
<td>36</td>
<td>36/64</td>
<td>89</td>
<td>25 A, 31 V, 17 C, 27 S</td>
<td>30</td>
<td>19</td>
</tr>
</tbody>
</table>

Main RA: 67-86%
Main RV: 25-56%
Segmental alone: none
**Mx: Renovascular– Venous**

- **Venous Injury**
  - **Venous Thrombus**
    - 2 kidneys
      - Observe vs Nx
    - Solitary kidney
      - Thrombectomy
  - **Avulsion**
    - 2 Kidneys
      - Nx (Immediate)
    - Solitary Kidney
      - Repair vs Nx


**Mx: Renovascular– Arterial**

- **Arterial Injury**
  - **Segmental**
    - No Intervention
      - 2 kidneys
      - Observe
      - Nx (if necessary)
    - Solitary
      - Thrombectomy
  - **Intimal Injury**
    - 2 Kidneys
      - Observe or Stent
      - Nx (if necessary) (delayed if possible)
    - Solitary
      - Repair
      - Nx (if necessary)

Mx: Operative Relative Indications

**RA Reconstruction Indications:**
- Solitary kidney
- Bilateral renal injury
- Simple arteriorrhaphy possible
- Laparotomized, Stable, Early Dx, Non-ischemic, Incomplete

**Revasc seldom indicated if normal contralateral kidney** (LOE: 3)
**Mx: Renal Artery Occlusion**

- Success of Reconstruction:
  - **Poor**: 22-56%
  - Risk of HTN not significantly changed
  - Factors:
    - Duration
      - Most recommend attempt only if <5hr max
    - Degree of ischemia
    - Collateral flow


**Mx: Renal Artery Occlusion**

HTN
- Not improved w/ revascularization (57 vs 50%)
- Routine Nx too aggressive

Operative Technique

Medial to IMV

Early Vascular Control

TABLE 7 Nephrectomy rates in patients undergoing renal exploration with and without preliminary vascular isolation:

<table>
<thead>
<tr>
<th>Ref</th>
<th>Vascular control %</th>
<th>No control %</th>
</tr>
</thead>
<tbody>
<tr>
<td>[10]</td>
<td>68</td>
<td>37</td>
</tr>
<tr>
<td>[8]</td>
<td>30</td>
<td>31</td>
</tr>
<tr>
<td>[12]</td>
<td>33</td>
<td>30</td>
</tr>
</tbody>
</table>

McAninch & Carroll 1982
Exploration

- Options:
  - Nephrectomy
  - Partial Nephrectomy
  - Renorrhaphy

Mx: Operative & Nx Rates (Blunt)

<table>
<thead>
<tr>
<th></th>
<th>OR Rate</th>
<th>Nx Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>UCSF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gr III</td>
<td>76%</td>
<td>3%</td>
</tr>
<tr>
<td>Gr IV</td>
<td>78%</td>
<td>9%</td>
</tr>
<tr>
<td>Gr V</td>
<td>93%</td>
<td>86%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>OR Rate</th>
<th>Nx Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>VGH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gr III</td>
<td>12.5%</td>
<td>12.5%</td>
</tr>
<tr>
<td>Gr IV</td>
<td>22.3%</td>
<td>16.6%</td>
</tr>
<tr>
<td>Gr V</td>
<td>90.9%</td>
<td>90.9%</td>
</tr>
</tbody>
</table>

Santucci, J Trauma 2001. 20 yr  Baverstock R, MGM. Cdn JU 2001. 7 yr. n=227
Renal Reconstruction

- Complete exposure
- Debridement
- Suture bleeders
- Close collecting system
- Close parenchymal defects
- ± Fibrin sealant (Shekarriz JU 2002)
- ± Omental interposition
- Drain

Mx: Post-Op F/U (EAU 2003)

1.4.5.1 GUIDELINES ON POST-OPERATIVE MANAGEMENT AND FOLLOW-UP
- Repeat imaging is recommended for all hospitalized patients within 2 to 4 days following renal trauma
- Nuclear scintigraphy before discharge from the hospital is useful for documenting functional recovery
- Within 3 months of major renal injury, patients’ follow-up should involve:
  1. Physical examination
  2. Urinalysis
  3. Individualized radiological investigation
  4. Serial blood pressure measurement, and
  5. Serum determination of renal function
- Long-term follow-up should be decided on a case-by-case basis
**Mx: Conservative**

The Literature Increasingly Supports Expectant (Conservative) Management of Renal Trauma — A Systematic Review

Richard A. Santucci, MD, and Mark B. Fish, MD

- **Conservative Mx**
  - “If you don’t operate on the kidney, you can’t do a Nx”
  - ↓ Nx rates 19-30% (“Iatrogenic Nx rate”)
  - Delayed intervention: 0-2% overall, 10% Gr IV

**Mx: Conservative—Blunt**

<table>
<thead>
<tr>
<th>Table 1 Blunt High Grade IV</th>
<th>Number</th>
<th>% Managed</th>
<th>% Delayed</th>
<th>% Requiring</th>
<th>% Nephrectomy</th>
<th>% Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Santucci, 2004™</td>
<td>11</td>
<td>100</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>9% delayed partial nephrectomy</td>
</tr>
<tr>
<td>Rogers, 2004™</td>
<td>6</td>
<td>100</td>
<td>13</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hammer, 2003™</td>
<td>6</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Musulkin, 2001™</td>
<td>15</td>
<td>100</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Manei, 1997™</td>
<td>31</td>
<td>81</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mathews, 1997™</td>
<td>20</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Robert, 1986™</td>
<td>11</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Ohnag, 1983™</td>
<td>7</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Kontarras, 1992™</td>
<td>30</td>
<td>80</td>
<td>60</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hufnann, 1996™</td>
<td>50</td>
<td>82</td>
<td>24</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roberts, 1987™</td>
<td>23</td>
<td>87</td>
<td>20</td>
<td>20</td>
<td>0</td>
<td>24% delayed partial nephrectomy</td>
</tr>
<tr>
<td>Kräger, 1984™</td>
<td>6</td>
<td>83</td>
<td>20</td>
<td>20</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Gibson, 1982™</td>
<td>34</td>
<td>82</td>
<td>23</td>
<td>20</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Evans, 1990™</td>
<td>4</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Thompson, 1977™</td>
<td>43</td>
<td>100</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>2% partial nephrectomy</td>
</tr>
</tbody>
</table>

### Mx: Conservative– Stab

#### Table 2 Stab

<table>
<thead>
<tr>
<th>Number</th>
<th>Managed</th>
<th>Expended</th>
<th>% Requiring Delayed Surgery</th>
<th>% Nephrectomy</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hamner, 2003†</td>
<td>2</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>3% hemorrhage necessitating reconstruction</td>
</tr>
<tr>
<td>Aravamudan, 1999†</td>
<td>200</td>
<td>95</td>
<td>3</td>
<td>0</td>
<td>11% hemorrhage, 3% angiembolization</td>
</tr>
<tr>
<td>Wassell, 1994†</td>
<td>71</td>
<td>52</td>
<td>11</td>
<td>0</td>
<td>27% delayed bleeding (7% angiembolization, 20% partial nephrectomy)</td>
</tr>
<tr>
<td>Thall, 1996†</td>
<td>16</td>
<td>69</td>
<td>0</td>
<td>0</td>
<td>6% hematoma</td>
</tr>
<tr>
<td>Cheng, 1994†</td>
<td>6</td>
<td>65</td>
<td>1</td>
<td>0</td>
<td>10% angiembolization, 2% heminephrectomy</td>
</tr>
<tr>
<td>Heyns, 1992†</td>
<td>65</td>
<td>65</td>
<td>7</td>
<td>3</td>
<td>20% (11% delayed bleeding, 2% A-V fistula, 2% hematuria)</td>
</tr>
<tr>
<td>Heyns, 1995†</td>
<td>41</td>
<td>56</td>
<td>0</td>
<td>0</td>
<td>2% pneumonia</td>
</tr>
<tr>
<td>Banath, 1993†</td>
<td>47</td>
<td>72</td>
<td>14</td>
<td>18</td>
<td>3% delayed hemorrhage (A-V fistula)</td>
</tr>
</tbody>
</table>

Delayed bleed ~ 20%

### Mx: Conservative– GSW

#### Table 3 GSW

<table>
<thead>
<tr>
<th>Number</th>
<th>Managed</th>
<th>Expended</th>
<th>% Requiring Delayed Surgery</th>
<th>% Nephrectomy</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serlesnik, 2004† (low velocity)</td>
<td>53</td>
<td>75</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hamner, 2003†</td>
<td>3</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Velahos, 1996†</td>
<td>62</td>
<td>98</td>
<td>5</td>
<td>0</td>
<td>5% delayed partial nephrectomy</td>
</tr>
<tr>
<td>Wassell, 1994†</td>
<td>4</td>
<td>109</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Thall, 1995†</td>
<td>16</td>
<td>31</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cheng, 1994†</td>
<td>9</td>
<td>67</td>
<td>1</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>McLaren, 1999†</td>
<td>87</td>
<td>21</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Lower threshold to operate
### Conservative Mx F/U Imaging

<table>
<thead>
<tr>
<th>Grade</th>
<th>F/U Imaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-II</td>
<td>None</td>
</tr>
<tr>
<td>III</td>
<td>None (if HDN stable, no devitalized frags)</td>
</tr>
<tr>
<td>IV-V</td>
<td>Repeat CT w/ Delays (@36-72 hr) Renogram @ 3 mo</td>
</tr>
</tbody>
</table>


### Complications

- Urinoma
- Abscess
- 2º Bleed
- HTN
- Renal insufficiency
**Cx: Urinoma & Perinephric Abscess**

- Extrav resolve spontaneously 80-90%
- Urinoma 1-7%, Abscess 1%  (Urol Clin NA Feb 2006)
- Risk factors:
  - Devitalized fragments
  - Coexisting pancreatic or enteric injuries
  - Sources of infection (eg. CVC)
  - Penetrating trauma (7-30% urinoma, 5% abscess)
- Mx:
  - Perc drainage +/- ureteric stent (Consensus. BJUI 2004)
  - Ureteric stent or perc NT  (Santucci Urol Clin NA 2006)

**Cx: 2° Bleed**

- Etiology:
  - AVF (0-7% stabs)
  - Pseudoaneurysm
- 2-36 days post injury
- 13-25% of Gr III/IV  (Conservative Mx)
- Often need intervention:
  - Angiographic embolization

**Cx: HTN**

- Incidence: 5.2% (0.6-33%)
  - RA occlusion: ↑ incidence 30-50%
  - Transient HTN 6-10% (2-7 wks)
- Renal ischemia → Excess renin
- Time course: widely variable (37 days - decades)
- Prevention? Conflicting evidence
- Recommendation (LOE: 5)
  - Gr 4 & 5: periodic BP x yrs
  - No Guidelines & indications for imaging

Al-Qudah Urol Clin NA 2006; BJUI 2004

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**Mx: Operative Relative Indications**

- Renovascular hypertension
**Cx: HTN**

- **Mx:**
  - Spontaneous resolution reported
  - Medical Mx (30-40% effective)
  - Surgical:
    - Nephrectomy: Partial or Total
    - Capsulectomy (chronic Page kidney) <50% success
    - Renal revascularization

-Al-Qudah Urol Clin NA 2006; BJUI 2004

**Cx: Renal Insufficiency**

- Incidence 0-7% overall
- Renal fxn worse if Nx vs Repair or Conservative
- Conservative Mx
  - Gr V 29% fxn (mean)
  - Gr II-IV preserved fxn
- ARF in Trauma pts multifactorial

-Al-Qudah Urol Clin NA Feb 2006; McGonigal J Trauma 1987; Keller J Trauma 2004
Ureteral Trauma

Mechanism of Injury

• External
  – Rare (<10/yr @ major trauma centers)
  – Almost always assoc intra-abdo injuries
  – GSW (Most common- 81%)
  – Stab wounds
  – Blunt (Rare– Peds rapid decel @ UPJ)
• Iatrogenic (Most common: >75%)
**Location**

- Varies depending on Etiology
- External:
  - Upper 39%
  - Mid 31%
  - Distal 30%
- Blunt: UPJ
- Iatrogenic: Distal ureter

---

**Grading: AAST**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Type of injury</th>
<th>Description of Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Hematoma</td>
<td>Contusion or hematoma without devascularization</td>
</tr>
<tr>
<td>II</td>
<td>Laceration</td>
<td>&lt; 50% transection</td>
</tr>
<tr>
<td>III</td>
<td>Laceration</td>
<td>≥ 50% transection</td>
</tr>
<tr>
<td>IV</td>
<td>Laceration</td>
<td>Complete transection with &lt; 2cm devascularization</td>
</tr>
<tr>
<td>V</td>
<td>Laceration</td>
<td>Avulsion with &gt; 2cm of devascularization</td>
</tr>
</tbody>
</table>

*Advance one grade for bilateral up to grade III. From Moore et al. [2] with permission*
**Dx: Clinical**

- **Immediate:**
  - Hematuria unreliable sign
    - Absence does not r/o injury
    - Present in only ½ of ureteral trauma
  - Blunt: Hyperextension or deceleration (LOE 3)
    - Child
    - Fall from height

- **Delayed:**
  - Prolonged ileus (LOE: 3)
  - Urine leak/ Prolonged drain output (LOE: 3)
  - Fever/ Sepsis (LOE: 4)
  - Persistent flank/abdo pain/mass (LOE: 4)
  - Urinary obstruction (LOE: 4)
  - ↑ Cr or BUN (LOE: 5)
**Dx: Clinical**

- High index of suspicion
- Low threshold for imaging
- Delayed Dx = ↑ Complication rate (LOE: 3)

- Surgical Exploration:
  - Reliable & accurate (+/- dye)
  - Explore all peri-ureteral GSW & assoc RP hematomas @ laparotomy (LOE: 3)

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**Penetrating Ureteric Injuries**
Penetrating Ureteric Injury

• Stab
  – Wounds to back
  – Wounds to abdo (w/ long blade)
  – Short segment loss (cp GSW)
• GSW
  – Blast effect– initially may appear normal
    • Up to 2 cm micro vasc damage beyond gross injury
      (Amato Arch Surg 1970)

Dx: Imaging

• IVP
  – 1 shot: Not reliable (LOE: 3)
    • Sensitivity: 38%
  – ?Complete IVP is accurate (LOE: 3)
    • Wide range: overall 61% (Urol Clin NA 2006)
• Retrograde Pyelogram
  – Sensitive & specific
  – Limited use in acute setting
• CT
  – Insufficient data (BJU 2004)

Renal Concensus BJUI 2004.
**Mx: Penetrating**

- Untreated: Stricture, necrosis, fistula  
  \( \text{(LOE 4)} \)
- Minimal contusion
  - Ureteric stent
- Severe contusions:
  - Segmental excision & UU  
  \( \text{(LOE 4)} \)
- High-velocity GSW:
  - ↑ rates delayed leak
- Remember adequate ureteric debridement

**Mx: Penetrating**

- Timing:
  - Early Rx preferred  
  \( \text{(LOE 3)} \)
  - If unstable, delay definitive reconstruction  
  \( \text{(LOE 4)} \)
- Delayed Dx or 2º leak
  - Perc NT → antegrade ureteric stent
  - Retrograde stent often unsuccessful
- Assoc bowel injury/ fecal contamination
  - No ↑ Cx rate  
  \( \text{(LOE 4)} \)
- Urinomas
  - Perc drain
**Blunt Ureteric Injuries**

**Blunt Dx: Imaging**

- Delayed Dx in most (75-93%)
- CT w/ delays:
  - Gold Standard
  - More sensitive than IVP
  - Medial perirenal extrav (LOE 3)
  - Unopacified ureter (LOE 4)
  - Intact renal parenchyma (LOE 4)
  - Lack of perirenal hematoma (LOE 4)
Mx: Blunt

- Typically to UPJ, then Prox Ureter (LOE 3)
- Partial UPJ (LOE 4)
  - 1º repair
  - Ureteric stent ± Perc NT
- Complete UPJ (Avulsion) (LOE 3)
  - UU or Ureteropyelostomy

Iatrogenic Ureteric Injury
**Etiology**

- Leading cause of ureteric injuries
- Gyne:
  - 52-82% of iatrogenic
  - Distal ureter
  - Hysterectomies:
    - 0.5-2% overall; 10% Radical Hysterectomies
    - ligation of ovarian & uterine vessels
  - Vaginal approach: vaginal vault/cuff
- Colorectal, Vascular Surgery & Us!

**Risk Factors**

- **Intraop hemorrhage**
  - Main risk factor
  - Avoid blind cautery/suturing
- Large pelvic masses
- Prev pelvic surgery
- Infection/Inflammation (eg. PID)
- Radiation
Prevention

- Risk Factors
  - Most reported injuries have none
- Adequate exposure, ID ureter
- ? Pre-op ureteric imaging
  - No clear benefit
- Ureteric stenting
  - Does not ensure prevention of injury (Bothwell 1994)
  - Helps to ID injury when it does occur

Dx: Intraoperative

- Exposure
- Ureteric/IV injection: Methylene Blue
  - 2-3 cc w/ 27 gauge needle intraureteric
- Ureteral catheterization (Cysto or cystotomy)
- Signs of ureteric devascularization: (Presti 1989)
  - Wall discoloration
  - Absence of capillary refill
  - Lack of bleeding edge
• Delayed Dx >65%
  – Most not recognized intraoperatively
• IVP or CT IVP:
  – Extrav (hallmark)
  – Delayed fxn
  – Dilation
  – Ureteric deviation
• Retrograde pyelogram
  – Most accurate
  – Useful in delayed Dx setting

“Poor Man’s IVP”
- KUB 30 min post CT
- If high suscipation & CT non-Dx

Management:
Iatrogenic Ureteric Injuries
Mx: Vascular graft surgery

• Controversial, no clear consensus
• Options:
  – Nephrectomy
    • Treatment of choice 2 decades ago (Shapira JU 1981)
  – Ureteric repair
    • If urine is sterile, no ↑ failure rate or ↑ graft infection (Spink et al. JU 1989)


Mx: Suture Ligation

• Assess ureteric viability
  – If in question, Repair
  – If minimal, remove stitch ± ureteric stent
• Vag approach
  – ? Routine IV indigo carmine/ cysto
  – If cystocele, enterocoele, BN suspension
    • Remove Suture
  – If vag vault recon or vag hysterectomy:
    • Reimplant ureter, sutures typically not removed
• Delayed Dx (Post-Op)
  – If absorbable suture, Perc NT until suture absorbs

**Mx: C-Section Ureteric Injuries**

- 0.09% of C-Sections
- Often **Emergent C-S**: Lateral extension of uterine myotomy to broad ligament
  - Hemostatic sutures injure ureter
- Bleeding & gravid uterus
  - Visual ID of ureter can be difficult
- IV Methylene blue inaccurate
  - Hydroureter & ↓ peristalsis
- 1 of 17 Urology consults had injury \[(JU\,172,2004)\]


**Mx: C-Section Ureteric Injury**

- Open dissection-
  - more risk than benefit
- Preferred Dx method:
  - Ureteric catheter
  - Fluoro if available

**Mx: Crush Injury**

- Likelihood of significant injury high *(LOE 4,5)*
  - Ischemic injury manifests several days
  - Factors: clamp size, duration, amount tissue

- Minor injuries → stent & drain
- If in doubt, segmental resect & repair

Ureter Concensus BJUI 2004.

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**Mx: Devascularization**

- Often delayed Dx
  - Leak or stricture
- Intraop:
  - Extensive skeletonization or cautery
  - Viability difficult to assess in most cases
  - Ureteric stent at a minimum
  - If in doubt, segmental excision & repair

Ureter Concensus BJUI 2004.
**Mx: Partial & Complete Transection**

- Partial (< 50% diameter)
  - 1º suture closure, stent, drain

- Complete or Partial > 50% diameter
  - Ureteric division & repair

*Ureter Concensus BJUI 2004.*

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**Mx: Ureteroscopic Injury**

- Incidence ↓ over the years
  - Equipment
  - Surgeon experience

- Perforations (2-6%):
  - Stent

- Avulsion (0.3%):
  - Mx as per transection injuries
**Mx: MIS Ureteric Injuries**

- Delayed Dx
- Most common:
  - Endometriosis laser ablation
  - MIS assisted vaginal hysterectomy

- Mx as per open cases
  - Low threshold to open

Ureter Concensus BJUI 2004.

**Mx: Associated Injuries**

- Fecal contamination/ Bowel injury
  - Ureteric repair success/ Cx rate unaffected
  - Tissue interposition

Ureter Concensus BJUI 2004.
Ureteral Injury: Management Options

**Mx: Timing**

- Optimum time for repair: @ time of injury
- Delayed Dx: Most iatrogenic & blunt
  - Perc NT
    - Δ to Antegrade stent
    - Open repair if persistent leak or stricture
  - Retrograde stent often unsuccessful (50-95%)
    - Attempt only for low-grade injuries
  - Definitive repair should be delayed/staged
**Mx: Damage Control**

- Patient unstable, coagulopathic, acidotic
- Delay ureteric repair until stable
- Options:
  - Ureteric ligation & Perc NT
  - Ureterostomy

**Mx: Ureteric recon—1° Closure**

- Low grade partial lacerations
- Should not be used for GSW
**Mx: Ureteric Recon—UU**

- Option of choice for upper/middle ureter
- Debride to viable ureter
- Spatulate on opposite sides
- Watertight, tension-free over ureteric stent
- Drain
- ± omental wrap

**Mx: Distal Ureter—Ureteric Reimplant**

Psoas Hitch  Boari flap
**Mx: Extensive Ureteric Loss**

- TUU
- Ileal interposition
- Renal Autotransplant
- Nephrectomy

- Often not in acute setting
  - Perc NT, ligate ureter
  - d/w pt elective options

**Delayed Ureteric Complications**

- 2º ischemia & necrosis
- Fistula
  - RFs: Infection, XRT, foreign body, neoplasia
  - Mx:
    - Ureteric stent
    - UU or ureteric reimplant
- Stricture
Summary

• ABCs
• Focused Hx
• Stage

Summary: Renal Trauma

• AAST Stage important: CT
• Intraoperative IVP
  – Assess contralateral kidney
• Trend towards conservative Mx
Summary: Ureter

- High index of suspicion
- Immediate Dx/ Mx preferred
  - If in doubt, repair
- Distal: Reimplant
- Mid/Proximal: UU

Happy Holidays!