Objectives

• Review diagnosis and management of urologic injury
• Establish indications for stenting, cystoscopy, and ureteral repair
• Demonstrate ureterolysis and cystotomy closure

HOW LONG IS THE URETER?
HOW LONG IS THE URETER?

• 25-30 cm

And you are responsible for all of it!

Importance of the Ureter

• 19% of unplanned consults to Gyn Onc were for inability to identify the ureter
• Incidence of injury during LH (2004-14):
  – Overall: 0.3 - 1%
  – Bladder injury: 0.05 - 1.8%
  – Ureteric injury: 0.02 - 1.5%
• Same for TLH performed for cancer (Matsuo)
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- 91-fold increased risk of litigation after ureteral tract injury in gynecologic surgery

Factors Affecting Incidence

<table>
<thead>
<tr>
<th>Route</th>
<th>Rate of injury (per 1000 hysts)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bladder</td>
</tr>
<tr>
<td>Abdominal</td>
<td>5.8</td>
</tr>
<tr>
<td>Vaginal</td>
<td>5.1</td>
</tr>
<tr>
<td>Laparoscopic</td>
<td>7.3</td>
</tr>
<tr>
<td>Robotic-Assisted</td>
<td>16.5</td>
</tr>
</tbody>
</table>

- Procedural Factors: Malignancy, Prolapse, Incontinence procedures, Laparoscopic approach

Aviki EM. Gynecol Oncol 137(1):93-97, 2015
Factors Affecting Incidence

- Patient Factors
  - Prior pelvic surgery
  - Endometriosis
  - Urinary tract anomalies (pelvic kidney, duplicated ureter)
  - Prior pelvic irradiation
  - Obesity
  - Large pelvic mass
  - Fibroids, especially when located in broad ligament or near cervix
  - Large uterus (>250 gm)

Good news: We have improved

- Learning curve reaches significance at 30 cases

Review anatomy related to identification and dissection of the ureter and bladder

Anatomy of the Ureter

Ureter is close to ovarian vessels: must visualize vermiculation

Find this at the bifurcation of the iliacs (pelvic brim)
Anatomy of the Ureter
Types of Urinary Tract Injury

- Bladder:
  - Cystotomy
  - Devascularization or denervation
  - Accidental placement of intravesical suture or staple
- Ureter:
  - Crush injury
  - Kinked or ligated with suture or staple
  - Lacerated or transected during sharp or blunt dissection
  - Thermal injury
  - Devascularization or denervation
3 points of ureteral injury

- When clamping the IP (gonadal vessels)
- When clamping the uterine vessels
- With inadequate bladder flap development (clamping the cardinal ligaments)

Identify the ureter

- Remember the course of the ureter
- Open the retroperitoneum in a safe, lateral location – remember the “triangle”
- Always safe to go lateral and cephalad
- Higher is better
- Adherent to the medial leaf of the peritoneum
- Use more suction, less (no) irrigation
Right Pelvic Sidewall

IP ligament

URETER

External Iliac A

Internal Iliac A
Ureter and Appendix
Ureter Under the Uterine Artery

Uterosacral Lig Uterine Artery
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The Triangle (Right Side)
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Identify the ureter

- Lyse adhesions as needed to identify the course of the ureter
- Important at the level of the IP
- Important at the level of the uterines
- At the level of the IP, stay lateral! Lateral is safe
- Open the retroperitoneum in a safe, lateral location – remember the “triangle”

Prevent Injury at the Pelvic Brim
Finding the Ureter

Prevent Injury at the Uterine Artery and Pelvic Sidewall
Prevent Injury at the Uterine Artery and Pelvic Sidewall

- Do NOT go below the Koh ring
- Have strategies to deal with bleeding
- Seal vessel without tension
- Hemostatic agents
- Ligate uterine artery at its origin
- Isolate the ureter in difficult cases

Prevent Injury at the Vaginal Cuff

- Surgical Technique
  - Always identify ureters and bladder!
  - Be aware of thermal spread
    - Traditional bipolar – 2 to 22 mm
    - Harmonic scalpel – 0 to 3 mm (depends on application time and device setting)
    - Ligasure device – 1.8 to 4.4 mm
  - Cephalad displacement of uterus (“If you’re not sweating, you’re not pushing hard enough!”)
  - Skeletonize uterine vessels
  - Dissect bladder off upper vagina

Use a ring to push the ureters away - always!

Identify and manage urologic injury

- Direct visualization of cystotomy or ureteral injury
- Hematuria in foley bag
- Gas in foley bag
- Visualization of foley balloon in surgical field
- Extravasation of urine into surgical field
  - Retrograde bladder fill (diluted methylene blue, sterile milk)
  - Stent placement
  - IVP
  - Retrograde ureteral dye study
- Crush, delayed thermal injury, and partial obstructions are difficult to recognize

Hurt WG, Gynecologic and Obstetrical Surgery (Nichols DH ed), Baltimore, Mosby, 1993
Identify intraoperatively

• Cystoscopy
  – Evaluate bladder for perforation, bleeding, suture
  – Evaluate bilateral ureteral jet efflux
  • PO pyridium (100-200 mg in pre-op)
  • IV sodium fluorescein (1 mL of 10% fluorescein diluted in 9 mL saline; administer 1 mL diluted fluorescein IV)
  • Intravesical mannitol or glycine solution
  • IV indigo carmine
  • IV or Intravesical methylene blue
  • Can also give dose of IV Lasix +/- fluid bolus +/- reverse Trendelenburg

Benefit to early detection

• 15 patients with ureteral injuries
  • 7 patients detected by intraop cystoscopy or early postoperative ureteral jet US
  • 5 patients detected by signs or symptoms
  • 3 patients developed injury despite normal cysto/US
• Diagnosed earlier (1.7 vs. 19.9 days)
• OR of 10 for more conservative treatment - 1/7 early patients required preimplantation vs. 5/8 late diagnosis patients

Wu HH, JMIG 13:403, 2006
Intra-operative Recognition

- What if a clamp is placed across the ureter?
  - Remove clamp
  - Inspect for integrity
  - Stent (2-6 weeks)
  - Drain (7-10 days)
    - Output should be <50 cc/day
    - Check Cr prior to removal (should = serum)
    - Leave longer if necrosis or if devascularized
  - Close peritoneum

Wu HH, JMIG 13:403, 2006

Didn’t see it in the OR…

- Flank pain / CVA tenderness
- Unexplained fever
- Persistent ileus
- Lower abdominal mass (urinoma)
  - U:P Cr = 30-100:1
- Urine leakage from vagina
- Decreased urine output
- Unexplained hematuria

Postoperative Diagnosis of Urinary Tract Injury

- Imaging Studies
  - Cystoscopy
  - CT Cystogram – can sometimes miss subtle findings
  - Renal ultrasound – evaluate for hydronephrosis or retroperitoneal fluid collection
  - Retrograde pyelogram – gives more information on precise location of injury once injury is suspected or confirmed
  - CT Abd/Pelvis

Postoperative Management of Urinary Tract Injury

- Relieve obstruction
  - Retrograde stents
  - If unable to pass retrograde stents, try anterograde stents
  - May need percutaneous nephrostomy tubes
- Treat infection
- Stop urine leakage
  - Consider bladder catheter
Sequelae of Injury

- Ureteral obstruction
  - Can lead to hydronephrosis and kidney injury
- Genitourinary fistula
- Urinoma
- Hematoma, infection, abscess formation, ischemia, necrosis

Indications for urinary stents

- Stents can be placed prior to difficult procedures
- Make identification of ureter easier
- Have not shown reduction in injury
- May decrease unrecognized injury
- Lighted stent cannot be seen when field is illuminated during surgery
- Routine use is controversial:
  - Wood: 7/92 scented patients had oliguria/anuria compared with 0/400 unstinted patients
  - Merritt: Successfully placed in 313/397 patients in 5.4 minutes for experienced surgeons and 8.4 minutes for inexperienced surgeons; complications included UTI, AKI, Fistula (all <2%)

Wood EC, JAAGL 3(3):393, 1996
Indications for urinary stents

- Prophylactic ureteral stents
  - Universal use is not recommended
  - Cost-effective only if ureteral injury rate >3.2%
  - Can be considered in cases where ureteral identification is expected to be challenging:
    - Severe endometriosis
    - Large cervical fibroids
    - Prior pelvic radiation
    - Planned c-hysterectomy


Sound smart... what size stent do you call for?
Sound smart...
what size stent do you call for?

Whistle tip if temporary to find the ureter
Double J if it is indwelling due to injury

Stent length in cm = Ht in inches - 42
5’ 6” = 66 - 42 = 24 cm

Width: 4.8 or 6 French
(1Fr = 1/3 mm)

Universal cystoscopy?

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>n</th>
<th>Injuries</th>
<th>Preop detection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ibeanu, 2003</td>
<td>839</td>
<td>51 (6.1%)</td>
<td>97% detected with universal cysto; missed 1 burn injury</td>
</tr>
<tr>
<td>Vakili, 2005</td>
<td>471</td>
<td>24 (5.3%)</td>
<td>12% ureteral, 3% bladder injuries</td>
</tr>
<tr>
<td>Nguyen, 2014</td>
<td>249</td>
<td>0</td>
<td>n/a</td>
</tr>
<tr>
<td>Sandberg, 2012</td>
<td>1982</td>
<td>5 (0.25%)</td>
<td>Cysto missed 2 bladder injuries; all ureteral injuries in group with no cysto</td>
</tr>
<tr>
<td>Chi, 2016</td>
<td>1848</td>
<td>34 (1.8%)</td>
<td>47% detected intraop, improved compared to historical cohort</td>
</tr>
</tbody>
</table>
Details

- Bladder injuries more common than ureteral injuries (Vakili)
  - 24 urinary tract injuries (5.3%): 17 bladder, 8 ureteral
- Ureteral: prolapse surgery (7.3% vs 1.2%, p = 0.03)
- Bladder: incontinence surgery (12.5% vs 3.1%, p = 0.005)
- Negative cysto does not exclude injury due to burn or partial obstruction (Ibeanu)
- Meta-analysis: 1.6 to 0.7/1000 ureter; 0.8 to 1/1000 bladder
- Hard to show benefit with a rare complication (Nguyen)
- Low risk: 1 [mechanical] complication of 5283 patients reported
- Einarsson: Recommended selective cystoscopy with low threshold - low volume surgeons, complex cases

Confirmed by Decision Analysis

- Quantified cost of routine, selective, or no cystoscopy at the time of benign hysterectomy (open, LSC/robot, vaginal)
- Cost:
  - Selective: + $13.20 - 26.13 over no cysto
  - Universal: + $64.59 - 83.99 over no cysto
- Cysto became cost saving as injury risk increased
  - Selective cysto: cost saving if bladder risk > 4.48% and ureteral risk > 3.96%
  - Universal cysto: cost saving if bladder risk was >20% and ureteral injury >27%
- Modest increase in suspicion for injury should prompt cysto
VENIAL

Slight and pardonable
“The venial sin is the injury of the ureter, but the mortal sin is the failure of recognition.”

- Higgins CC, JAMA 1967

Ureteral repair

- Most require stenting or advanced surgical repair
  - Exception: kinking or ligation of ureter with suture
    - Remove suture
    - Assess integrity of ureter
    - If abnormal or if absent efflux on cystoscopy, patient will need stent placed

Ureteral repair

- Most occur in distal 4-5 cm of ureter: ureteroneocystostomy
Ureteral repair

- If just below pelvic brim: ureteroureterostomy or ureteroneocystostomy
- If above pelvic brim, do NOT do ureteroneocystostomy

Call for help if:

- Thermal urinary tract injury
- Injuries to the trigone
- Delayed diagnosis of injury
- Most ureteral injuries
  - Transection
  - Crush injury
  - Thermal damage
  - Absent or abnormal efflux
Will the ureter heal? Yes - blood supply
Name 5 vessels that supply the ureter...
Ureterolysis

Repair of cystotomy

Bladder Dome:
- <2 mm: expectant management
- <1 cm: repair vs foley for 5-7 days
- >1 cm: repair

2 layers absorbable suture
- 3-0 then 2-0 Vicryl, Monocryl or PDS
- Full thickness
- Interrupted or running
- Barbed suture is fine

Retrograde fill bladder to assess integrity of repair
Repair of cystotomy

- Can be repaired laparoscopically if:
  - Small injury
  - Adequate surgeon expertise
  - Adequate visualization
  - No involvement of trigone or bladder neck

Postoperative Care After Cystotomy

- Bladder decompression with foley catheter for 5-14 days depending on size and location of injury
  - Bladder reepithelializes within 3-4 days, regains normal strength by 21 days
- CT cystogram prior to catheter removal
- Consider voiding trial with foley removal (Fill with 300cc, must void 200 cc), or bladder scan
Prophylactic Antibiotics

• If diagnosed intraoperatively, no additional antibiotics indicated
  – If no surgical prophylaxis abx given (i.e. lsc BSO), give antibiotic to cover Gram negative and enterococci

• Antibiotics for patients who go home with a foley?
  • ACOG: limited evidence to support ciprofloxacin 250 mg from POD2 until Foley out
  • Cochrane: Antibiotics at time of catheterization yields less bacteriuria than prolonged use

Lusardi G, Cochrane Database Syst Rev 2013; :CD005428

Thank you!
References

References

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