Congenital and Iatrogenic Incontinence: Ectopic Ureter, Ureterocele, and Urogenital Sinus

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21.1 Ectopic Ureter

21.1.1 Embryology

During fetal development, the ureters and the collecting system of the kidneys differentiate from the ureteric bud. At about 28 days of gestation, the ureteric bud develops from the caudal end of the mesonephric duct in response to signals from the metanephric mesenchyme. Bifurcation of the ureteric bud occurs after the developing bud penetrates the metanephric mesenchyme and begins proliferating into the primitive collecting system. Direction of development of the ureteric bud has been demonstrated by manipulation of Gdnf and the Ret receptor, Foxc1/2, Bmp4, Eya1, and Hox11 and expression of other molecules implicating their involvement in appropriate maturation and location. Failure of the interactions between the ureteric bud and nephrogenic and stromal mesenchyme can cause renal agenesis. Early bifurcation of a single ureteric bud causes a bifid ureter which joins into one ureter distally before entering the bladder.

Should the mesonephric duct have two distinct ureteric buds develop, complete duplication occurs as each bud independently penetrates the metanephric mesenchyme. The upper pole of the kidney is induced by the cranial bud, and the lower pole is induced by the caudal bud. As development continues, the common excretory duct enters the posterior wall of the urogenital sinus. The caudal ureteric bud is incorporated first, and earlier incorporation allows for more migration laterally within the bladder. The cranial bud is incorporated at a later stage and has less time for migration. As a result, this ureteral orifice is located more medially and caudally.
within the bladder or sometimes ectopically located into any structure that derives from the caudal mesonephric duct. This relationship between the two ureteral orifices is constant and called the Weigert-Meyer rule. Abnormal insertion sites of ureters into the urogenital sinus may be asymptomatic or be associated with vesicoureteral reflux, incontinence, obstruction, or recurrent infections.

In males, ectopic ureters insert above the external sphincter muscle; therefore, incontinence does not occur. Common sites of insertion of an ectopic ureter are the bladder neck, prostatic urethra, ejaculatory duct, vas deferens, and seminal vesicle. For females an ectopic ureter may insert into the bladder neck, vestibule, vagina, or uterus as these are the differentiated organs of the caudal mesenteric duct. Because some of these insertion sites are distal to the external sphincter mechanism, incontinence may occur. If both right and left ureters in single system kidneys fail to incorporate into the posterior bladder wall, then the trigone and bladder neck do not develop properly. In this scenario, an incompetent bladder outlet leads to poor bladder capacity and incontinence. Although incontinence from a unilateral ectopic ureter occurs only in females, it should be noted that males may be incontinent if bilateral single system ureters fail to enter the bladder properly.

While the majority of ectopic ureters are associated with duplicated systems, ectopy can occur with single systems. During development, a single ureteric bud that is located in a more cranial position, and is carried with the mesonephric duct, will migrate ectopically. Single system ectopic ureters are more commonly seen in males and are associated with a higher incidence of associated anomalies. When an ectopic ureter from a single system is unilateral, then the bladder neck is likely intact, and incontinence relates to the insertion of the ectopic ureter. In the situation where bilateral ectopic ureters are associated with a single system, the bladder neck is compromised, and severe incontinence is seen.

### 21.1.2 Clinical Presentation

Ectopic ureters occur more often in females and can be associated with draining a single kidney or more commonly with draining a duplex kidney, which occurs 80% of the time [1, 2]. When the ureteral orifice is above the external sphincter in the bladder neck, incontinence is less likely. Obstruction of the ureter, however, can occur due to increased surrounding musculature of the bladder neck, which is contracted most of the time. More than half of girls present with persistent urinary leakage even though they have been appropriately toilet trained without feeling urgency or incomplete emptying [3]. The incontinence may only occur when standing if the ureter is able to accommodate urine while the child is supine. For those not presenting with incontinence, an ectopic ureter may be discovered in evaluation of hydronephrosis, frequent urinary tract infections, cysts within the vestibule, foul odors, or purulent discharge from the perineum. Infections may occur with low-grade fevers with periodic spikes [4]. In females, continuous leakage is the symptom that most often prompts investigation of a possible ectopic ureter.
Since males do not experience urine leakage due to an ectopic ureter, presentation can vary. Complaints include recurrent epididymitis, frequency of urination due to persistent urine in the posterior urethra, recurrent UTI, prostatitis, and calculi. For those children with the rare condition of bilateral ectopic ureters draining single systems, presentation consists of other genital, renal, anal anomalies and incontinence [5]. The incontinence in this scenario is generally more continuous and severe than that occurring with an ectopic ureter draining a duplex system.

### 21.1.3 Diagnosis

Diagnosis of an ectopic ureter may prove to be difficult due to the presence of non-specific symptoms or the absence of symptoms. Because the ectopic ureter does not drain into the bladder, the urine culture may be negative in the presence of infection [6]. Imaging usually starts with an ultrasound, but VCUG can also be helpful. Ultrasound is useful for diagnosis of ectopic ureter by visualizing a dilated ureter, and occasionally one can identify the insertion at the bladder neck or more distally (Fig. 21.1). Hydroureter associated with an upper pole moiety of a duplicated renal unit in the absence of a ureterocele is most commonly caused by an ectopic ureter. Because ectopic ureters have a high association with a nonfunctional moiety in males [7], ultrasound may show a dilated ureter to this unit. VCUG may be suggestive of an ectopic ureter which inserts into the bladder neck or urethra showing reflux only upon voiding. Isolated reflux into the upper pole of a completely duplicated system is diagnostic of an ectopic ureter (Fig. 21.2).

The identification of unilateral and bilateral single ectopic ureters may require supplemental tests or invasive procedures. If ultrasound and VCUG are not conclusive, alternative imaging studies such as MRI, CT, vaginogram, vasogram, or IVP may be useful. Cystoscopy or vaginoscopy with an exam under anesthesia may be needed. In the rare instance of bilateral single ectopic system ureters, a VCUG would show an open bladder neck and a small bladder. The ureters may or may not reflux. Cystoscopy in these patients will show a small capacity bladder and funnel-shaped bladder neck [4].

![Fig. 21.1 Ultrasound of an ectopic ureter associated with a duplicated system. (a) Shows hydronephrosis of an upper pole moiety; (b) demonstrates a large dilated ureter located behind the bladder](image-url)
21.1.4 Intervention

It is important to note that surgical treatment of an ectopic ureter should be individualized, as patients have variations of complex anatomy and function. When planning surgery, one must consider the function of the associated renal unit. For those single system ectopic ureters associated with a poorly functioning renal unit, nephroureterectomy is appropriate with attempt to remove as much of the ectopic ureter as possible [8]. This may be more effectively accomplished with a laparoscopic or robotic approach. Patients with functional renal units associated with single system ectopic ureters are candidates for reimplantation into the bladder. Functional status must also be assessed in a duplex kidney associated with ectopic ureter. For those without adequate function, partial nephrectomy is performed [9]. The goal with a functional renal unit is diversion of urine from the upper pole into the lower pole system via ureteropyelostomy or ureteroureterostomy. Surgical intervention for unilateral ectopic ureters provides a high rate of dryness following the procedure [4]. The use of dextranomer/hyaluronic acid subureterically for vesicoureteral reflux for ectopic ureters with entrance at the bladder neck is not recommended, as studies have shown low success rates in this scenario [10]. Bilateral single ectopic ureters with incompetent bladder necks and incontinence are intricate cases. Depending on the degree of bladder outlet incompetence and bladder capacity, surgical correction
can range from ureteral reimplantation to bladder neck reconstruction with or without augmentation to urinary diversion to achieve continence.

21.2 Ureterocele

21.2.1 Embryology

A ureterocele is a cystic dilation of the intravesical portion of the ureter. In 1927, Chwalle postulated the embryologic origin of a ureterocele was the persistence or incomplete dissolution of a distal membrane that separates the ureteral bud from the urogenital sinus, known as the Chwalle’s membrane, leading to the formation of a ureterocele. More recent investigations have brought forth the idea that the Chwalle’s membrane may be a derivative of luminal cells in the ureter undergoing apoptosis at a late stage [4]. Delayed development of a lumen in the ureteral bud with the mesonephric duct may cause expansion of the ureter into the bladder [11]. Although both models provide partial explanation of ureteroceles, neither accounts for all anatomic variations seen. Ureteroceles may be associated with a single system or a duplex system.

21.2.2 Clinical Presentation

The incidence of ureteroceles is approximately 0.02%, with 80% occurring in females [4]. The majority of ureteroceles are associated with the upper pole of a duplicated system, and about 60–80% of ureteroceles are ectopic in that they extend beyond the bladder neck [12]. They are frequently associated with obstruction of the system which they subord. Prenatal diagnosis of hydronephrosis is the most common presentation. Postnatally, ureteroceles most often present with urinary tract infections, hematuria, or a palpable bladder mass. The most worrisome presentation is acute outlet obstruction caused by the ureterocele prolapsing into the bladder neck. When this occurs, it may be possible to see a purple red or necrotic mass protruding from between the labia [5]. A large ureterocele may distort the bladder neck and manifest with incontinence, although this is a more rare presenting scenario [13].

21.2.3 Diagnosis

Ureteroceles are most often diagnosed on prenatal ultrasound. Investigation of a possible ureterocele relies heavily on imaging, which may include ultrasound, VCUG, renal scan, IVP, CT, and possibly MRI. Ultrasound is normally utilized first to assess the kidneys and bladder. It is important to note that ultrasounds should be done with a full bladder so that the lining of a large ureterocele within the bladder is not misinterpreted as bladder mucosa. On ultrasound, a ureterocele appears as a round lucent structure sitting within the bladder (see Fig. 21.3). The next step in
diagnosis is a VCUG which may show a ureterocele as a rim enhancing shadow within the bladder (see Fig. 21.4). Because ureteroceles are mostly associated with duplicated systems, VCUG may also serve to demonstrate vesicoureteral reflux to the lower pole of the kidney or into the contralateral system. On the voiding phase, one should note if prolapse of the ureterocele into the bladder neck is causing outlet obstruction. Nuclear scans are most often used to assess the function of the associated renal unit. Diuretic renograms may be used to diagnose or rule out obstruction. Direct visualization of ureteroceles using cystoscopy may be misleading. The size of the ureterocele may make it difficult to assess laterality, identify the ureterocele, or distinguish it from the bladder diverticulum or trigonal cysts. If further anatomical detail is necessary, magnetic resonance urography can be considered.
21.2.4 Intervention

The principal reasons for surgically intervening on a ureterocele are preservation of renal function, elimination of infection, obstruction, and maintaining urinary continence. Ureteroceles which present with moderate to severe hydronephrosis prenatally are managed initially with antibiotics to reduce the risk of infections. In order to preserve renal function, one must correct the obstruction and prevent reflux. Acute decompression and resolution of the obstruction may be required in those patients with sepsis or those with bladder outlet obstruction by performing a transurethral incision of the ureterocele. Transurethral incision of a ureterocele may be definitive treatment for 77–93% of cases depending on the anatomy, as there are lower rates of secondary procedures for the intravesical ureterocele [6, 14]. Non-emergent treatment options include transurethral incision, ureterocele excision, common sheath ureteral reimplantation, ureteroureterostomy, partial nephrectomy for nonfunctioning upper poles, and observation. Some studies have shown observation in patients with a nonfunctioning, minimally hydronephrotic, or cystic dysplastic upper tract segment associated with a ureterocele managed nonoperatively may have a benign clinical course [15].

Although the majority of ureteroceles do not present with incontinence, as stated previously, large ureteroceles may distort the bladder neck causing urinary leakage. Incontinence may be iatrogenic, or initial incontinence may fail to improve after surgical correction or excision, due to an incompetent bladder neck. These surgical procedures may also cause bladder dysfunction due to bladder hypertrophy and hyperactivity, subsequently leading to incontinence. Urinary leakage may be seen with ectopic ureteroceles, as their insertion sites may be distal to the external sphincter. Ureteroceles may also be associated with inherent bladder dysfunction such as detrusor instability, which may be associated with incontinence.

21.3 Urogenital Sinus

21.3.1 Embryology

The urogenital sinus is a normal structure during embryonic development. A portion of the developing hindgut expands into the cloaca, lined with endoderm, by the second week of gestation. Between the fourth and sixth weeks of fetal life, the cloaca is separated by the urorectal septum into the anorectal canal dorsally and the urogenital sinus ventrally. It is theorized that the fusion of yolk sac extra embryonic mesoderm and allantois membrane is what comprises the urorectal septum [16]. The urorectal septum grows down toward the cloacal membrane but before the two merge the cloacal membrane ruptures, allowing the urogenital sinus and the anorectal canal to reach the exterior at the level of the primitive perineum. The urogenital sinus will eventually become the bladder and two separate segments. The superior segment gives rise to the proximal urethra, and the inferior will differentiate into the penile urethra in males and the vestibule of the vagina in females.
In females, the urogenital sinus interacts with the uterovaginal primorium, forming the Müllerian tubercle which induces the formation of the sinovaginal bulbs. These bulbs become the vaginal plate, which will canalize in a caudal to cranial direction to form the proximal two thirds of the vagina. The inferior aspect of the urogenital sinus becomes the vestibule of the vagina, so the urethra and vagina develop separate external openings. The disruption or cessation of vaginal differentiation can cause persistence of the urogenital sinus. Interruption at an early stage of development may lead to a long urogenital sinus with a short vagina. Comparatively, females may have a short urogenital sinus with a near normal vaginal vestibule, if the disruption occurs later in development [9].

21.3.2 Clinical Presentation

The persistence of the urogenital sinus is often diagnosed prenatally on ultrasound. It is crucial, however, to note that urogenital sinus abnormalities are most often seen with disorders of sexual differentiation, most commonly with congenital adrenal hyperplasia (CAH). CAH is a group of rare inherited autosomal recessive disorders characterized by abnormalities of adrenal steroid biosynthetic enzymes. Given that CAH may be life-threatening, the presence of ambiguous genitalia warrants a thorough newborn physical exam, maternal history, karyotype, measurement of serum electrolytes, and evaluation of hormone levels.

In addition to urogenital sinus seen with ambiguous genitalia, there is a pure form of persistent urogenital sinus, urogenital sinus associated with cloacal abnormalities, and urogenital sinus associated with female exstrophy. Palpation for abdominal masses may reveal a distended bladder or hydrometrocolpos, which can be the first sign of urogenital sinus abnormality. Due to the association of spinal cord and urogenital sinus abnormalities, it is important to inspect the back and spine. Genital examination should include evaluation of the clitoris or phallus and the status of the erectile bodies, presence of gonads, status of the labioscrotal folds, placement of the sinus opening, and examination of the rectum (see Fig. 21.5a).

21.3.3 Diagnosis

Although the diagnosis of persistent urogenital sinus can be confirmed by physical exam, it is important to have a thorough understanding of a patient’s anatomy before attempting surgical intervention. Key pieces to each individual’s puzzle include length of the common urogenital sinus or conversely the distance between the bladder neck and the confluence of the urinary and genital cords, urethral and bladder anatomy, and the relationship between the urethra, bladder, and vagina. The location of the vagina in reference to the bladder neck may be essential to guiding surgical reconstruction. Ultrasound is the first step to assess the status of the kidneys, adrenals, ovaries, bladder, and ureters. Retrograde genitogram (see Fig. 21.5b) or MRI
will help outline anatomy and identify the length and extent of abnormality, define spinal abnormalities, and investigate sphincteric muscle development of the anus should there be concordant disruption. Cystoscopy and vaginoscopy should also be performed in all patients to evaluate the vaginal confluence under direct vision and to observe the number and structure of the vaginal canal.

### 21.3.4 Treatment

Persistent urogenital sinus is a complex malformation with a wide anatomic spectrum. The goal of surgical reconstruction is separation of the urinary and genital tracts while trying to preserve all sphincteric mechanisms for urinary and anal continence. Often, females born with urogenital sinus and ambiguous genitalia require some combination or variation of clitoroplasty, labiaplasty, and vaginoplasty. The spectrum of abnormality can vary greatly, so the extent of surgery is individualized and timing of surgical reconstruction is debatable. Vaginoplasty techniques involve four main types of repair: the cutback, the flap, the pull-through, and the complete vaginal replacement. During mobilization of the urogenital sinus, injury may occur to neural fibers or sphincter mechanisms. Interruption of pelvic floor anatomy may also lead to stress incontinence after toilet training. It is important to note that patients undergoing vaginoplasty prepubertally may require a secondary procedure postpubertally due to vaginal introital stenosis. Other complications such as incontinence, poor sexual function, and poor cosmetic outcomes can result. Extensive counseling and discussions with parents should take place preoperatively.

**Fig. 21.5** Persistent urogenital sinus (a) on physical exam; there is one common orifice with clitoral hypertrophy and abnormal labial folds. Associated genitogram (b) shows a moderately high confluence with a clear separation of the bladder and vagina.
Persistent urogenital sinus is typically identified before toilet training age and rarely presents with incontinence. A high vaginal confluence can be associated with a hypospadiac urethra causing urinary leakage. The major concern for incontinence, however, is iatrogenic during surgical repair. Postoperative incontinence may be seen with a myriad of pelvic surgeries but notably can occur in both total urogenital mobilization (TUM), described by Peña, and partial urogenital mobilization (PUM), described by Rink [17]. Using TUM, the urogenital sinus is mobilized and brought to the perineum en bloc, so that vaginal separation using a pull-through vaginoplasty is no longer required. Similarly, PUM avoids the need for vaginoplasty but differs in that dissection does not extend beyond the pubourethral ligament and external sphincter, preserving delicate innervation. While pediatric urologists have shifted more toward PUM, recent literature has suggested that the outcomes between the two procedures may be comparable [17]. What is indisputable with persistent urogenital sinus is that iatrogenic urinary incontinence is an important complication to consider when choosing a surgical approach.

References


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