Pictorial essay: Congenital anomalies of male urethra in children

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Abstract
Congenital anomalies of the male urogenital tract are common. Some lesions like posterior urethral valve or anterior urethral diverticulum tend to present early in infancy and are often easily diagnosed on conventional contrast voiding cystourethrograms. Other conditions like posterior urethral diverticulum or utricle can be relatively asymptomatic and therefore present late in childhood. We present the spectrum of imaging findings of common and uncommon anomalies involving the male urethra. Since the pediatric radiologist is often the first to make the diagnosis, he or she should be well aware of these conditions.

Key words: Congenital urethral anomalies; intravenous urogram; voiding cystourethrogram

Introduction
Congenital anomalies of the urogenital tract are among the commonest anomalies found in the fetus, neonate, and infant.[1] Most of these anomalies can be easily diagnosed by conventional contrast voiding cystourethrogram (VCUG), retrograde urethrogram (RGU), intravenous urography (IVU), or nuclear imaging, and can be successfully treated with a good outcome. Hence, the radiologist should be aware of not just the common but also the uncommon congenital anomalies and their imaging correlates; this requires a good knowledge of the anatomy and embryology of the genitourinary tract.

Of the congenital anomalies of the urogenital tract, many involve the male urethra [Table 1], sometimes with associated anomalies of the external genitalia or anorectal malformations. This article attempts to give a pictorial overview of the congenital anomalies of the male urethra in children.

Table 1: Congenital anomalies involving the male urethra

| Congenital anomalies involving the male urethra |
|------------------------------------------------|
| Absent phallus/ agenesis of urethra[3]          |
| Hypospadias                                     |
| Epispadias-exstrophy complex                     |
| Congenital urethral duplication                  |
| - Partial duplication                            |
| - Complete duplication                           |
| - Duplications of urethra as a part of complete caudal duplication |
| Congenital urethral fistulae                     |
| - H type urethral fistula                        |
| - Rectourethral fistula/ anourethral fistula with anorectal atresia |
| Posterior urethral valve                         |
| Anterior urethral valve                         |
| Diverticulae                                    |
| - Posterior urethral diverticulum                |
| - Anterior urethral diverticulum                 |
| Congenital megalourethra                        |
| - Scaphoid megalourethra                        |
| - Fusiform megalourethra                        |
| Prune- belly syndrome                            |
| Posterior urethral polyp                        |
| Prostatic utricle                               |
| Congenital meatal stenosis                      |
| Congenital urethral stenosis                    |

Embryology
The male urethra can be divided into a proximal pelvic urethra and a distal phallic urethra. The pelvic urethra (prostatic and membranous urethra) develops from the urogenital sinus. The phallic urethra (bulbar and penile part) develops from the degeneration of the urethral plate and ventral fusion of the urethral folds between the 8th and 12th week of gestation.[2]
Congenital Conditions

Hypospadias
Hypospadias is the most common congenital urethral anomaly. It is sometimes associated with other urogenital abnormalities. The urethral meatus is located on the ventral surface, anywhere from the penile shaft to the penoscrotal region, and is associated with a dorsal chordee [Figure 1].

Epispadias
Epispadias can be isolated or seen as part of the extrophy–epispadias complex. The urethral meatus is located dorsally on the penile shaft [Figure 2]. In severe forms associated with extrophy, there is a deficient lower anterior abdominal wall and anterior urinary bladder wall, a small phallus, and widely divergent pubic bones [Figure 3]. The ureters take an abnormal lateral and upward curvature at the terminal part to give a hooked or “Hurley-stick appearance.”

Congenital urethral duplication
Urethral duplication can be divided into the following types:

- Type I, blind and incomplete
- Type IIA, complete patent duplication, with two meati
- Type IIB, complete patent duplication, with both the urethrae joining distally and opening through a single meatus
- Type III, urethral duplication occurring as part of a very rare anomaly termed complete caudal duplication. In complete caudal duplication, the bladder is usually completely divided in the sagittal plane, each half receiving one (ipsilateral) ureter and having a separate urethra [Figure 4 A-B]. Rarely, there may be a single urethra leading to outlet obstruction of one of the bladders. Urethral duplication commonly occurs in the sagittal plane, though rare cases of duplication in the coronal plane have also been reported. Duplication of the urethra could be partial [Figure 5] or complete [Figure 6] and either hypospadiac or epispadiac [Figure 7], depending on the relation of the accessory channel with the orthotopic urethra. In the rare epispadiac type, there is a dorsal accessory urethral opening and the child is usually incontinent.

H- or N-type recto- or anoprostatic urethral fistula
This is an extremely rare type of anorectal malformation. There is a fistulous communication between the prostatic urethra and the anterior wall of the rectum or anus. Typically, the urethra distal to the site of the fistula is narrow and stenotic, resulting in a poor urinary stream. Some

![Figure 1: Penile hypospadias with meatal stenosis in a 10-year-old male presenting with a short phallus and thin urinary stream. An oblique VCUG image reveals a uniformly dilated urethra up to the tip (arrows) and abrupt narrowing of the urinary stream at the hypospadiac meatus (arrowhead).](image1)

![Figure 2: An oblique VCUG image of a young male shows a short epispadiac urethra opening on the dorsal surface of the penile shaft (arrow).](image2)
Figure 5: Hypospadiac type of partial urethral duplication (Effmann type IIA2) in a 12-year-old boy with a history of a double urinary stream. An oblique VCUG image reveals two separate meati, two incomplete urethral channels joining at the posterior urethra. The ventral hypospadiac channel is of normal caliber (arrow), whereas the orthotopic dorsal one has a small caliber (curved arrow).

Figure 6: Hypospadiac type of complete urethral duplication (Effmann type IIA1) in a child presenting with passage of urine through a preanal opening and absence of micturition through the normal urethral meatus. An oblique RGU image performed from both the meati reveals a dorsal orthotopic channel of narrow calibre (arrow), with a ventral channel (curved arrow) originating separately from the bladder.

studies suggest that the ventral urethra is usually functional in all cases of hypospadiac urethral duplication, whereas in congenital urethroperineal fistula the dominant urinary stream is through the dorsal orthotopic channel.\[11\]
Rectourethral fistula associated with anorectal malformation
Congenital rectourethral fistula is usually associated with the high and intermediate type of anorectal malformations. A contrast study, either through the colostomy or via retrograde urethrography, demonstrates the fistulous tract in most patients. The fistulous communication is between the blind-ending rectum and either the bulbar urethra [Figures 8 and 9] or, more commonly, the prostatic urethra.\[10,12\]

Posterior urethral valve
Posterior urethral valves (PUVs) are the commonest cause of bladder outlet obstruction in a male child.\[2\] This condition may be diagnosed antenatally, in the neonatal period, or later, with the age at presentation depending on the degree of obstruction. Though earlier divided into three types,\[13\] currently only one type (formerly called type I) is recognized. PUVs can only be diagnosed with a VCUG and not with retrograde urethrography. VCUG shows a disproportionately dilated posterior urethra, with an abrupt transition into a narrow anterior urethra, bladder neck hypertrophy, and trabeculation/sacculation of the bladder [Figures 10 and 11], usually with a small capacity; also, there may or may not be associated vesicoureteric reflux. In high-grade obstruction, a neonate may present with perirenal urinoma, dysplastic kidneys, or urinary ascites.\[14,15\] Nowadays, the entity is termed congenital obstructive posterior urethral membrane (COPUM).

Posterior urethral polyp
Posterior urethral polyp, a rare cause of intermittent urethral obstruction,\[16\] is an elongated pedunculated polypoid lesion attached to the verumontanum. On VCUG, the lesion appears as a lucent filling defect that moves downwards during micturition.

Prostatic uricle
The prostatic uricle is a small, blind-ending midline pouch arising from the prostatic urethra at the level of the verumontanum [Figure 12]. It represents the remnant of the caudal end of the fused Müllerian ducts.\[17\] A large prostatic uricle may be associated with urinary retention, stasis, and infection. It can be associated with hypospadias or the prune belly syndrome.\[18\]

Posterior urethral diverticulum
Most posterior urethral diverticulae are acquired in origin and lined with columnar epithelium or granulation tissue. A congenital posterior urethral diverticulum is a rare entity [Figure 13]. A large diverticulum may be complicated by urinary stasis, infection, and calculi formation.

Anterior urethral diverticulum
An anterior urethral diverticulum is a saccular outpouching arising from the ventral surface of the anterior urethra. Two types are described. Most commonly it arises from the ventral surface of the bulbar urethra [Figures 14 and 15]. The other rarer type is found located near the penile tip.
Figure 9: Rectobulbar fistula with anorectal agenesis in an 11-month-old male child who had no anal opening and a history of urethral passage of meconium. A contrast cologram performed through a sigmoid colostomy revealed a fistulous communication between the rectum and the bulbar urethra (arrow), along with agenesis of the distal rectum and anal canal.

Figure 10: Posterior urethral valve in a 7-year-old male child. An oblique VCUG image shows a dilated posterior urethra (arrow) with an abrupt transition to a normal-calibre anterior urethra. Note the bladder neck hypertrophy, the irregular trabeculated bladder wall, and the left-sided grade III vesicoureteric reflux (curved arrow).

Figure 11: Posterior urethral valve in a newborn. An oblique VCUG image shows a dilated posterior urethra (arrow) and a trabeculated urinary bladder.

Figure 12: Prostatic utricle. Oblique RGU image reveals a blind-ending outpouching, filled with the contrast, arising from the prostatic urethra (arrow). The anterior urethra appears normal.

Jana, et al.: Congenital urethral anomaly
Anterior urethral diverticulum

Anterior urethral diverticulum is a congenital anomaly with an incidence of 1 in 50,000. It is the most common congenital urethral anomaly. There are two types of anterior urethral diverticulum: a wide-necked diverticulum, which usually presents with obstruction and is more prone to calculus formation, and a narrow-necked diverticulum, which is more likely to cause external compression of the penile urethra, leading to a poor urinary stream.

Anterior urethral valve

Anterior urethral valve is a posteriorly directed semilunar fold arising from the floor of the anterior urethra and causing urethral obstruction during micturition. On imaging, it can mimic an anterior urethral diverticulum, but the posterior lip is absent in a valve.

Congenital megalourethra

This is a rare congenital anomaly resulting from the faulty development of the corpora cavernosa and corpus spongiosum. Two types are described. The milder and commoner form, scaphoid megalourethra, results from a localized underdevelopment or deficiency of the corpus
spongiosum [Figure 17],[22-23] with intact corpora cavernosa. Fusiform megalourethra is the rarer, more severe, form in which there is deficiency of the corpora cavernosa as well as the corpus spongiosum,[22-24] resulting in diffuse dilatation of the penile urethra [Figure 18].

**Prune belly syndrome**
This refers to a constellation of anomalies, including lax abdominal wall musculature, cryptorchidism, and various lower urinary tract anomalies.[25-27] The posterior urethra is typically dilated, high-placed, and tapered distally; the appearance may mimic a posterior urethral valve [Figure 19 A–C].

**Congenital meatal stenosis**
Congenital meatal stenosis is most frequently associated with hypospadias. On VCUG, the entire urethra up to the meatus is dilated [Figure 1].

**Conclusion**
A number of congenital conditions can affect the male urethra, and the diagnosis is predominantly based on VCUG, RGU, and USG. Congenital causes of urethral obstruction like PUV can be diagnosed on antenatal USG or MRI. Though VCUG may be essential for diagnosis, radiation issues should be taken into consideration when performing the investigation in a newborn or an infant.
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