FLUOROSCOPIC REVIEW: SPECTRUM OF URETHRAL DISEASE

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DISCLOSURES

- The authors have no conflict of interest or financial gain to disclose.
GOALS AND OBJECTIVES

• Review relevant genitourinary anatomy
• Review fluoroscopic imaging techniques of the lower male urinary tract, including retrograde urethrography, voiding cystourethrography, and cystography
• Illustrate imaging findings of urethral pathology across a spectrum of acute and chronic urethral disease
• Discussion of appropriate use of imaging for diagnosis and management guidance in urethral disease

The target audience of this presentation is medical students and radiology residents, fellows, and attendings.
SPECTRUM OF PATHOLOGY

Acute
- Trauma

Chronic
- Diverticula
- Stricture
  - Fistulae
    - Urethrocutaneous
    - Urethrorectal
    - Urethroperineal
  - Postsurgical complications
    - Leak
    - Recurrent stricture
ANATOMIC REVIEW OF THE LOWER MALE GENITOURINARY TRACT

The male urethra is divided into anterior and posterior segments.

Anterior:
- Penile urethra
- Bulbous urethra

Posterior:
- Membranous urethra
- Prostatic urethra
ANATOMIC REVIEW OF THE LOWER MALE GENITOURINARY TRACT

Anterior:
- Penile urethra
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Posterior:
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Penile urethra (labelled “spongy” on image left):
- Most distal, longest segment, with focal dilation at the glans penis called the “fossa navicularis”
- Iatrogenic strictures occur here

Bulbous urethra (labelled “B” on image left):
- Drainage from glands of Littré/Cowper’s (bulbourethral) glands
- Gonococcal strictures occur here
ANATOMIC REVIEW OF THE LOWER MALE GENITOURINARY TRACT

**Anterior:**
- Penile urethra
- Bulbous urethra

**Posterior:**
- Membranous urethra
- Prostatic urethra

**Membranous urethra:**
- Short, narrow, immobile
- Situated within the urogenital diaphragm
- Particularly vulnerable to trauma

**Prostatic urethra:**
- Most proximal segment
- Receives drainage from paired ejaculatory ducts, the orifices of which are at the "verumontanum" posteriorly along this segment
  - Verumontanum is where obstruction occurs in the setting of posterior urethral valves
- Also vulnerable to trauma

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Retrograde urethrography is the best initial study in imaging of the male urethra, when looking for urethral or periurethral pathology, including trauma, strictures, or fistulae.

Procedure involves the sterile insertion of balloon catheter into the fossa navicularis, with subsequent balloon inflation and occlusion of the distal urethra. Iodinated contrast is then instilled via the catheter under fluoroscopic guidance. Ideally, a small jet of contrast can be seen entering the bladder. Oblique still-exposures are obtained.

Relatively quick and cost-effective exam.

Procedural Pearl:
Alternatively, if indwelling urinary catheter is in place, a small angiocatheter can be inserted alongside the existing catheter to instill contrast in the same retrograde fashion.

Normal retrograde urethrogram, see next slide for details
Retrograde urethrogram performed in a 34 year old man for hematuria following dog bite to the penis reveals normal anterior urethral anatomy to the level of the membranous urethra (arrow) prostatic portion not visualized.

Retrograde urethrogram performed in an 8 year old male for suspected stricture demonstrates normal anterior and posterior anatomy, with contrast entering the bladder (arrow).
Although largely replaced by CT cystography and cystoscopy, conventional cystography remains a viable and valuable fluoroscopic modality in imaging of the bladder across a breadth of pathology, including trauma, bladder dysfunction, and post-surgically.

The bladder is filled with contrast material via a standard transurethral catheter using sterile technique, with fluoroscopic images obtained in frontal and bilateral oblique views. If performed in a post-surgical patient, the volume of contrast to be instilled should be confirmed with ordering provider.

Post-surgical fluoroscopic images from a cystogram performed in a 59 year old man following open cystostomy to remove pencil voluntarily inserted into urethra/bladder. Normal examination.
IMAGING TECHNIQUES OF THE LOWER MALE GENITOURINARY TRACT: **VOIDING CYSTOURETHROGRAPHY**

- While not often used in imaging of the adult male urethra, voiding cystourethrogram(s) are routinely performed in the imaging of the female urethra, and in pediatric patients where posterior urethral valves are suspected.

- Using sterile technique the bladder is instilled with contrast material through a standard transurethral catheter. Once filled, the catheter is either removed or voided out by the patient, and fluoroscopic images are obtained throughout micturition.

- Of note, this is not the ideal imaging modality for the more distal aspects of the adult male urethra (anterior urethra), as these segments do not fully distend during voiding.

**Oblique fluoroscopic images demonstrate normal bladder and posterior urethral anatomy in a 69 year old man imaged for nonspecific penile pain, with an otherwise normal workup. While the anterior urethra also appears to be grossly normal, this is a suboptimal examination for pathology therein.**
ACUTE URETHRAL DISEASE: TRAUMA

- Most widely accepted classification system for urethral injury established by Goldman et al. This system places emphasis on the location of injury, rather than the prognosis and/or treatment (as in the system suggested by the American Association for the Surgery of Trauma). That said, accurate diagnosis directly influences treatment, regardless of the classification system used.

- The Goldman classification system is as follows:

<table>
<thead>
<tr>
<th>Type of Injury</th>
<th>Injury Description</th>
<th>Urethrographic Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Stretching/elongation of the posterior urethra, without disruption</td>
<td>Stretched, intact urethra</td>
</tr>
<tr>
<td>II</td>
<td>Urethral disruption above the urogenital diaphragm, with membranous segment intact</td>
<td>Contrast extravasation above urogenital diaphragm only</td>
</tr>
<tr>
<td>III</td>
<td>Disruption of the membranous urethra, below urogenital diaphragm, and involving the anterior urethra</td>
<td>Contrast extravasation below urogenital diaphragm, may extend to pelvis/perineum, intact bladder neck</td>
</tr>
<tr>
<td>IV</td>
<td>Bladder neck injury, extension into proximal urethra</td>
<td>Extraperitoneal contrast extravasation, bladder neck injury</td>
</tr>
<tr>
<td>IVa</td>
<td>Bladder base injury</td>
<td>Periurethral contrast extravasation, bladder base injury</td>
</tr>
<tr>
<td>V</td>
<td>Isolated anterior urethral injury</td>
<td>Contrast extravasation below urogenital diaphragm, confined to anterior urethra</td>
</tr>
</tbody>
</table>

Retrograde urethrogram performed following penile trauma sustained during intercourse demonstrates isolated anterior urethral injury, type V.

More common pattern of traumatic injury involves the posterior urethra, such as in this case of a straddle injury in a 23 year old man. Contrast extravasates about the membranous urethra, and below the urogenital diaphragm along the bulbous urethra, making this a type III injury.
ACUTE URETHRAL DISEASE: TRAUMA

Unique Case: Follow up retrograde urethrograms performed throughout course of treatment following surgical removal of voluntarily inserted pencil into the urethra and bladder. While fluoroscopic imaging was not obtained at the time of injury, imaging performed at 1, 4, and 5 months intervals demonstrate persisting focal pericatheter contrast extravasation within the bulbous segment of the urethra. Given unchanged, “contained” nature of this leak, the catheter was ultimately removed without necessitating further intervention.
CHRONIC URETHRAL DISEASE: DIVERTICULA

Retrograde urethrogram performed in a 56 year old man with a known posterior urethral stricture shows incidental penile urethral diverticulum (arrow).

39 year old man with history of remote straddle injury and treated gonococcus, with known bulbous urethral stricture demonstrates, shows focal contrast extrusion at the level of the prostatic urethra, consistent with diverticulum (arrow).

Pearls:
- Rare in men
- Congenital vs. acquired (infection, trauma, post-surgical)
- Complications include stone formation and urethral diverticulitis, rupture potential
CHRONIC DISEASE: **BLADDER DIVERTICULA**

- Also commonly seen are diverticula of the bladder. These can also be congenital or acquired, but are more often acquired, and typically seen in males in the setting of bladder outlet obstruction.

- The most common location of bladder diverticula are superolaterally to the ureteral orifices.

- Of note, “Hutch diverticula” are a form of congenital bladder diverticula almost exclusively seen in men, are located at the ureterovesicoureticular junction, and are associated with vesicoureteral reflux.

- While the same complications that afflict urethral diverticula are seen with bladder diverticula, the most concerning is the development of **transitional cell carcinoma** within a diverticulum.
CHRONIC URETHRAL DISEASE: STRICTURES

- Urethral strictures are regions of focal fibrous scarring resulting in narrowing along any segment of the urethra.

Retrograde urethrogram performed in a 65 year old man with hematuria, and otherwise negative workup, showed anterior stricture (arrow), involving the penile segment. Other notable causes of strictures include inflammation (balanitis), infection, and iatrogenic.

One of the most common causes of stricturing is trauma. Above is a case of a 41 year old man with tandem bulbous urethral strictures (arrows) secondary to straddle injury, the most cited injury type.

Pitfall: Don’t confuse physiologic narrowing at the membranous urethra for a pathologic stricture.
CHRONIC URETHRAL DISEASE: STRUCTURES

Imaging performed in a 34 year old man with a remote history of straddle injury demonstrates stricture formation at the bulbomembranous junction. The image on the bottom left is an ultrasound correlate in the same patient, with calipers (“+ +”) measuring the stricture length of approximately 1.3 cm.

Ultrasound is often used adjunctively in strictures involving the bulbous urethra, where it has been found to be more accurate in measuring the length of stricture than conventional urethrography.

Pitfall:
- Be careful not to confuse the filling of normal structures with a urethral disruption or leak. Here we see filling of Cowper’s glands, likely due to backpressure from the stricture (arrow).

Two additional examples of patients with bulbar urethral strictures, both of whom underwent urethral stent placement. The image of the left demonstrates stent failure, with recurrent tandem stenosis along the bulbar urethra (arrows). The image on the right shows subtle, focal contrast extravasation adjacent to the stent, suggesting small leak (arrow).
While numerous types of fistulae involving the lower male urinary tract have been described in the literature, the most commonly encountered are urethrocutaneous, urethreorectal, and urethroperineal. Many etiologies exist, including post-traumatic, post-surgical/post-radiation, and infectious, much like fistulae found elsewhere in the body. Characterization is conventionally based on location.

**Case below:** 55 year old man who underwent surgical repair of hypospadias in childhood, with chronic urethrocutaneous fistula involving the distal penile urethra (arrow). Otherwise noted are post-urethroplasty changes along the proximal anterior and posterior urethral segments.
CHRONIC URETHRAL DISEASE: FISTULAE

Contrast injected via suprapubic catheter in a 77 year old man treated for prostate cancer demonstrates anterograde filling of a proximal urethrocutaneous fistula.

CT correlation of urethrocutaneous fistula, showing contrast extravasation along the anterior aspect of the proximal urethra (posterior urethra) around an existing transurethral catheter.
CHRONIC URETHRAL DISEASE: FISTULAE

Additional case of a 75 year old man, also status-post treatment for prostate cancer, with a urethrectal fistula. Images from retrograde urethrogram (bottom right) show free communication and spillage of contrast into the rectum, where it outlines stool therein.

CT correlation (bottom left) demonstrates impressive fistula tract in communication with the rectum.

Urethrectal fistulae can be congenital in origin, often seen in the setting of imperforate anus, or acquired.
Case below left shows a significant bulbar urethral stricture. Post-urethroplasty pericatheter retrograde urethrogram shows contrast extravasation at the level of previously noted stricture. While stricture has been surgically corrected, the existence of a leak suggests persisting iatrogenic complication. Also noted, posterosuperiorly to the leak, is normal filling of Cowper’s glands, similar to that noted on a previous case.
Despite technologic advances in both radiology and urology, retrograde urethrography and cystography remain a viable and robust source of information in patient’s with urethral disease, and provide a minimally invasive starting point into the initial diagnosis of these patients. That said, as is demonstrated below, such imaging is also able to provide clinicians with a tool in which to evaluate their patients throughout the management of a disease process, which may help to ultimately dictate their care.

Case shows pre and post-operative imaging in a 28 year old man with an idiopathic stricture of the bulbous urethra, with additional focal narrowing at the verumontanum. Post-urethroplasty imaging demonstrates successful repair, without further complication. Catheter was removed, and patient continued to do well clinically.
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