Imaging of Urinary Diversion Procedures and Postoperative Complications: Surgical and Radiological Perspectives

Arvind K Shergill\textsuperscript{1,3} MBBS DNB, Seng Thipphavong\textsuperscript{1,3} MD FRCPC, Alexandre R Zlotta\textsuperscript{2,3} MD Phd FRCSC, Nasir Jaffer\textsuperscript{1,3} MD FRCPC

\textsuperscript{1}Joint Department Of Medical Imaging, University Health Network, Mount Sinai Hospital, Women’s College Hospital
\textsuperscript{2}Division Of Surgical Oncology, Princess Margaret Hospital, University Health Network
\textsuperscript{3}University of Toronto, Toronto, ON
Learning Objectives

- To learn the **surgical techniques** of common urinary diversions
- To review the **imaging techniques** and indications for imaging
- To illustrate the **imaging appearances of altered/post-operative anatomy**
- To discuss postoperative **complications**
Urinary Diversions: Background

- **Indications:**
  - Cancer of urinary bladder, prostate
  - Cancer of uterus, ovaries, rectum as part of pelvic exenteration
  - Congenital and acquired bladder dysfunction

- **Choice of surgical procedure depends on:**
  - Age, sex, overall physical status
  - Tumor stage and underlying indication for surgery

- **Procedures:**
  - Both continent and incontinent procedures available

- **Role of Imaging:** *important because...*
  - Surgeries alter normal anatomy
  - Imaging interpretation can be challenging, if the radiologist is unfamiliar with these surgical techniques
**Surgical Techniques**

**Incontinent:**
1. Cutaneous ureterostomy
2. Ileal conduit

**II. Continent:**
1. Cutaneous catheterizable reservoir:
   - Indiana
   - Kock
   - UCLA
   - Ureterosigmoidostomy/Mainz II
   - Mitrofanoff
2. Orthotopic neobladder:
   - W pouch
   - Studer pouch

**Described procedures are highlighted in orange**
Incontinent diversions

**Principle:** Bowel loop used to make conduit and ureters attached
Conduit opens in an external stoma

1. **Cutaneous ureterostomy:**
   - Ureters anastomosed directly to anterior abdominal wall

2. **Ileal conduit:**
   - Ileal segment (15–20 cm) isolated and ureters anastomosed
   - Distal end drains as cutaneous stoma in RLQ
   - Continence and voluntary voiding not possible
# Continent diversions

<table>
<thead>
<tr>
<th><strong>Indication</strong></th>
<th><strong>Complication Risk</strong></th>
</tr>
</thead>
</table>
| ➢ Young oncologic patients with good prognosis  
  ➢ Preserved positive body image and better quality of life | ➢ High due to complex surgical technique |

<table>
<thead>
<tr>
<th><strong>1. Cutaneous Catheterizable Reservoir</strong></th>
<th><strong>2. Orthotopic Neobladder</strong></th>
</tr>
</thead>
</table>
| ➢ Formation of pouch with tapered aperistaltic segment using bowel or appendix  
  ➢ Antireflux and continent mechanism  
  ➢ Intussuscepted nipple valve, appendiceal tunneling technique, tapered or imbricated terminal ileum and ileocecal valve | ➢ Segment of bowel used to create neobladder  
  ➢ Neobladder anastomosed to native urethra, voluntary voiding preserved  
  ➢ Should have *low pressure* to prevent reflux (more important than antireflux re-implantation) |
Indiana pouch

- Right colon isolated with 10 cm segment of terminal ileum
- Ureterocolonic anastomoses done by submucosal technique
- Right colon closed to construct reservoir
- Ileocecal valve doubly imbricated
- Terminal ileal segment tapered as efferent limb
- Efferent limb led through abdominal wall to make flush stoma

Self-catheterization (blue tube) to empty pouch
Ureterosigmoidostomy - Mainz II

- Creation of a low pressure pouch
- High capacity reservoir with detubularization of sigmoid boot and side-side anastomosis
- Ureters implanted via submucosal anti-refluxing tunnel
- Pouch fixed in area of promontory
**Mitrofanoff Technique**

- Segment of colon detubularized and folded to form reservoir
- Appendix anastomosed to reservoir at one end with a cuff of cecum and to the umbilicus at the other end, where patient voids by self-catheterization
- Mostly done in patients with congenital bladder dysfunction
Studer pouch

- 40-65 cm ileal segment detubularized
- Intestinal reservoir made by end-end or side-side anastomosis
- Isoperistaltic afferent limb created using 10 cm proximal ileal segment
- Ureters anastomosed to afferent limb
- Small opening made in distal most pouch and anastomosed to native urethra
## Imaging Techniques

<table>
<thead>
<tr>
<th>CT Urogram (CTU):</th>
<th>Fluoroscopic Techniques:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Non-contrast</td>
<td>- Urinary pouchography or loopogram</td>
</tr>
<tr>
<td>- Nephrographic Phase (80s)</td>
<td>- Scout images obtained for pre-existing ureteric stents</td>
</tr>
<tr>
<td>- Excretory Phase:</td>
<td>- 150-300ml contrast injected through external catheter</td>
</tr>
<tr>
<td>- &gt;=10 min in patients with delayed excretion or obstruction</td>
<td>- Multiple fluoroscopic images obtained in various projections (AP, LAO, RAO)</td>
</tr>
<tr>
<td><strong>CT Pouch Cystogram:</strong></td>
<td><strong>MRI:</strong></td>
</tr>
<tr>
<td>- 100 -200 cc dilute contrast injected into pouch though external catheter</td>
<td>- T1, high resolution T2, diffusion</td>
</tr>
<tr>
<td>- IV contrast</td>
<td>- Post-gadolinium</td>
</tr>
<tr>
<td>- Done for suspected urinoma (pouch leak, ureter-anastomosis dehiscence)</td>
<td></td>
</tr>
</tbody>
</table>
Loopogram - Ileal Conduit

- **Indication:**
  - To exclude leak
  - Assess ureteric strictures

- **Common findings:**
  - Balloon inflated catheter in ileal conduit (*)
  - Ureters (yellow arrows) anastomosed to proximal end (red arrow) of conduit
  - Distal end drains as cutaneous stoma (green arrow)
  - Ureteric reflux and mild bilateral hydronephrosis are expected

*Fig 1. Loopogram*
**Pouchogram - Indiana pouch**

- **Indication:**
  - Acute stage: Exclude leak
  - Late stage: Ureteric strictures

- **Common Findings:**
  - Foley catheter (blue arrow) through IC valve in colonic reservoir (*)
  - Course of left ureter towards ureterocolonic anastomoses (red arrow) is longer
  - Ureteric reflux and mild bilateral hydronephrosis are expected
  - Careful assessment of left ureter for stricture (as it is difficult to assess on CT)

Fig 2. Pouchogram
CT- Ureterosigmoidostomy: Mainz II

- CT is imaging modality of choice
- Pouchogram cannot be done due to antireflux technique
- Common Findings:
  - Sigmoid reservoir (*) filled with urine
  - Ureters usually hard to see, but course needs to be seen to assess small strictures
  - Left ureter (yellow arrows) mildly dilated; not expected

Fig 3. Contrast enhanced coronal, sagittal and MIP CT images
**Contrast study & CT - Mitrofanoff procedure**

- **Common Findings:**
  - Fig 4a:
    - Contrast opacified Mitrofanoff reservoir (yellow arrow)
  - Fig 4b:
    - Urine filled colonic reservoir (*)
    - Ureterocolonic anastomosis (red arrow)
    - Appendix (yellow arrow) anastomosed to reservoir at one end and to umbilicus at the other
CT - Orthotopic neobladder: Studer Pouch

- CT pouch cystogram can be done in this group
- Voluntary voiding preserved
- **Common Findings:**
  - Urine filled Ileal neobladder (*)
  - Small opening in distal aspect of reservoir (red arrow) anastomosed to native urethra (yellow arrow)

Fig 5. Contrast enhanced coronal and sagittal images
Complications of Urinary Diversions

**Early (<30 days)**
1. Intestinal complications
2. Anastomotic leak
3. Collections
   - Urinoma
   - Hematoma
   - Lymphocele
   - Abscess
4. Urinary Obstruction

**Late (>30 days)**
1. Infection
2. Lithiasis
3. Hydronephrosis
4. Herniation
5. Shunt malfunction
6. Anastomotic stricture
7. Renal Failure
8. Pyeloureteritis
   - Ureteritis cystica
   - Malacoplakia
9. Tumor recurrence

**Described complications are highlighted in orange**
Early Postoperative Reservoir Leak

Fig 6a. CECT axial image

Fig 6b. Loopogram

Fig 7. CECT coronal, sag, axial images

- Fig 6a. Urinoma (yellow arrow) surrounding ureteric stent (red arrow) within the ileal conduit, concerning for a leak.

- Fig 6b. Post urinoma drainage study shows contrast leakage (green arrow) from ileal conduit (blue arrow) into space around drainage catheter (red arrow).

- Fig 7. Contrast admixed with fluid (yellow arrows) surrounding colonic reservoir (*), with linear contrast column extending into vagina suggestive of leak.
Stones and Stenosis

Fig 8. Multiple small calculi (yellow arrow) in an ileal conduit.

Fig 9. Stenosis of left uretero-conduit junction (red arrow) with severe left hydroureter (yellow arrow).
**Ureteric Stricture with Pyonephrosis**

**Fig 10a. Axial and coronal CECT images**

- Fig 10a: Moderate left-sided hydronephrosis (yellow arrows), dilated left ureter (red arrows). Attempted dilatation of left ureteric stricture on subsequent nephrostogram, not successful.

- 10b: Same patient presented 1 month later with fever and renal failure. Worsening left hydronephrosis (purple arrows) with left perinephric stranding and uroepithelial thickening (green arrows) and layering hyperdense material in left pelvis indicative of pyonephrosis.
Ureteric Stricture with Intervention

Fig 11a. Coronal & sagittal CECT images

Fig 11b. Nephrostogram (left ureter)

- Fig 11a: Bilateral (L>R) hydrenephrosis, with narrowing of distal left ureter near reimplantation into colonic reservoir (*), concerning for stricture (red arrow).

- Fig 11b: Nephrostogram confirms stricture (green arrow) at left ureteric reimplantation site, ballooning (purple arrow) with subsequent improvement in calibre (blue arrow).
Hydronephrosis leading to Atrophy

- Fig 12a. Moderate bilateral hydronephrosis.
- Fig 12b. 1 Year later: Interval atrophy involving L. kidney (red arrows) with worsening renal function.

**Pearl:** Imaging assessment of progressive hydronephrosis crucial to salvage kidney and renal function with early interventional management.

Mainz II diversion

Fig 12a. Axial and coronal CECT images

Fig 12b. Axial and coronal CECT images 1 year later
**Pyeloureteritis**

- **Fig 13. Axial CECT images**
  - Fig 13. Lt renal pelvis with stent (blue arrow) shows uroepithelial thickening, suggestive of pyelitis secondary to stent malfunction.
  - Rt kidney shows significant hydronephrosis and cortical atrophy.

- **Ureteritis Cystica**
  - Fig 14: Dilated right ureter showing multiple small intramural filling defects (green arrows) suggestive of ureteritis cystica.
Disease Recurrence

- Fig 15a. Irregular intermediate signal intensity thickening (blue arrows) in ileal conduit in a patient with prior cystectomy for bladder cancer.

- Fig 15b. Abnormal region of thickening demonstrates enhancement on the post-gadolinium image (yellow arrows).

- Biopsy proven as tumor recurrence.
Conclusion

A: Surgical Techniques: Thorough knowledge important for proper evaluation, detection and management of early and late complications

B: Imaging:

- **Urinary Diversion Contrast study:** Useful in immediate post-operative phase for assessment of leaks, reservoirs and ureters (which may be difficult to assess on CT)

- **CT Imaging:** Important to diagnose early and late post-operative complications especially in continent diversions

**Pearl: Serial imaging**

- Crucial for assessment of progressive hydronephrosis, which could lead to renal failure

- Early intervention would salvage kidney and overall renal function