Urethrogram Revisited: A Pictorial Review

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INTRODUCTION

Pathologies involving the urethra and urinary bladder are a significant cause of morbidity, especially in developing countries. The gold standard for the evaluation of urethral pathologies is a retrograde urethrogram (RGU) followed by a micturating cystourethrogram (MCU). The most common indication of performing an RGU is in the diagnosis of anterior urethral strictures. Assessment of the location, length, severity, and concomitant urethral pathologies can be done based on RGU. Delineation of posterior urethral and bladder pathologies can be made only with MCU.

MATERIALS AND METHODS

This was a retrospective single-institution study wherein uroradiological evaluation was done over a 5-year period (from January 2011 to December 2015). A total of 252 patients were included in the study (mean age of 43.2 years). Of the 252 cases, there were 38% urethral and bladder diverticulum, 22% urethritis, 20% cases of posterior urethral valves (PUV), and 4% fistulas (including urethra - perineal, rectourethral and vesicovaginal fistulas). The rarer nontraumatic pathologies including prostatic urethre, urethral polyps, bladder neck obstruction, hypospadias, anterior urethral valve, vesical calculus constituted 7% of the cases.

Traumatic pathologies like urethral injury and intra/extraperitoneal bladder rupture constituted the rest 9% of the total cases.

Urethrogram Protocol

A scout film is first taken to detect the presence of any bony abnormalities, calcification along the urinary tract, etc. The external meatus is then prepared under sterile precautions, and the penis is then placed laterally over the proximal thigh with moderate traction. Thereafter, the patient is positioned in a supine oblique position and contrast is injected in a retrograde fashion following which spot images are obtained. 76% urografin (20-25 ml) diluted with normal saline in 1:1 ratio is injected per urethra. Slow and gentle pressure is to be used while injecting the contrast to overcome the resistance encountered due to spasm of the external urethral sphincter and also to prevent contrast extravasation.

In our institute, RGU is followed by MCU which involves instillation of 40-50 ml of contrast diluted in normal saline using an infant feeding tube or suprapubic catheter (in the case of meatal stenosis) to assess the posterior urethra and bladder. Once the bladder is distended, voiding films are taken after positioning the patient in right and left anterior oblique positions. The oblique position is for the optimal
visualization of the bulbar urethra and to avoid superimposition of the urethra on the pubic symphysis.

This is followed by a post void residue (PVR) assessment as a significant correlation was found between PVR and prostate volume. There was increased odds of prostatomegaly and urinary retention in patients with PVR greater than 50 ml.³

The sensitivity and specificity of RGU in detection of urethral stricture according to the current literature are 75-100% and 72-97%, respectively.⁴

This article reviews the imaging findings of some of the uncommon pathologies (traumatic and nontraumatic) of urethra and urinary bladder diagnosed in our institute.

**Urethroperineal Fistula (UPF)**
UPF involves the presence of a fistulous tract extending from the prostatic urethra to the perineal surface with the tract being ventral, this tract being stenotic at the level of the perineum. The differential diagnosis for this condition is urethral duplication, in which the ventrally positioned urethra is the functional tract.³ The principal diagnostic modality for distinguishing the two conditions is MCU and a fistulogram. In UPF while micturiting, the main urinary stream will be from the meatal opening while in the case of urethral duplication the main urinary stream will be from the perineal opening⁶ (Figure 1).

**Rectourethral Fistula**
Culp and Cahoon system classifies rectourethral fistulas based on etiology: Congenital, iatrogenic, traumatic, neoplastic, and inflammatory.⁷ The most common causative factors of rectourethral fistulas are pelvic fractures and iatrogenic causes (post urethral instrumentation and prostatectomy). Urethrocetal fistulas occurring post radical prostatectomy are usually seen at the vesicourethral region.⁸ The clinical presentation is meconium stained urine in children and recurrent urinary tract infection, urine per rectum, fecaluria, hematuria, and infection of the seminal vesicles.⁹

**Imaging findings**
The confirmatory test is urethrogram and in addition to the normal oblique views, a lateral view is required to demonstrate the fistulous tract⁸ (Figure 2).

**Vesicovaginal Fistula**
It is the presence of an abnormal fistulous tract between bladder and vagina usually as an iatrogenic complication (post hysterectomy/obstructed labor/post radiotherapy), pelvic malignancies, etc. The patient usually presents with symptoms such as continuous leakage of urine from the vagina. It is imperative to confirm the origin of the urinary leak, i.e., bladder, ureter or urethra.¹⁰

**Imaging findings**
In the case of any genitourinary fistula, the diagnostic modality of choice is cystourethrography followed by intravenous urogram to detect the anatomic origin of leak and for the detection of any other concomitant fistula. Before the procedure, gauze is inserted into the vagina to detect contrast leakage. Another prerequisite is a standard lateral film to delineate the fistulous tract¹¹ (Figure 3).

**Hypospadias**
Hypospadias refers to the ventral location of the urethral opening in male children. The classification is based on the location of the urethral opening namely: Proximal, mid and distal. The severity of this anomaly depends on the position of the urethral meatus with the perineal type being the
most severe. There is a correlation between hypospadias and the occurrence of prostatic utricle cyst. The surgical repair of the hypospadias involves urethroplasty and orthoplasty for chordee – a feature commonly associated with hypospadias.

**Imaging findings**
The diagnosis of hypospadias is made by clinical examination, and imaging is done to confirm the diagnosis and also look for the presence, position, and size of the utricle cyst (Figures 4 and 5).

**Urethral Polyp**
Polyps present mainly as filling defect in the urethra with its spectrum ranging from benign to malignant pathology and are a rare cause of bladder outlet obstruction.

Congenital polyps are usually benign comprising mainly vascular connective tissue. The fibroepithelial polyps are usually benign and are associated with the presence of congenital urinary tract anomalies.

It is difficult to differentiate between benign and malignant lesions radiologically as both present with filling defect within the prostatic urethra (Figure 6).

**Prostatic Utricle**
The prostatic utricle or the “Utriculus masculinus,” a homolog of the uterus and upper vagina in the female is a Mullerian duct remnant located in the verumontanum between the two openings of the ejaculatory ducts. It communicates freely with the urethra. This condition is associated with hypospadias (esp. perineal hypospadias) and intersex problems. A common differential is the Mullerian duct cyst, which is rounded in shape, not communicating with the prostatic urethra and shows no association with hypospadias. The diagnostic test of choice is magnetic resonance imaging (MRI) with an endorectal coil. The posterior sagittal rectum-retracting

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**Figure 3:** Micturating cystourethrogram (lateral view) showing a fistulous connection between bladder and vagina

**Figure 4:** Retrograde urethrogram showing pan narrowing of anterior urethra with evidence of mid shaft hypospadias

**Figure 5:** Retrograde urethrogram showing glandular hypospadias with meatal stenosis

**Figure 6:** Retrograde urethrogram showing filling defect in the prostatic urethra
approach is one of the most suitable approaches for the surgical management of this condition while non-surgical treatments include transurethral cyst catheterization and aspiration, cyst orifice dilation, unroofing, sclerotherapy, and electrofulguration.20

**Imaging findings**

A large prostatic utricle is more often associated with male hypospadias with there being a strong correlation between its size and severity of hypospadias.12 MCU and RGU define the utricular size and its origin from the prostatic urethra (Figure 7).

The other common differentials are:
1. Ectopic ureter
2. Dilated ejaculatory duct
3. Extravasation.

**PUV**

PUV is a common cause of lower urinary tract obstruction especially in male infants with the main pathology being the presence of an obstructing membrane in the posterior urethra. It was first classified by Young, with the commonest type being Type 1 and Type 3 being the least common.

The Types I and II valves arise from the verumontanum and attach to the lateral walls of the urethra and bladder neck, respectively, while the Type III valves comprise a circumferential diaphragmatic leaflet with a central hole.21

**Imaging findings**

The main imaging modality is MCU22 with the imaging findings being the presence of a dilated posterior urethra (keyhole sign)23 and a narrow anterior urethra, bladder trabeculations or a thick walled bladder due to chronic obstruction.15 The confirmatory test is cystourethroscopy which is also used to confirm presence of any other coexisting pathology like megaloureter, urethral duplication, and urethral diverticulum.22

Valve ablation and valve resection are the treatment of choice after normalization of the renal parameters22 (Figures 8 and 9).

**Bladder Neck Obstruction**

This condition occurs when the bladder neck fails to open adequately during micturition resulting in a poor voiding stream.24

Many theories have been proposed for the etiology of this condition such as the abnormal arrangement of detrusor trigonal muscle and sympathetic nervous dysfunction.25 This condition can be further classified into 3 types, i.e., classic high-pressure low flow, normal pressure with low flow with narrowing at the bladder neck and delayed opening of the bladder neck.26 The main radiological finding is narrowing at the vesical neck in MCU. The
diagnosis is confirmed with set criteria of detrusor contraction (any value) in addition to the radiological diagnosis. Another diagnostic criteria were proposed by Chassange et al. comprising detrusor pressure of greater the 20 cm H₂O and a low flow (Q max) of 15 ml/s. Treatment strategies include alpha blockers (esp. in young patients) and transurethral bladder neck incision. However, retrograde ejaculation is a major post-operative complication (Figure 10).

Urethritis

It is the leading cause of sexually transmitted disease with the broad classification given as; gonococcal and nongonococcal urethritis; chlamydia trachomatis being the most common cause of the latter.

The imaging modality of choice is RGU and it is primarily used for diagnosing complications such as include urethral stricture, peri-urethral abscess, and peri-urethral fistula.

Imaging findings

Irregular long segment stricture with or without the dilatation of Littre’s glands is the most typical finding in gonococcal urethritis. If the stricture extends to the membranous urethra, resection of the distal urethral sphincter is the treatment of choice, thus causing urinary incontinence as a post-operative complication. Conservative management includes immediate suprapubic urinary drainage and administration of appropriate antibiotics. In the case of complications like peri-urethral abscess, surgical abscess debridement is required. Complications of peri-urethral abscess include urethra-perineal fistulas causing “watering can perineum,” pseudodiverticulum formation in the case of urethral communication with a peri-urethral abscess (Figure 11).

Urethral Diverticulum

A urethral diverticulum is a saccular dilatation arising from the true urethral lumen. The diverticula can be classified as single/multiple, uni/multilocular or saddle diverticula (if it encircles the urethra). Coexisting conditions associated with the development of diverticulum are the presence of urethral stricture, trauma, infection, etc.

Proposed mechanisms for its development are related to increased urethral pressure, urethral fibrosis secondary to ischemia (especially post catheterization), etc. In males, MCU is imaging modality of choice while in females, MRI is used for its evaluation.

Imaging findings

The location of the diverticulum, neck size, volume, and the presence of any other urethral pathology are the factors to be considered for evaluation.

In females, the differential diagnosis of a urethral diverticulum includes vaginal cyst (Gartner duct cyst, paramesonephric or Mullerian duct cyst, epithelial inclusion cyst), ectopic ureterocele, endometrioma, and urethral tumors. The management is conservative, i.e., treatment with antibiotics in case of small diverticula while large diverticula require surgical correction (Figures 12-14).

Anterior Urethral Valve/Mucosal Flap

This is an uncommon cause of urethral obstruction and the obstruction is due to a prominent semilunar fold in either the bulbous or penile urethra, the most common location being the penoscrotal region. Its incidence is 30 times less common than PUV. There is dilatation of the proximal urethra eventually leading to the formation of a saccular diverticulum. The most commonly used surgical option is open excision of the valve/diverticulum with urethral repair with an excellent long-term prognosis. The common differential diagnosis includes congenital urethral
diverticulum, dilatation of Cowper’s gland, post-surgical/traumatic urethral stricture.

**Imaging findings**
MCU is imaging modality of choice in anterior urethral valve with evidence of dilatation of the anterior urethra with a small flap-like valve. There can also be associated findings of a saccular diverticulum and VUR. Obstruction by the valve can lead to difficulty in catheterization with the catheter entering the diverticulum (Figure 15).

**Vesical Calculus**
Bladder calculi are a common cause of urinary obstruction. The radio-opacity of the stone is determined by its composition, the usual composition being a mixture of calcium oxalate and calcium phosphate. Uric acid vesical calculi are usually radiolucent and multiple. The typical appearance of a calcium oxalate stone is the presence of speculation, and hence, it is called a jack stone calculus. Calcium phosphate and struvite stones are usually laminated and associated urinary infections. A major risk factor for the development of vesical calculi is urinary stasis secondary to infection or diverticula. Dumb-bell calculus usually develops in such cases with one part in the bladder and one part in the diverticulum.

**Imaging findings**
Radiopaque calculi are usually visualized in plain radiographs while radiolucent calculi can be detected by the presence of a filling defect post contrast administration. However, this needs to be differentiated from a bladder mass and prostatic enlargement. A key differentiating feature between bladder mass and calculus is the presence of mobility with position, in the case of calculi. In a plain radiograph, the presence of radio dense foci in pelvis could also represent phleboliths (Figure 16).

**Urethral Injury**
Post pelvic trauma urethral injuries are usually assessed by urethrography. Urethral injury is suspected if the patient
presents with hematuria, perineal swelling, difficulty in voiding, etc., (urethral injuries after pelvic trauma).

For the effective management of these injuries, a revised classification system was proposed by Goldman et al. based on the anatomic location of the injury.

The classification of urethral injury is as follows: 
I. Posterior urethra intact but stretched but urethral continuity is maintained
II. Partial or complete pure posterior injury with tear of membranous urethra above the urogenital diaphragm
III. Partial or complete combined anterior/posterior urethral injury with disruption of the urogenital diaphragm
IV. Bladder neck injury with extension into the urethra,
   IVA-injury of the base of the bladder with peri-urethral extravasation simulating a true Type IV urethral injury
   V-partial or complete pure anterior urethral injury (Figures 17-19).

**Bladder Rupture**

Bladder rupture is usually seen in context of pelvis trauma esp. in a full bladder state with the patient presenting with symptoms such as gross hematuria, increasing abdominal girth, and lower abdominal tenderness.

Bladder injury was characterized by Sandler et al. on the basis of anatomic location and degree of wall injury:

Type 1: Simple bladder contusion.
Type 2: Intraperitoneal rupture.
Type 3: Interstitial bladder injury which shows the presence of contrast material dissecting into the bladder wall.
Type 4: Extraperitoneal rupture.
Type 5: Combined intraperitoneal and extraperitoneal rupture.

In terms of treatment, Types I and III are managed conservatively with a Foley’s catheter while Type II is managed surgically (Figure 20).
periureteric/Hutch diverticulum. This is usually associated with VUR as the diverticulum alters the normal slanted anatomy of the ureteric orifice.\textsuperscript{35} These diverticula are diagnosed using MCU and also classified as wide and narrow necked based on the width of the diverticular neck. The primary or congenital diverticula are usually caused due to congenital defect in the muscle.\textsuperscript{36} The presence of multiple diverticula (acquired type) usually seen in patients with infravesical obstruction or neurogenic bladder giving it a trabeculated bladder (“pine cone bladder”)\textsuperscript{37} (Figures 21 and 22).

**CONCLUSION**

Thus to conclude, conventional techniques such as RGU-MCU form an integral component for the evaluation of anterior and posterior urethral pathologies. The next step in assessment for surgical planning involves cross-sectional imaging modalities such as CT and MRI.

**REFERENCES**


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