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PICTORIAL ESSAY

Transperineal ultrasonography

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Abstract Transperineal US has increased in use in the last decade. It is helpful in the evaluation of distal genitourinary structures, the rectum and overlying soft tissues. When used in conjunction with transabdominal US, transperineal US can further delineate anatomy and assess abnormalities that affect the lower pelvis. This paper describes optimal technique and common indications for transperineal US in children with examples of congenital and acquired lesions in pediatric patients.

Keywords Ultrasound · Transperineal · Mullerian duct anomalies · Urethra · Rectum · Children

Introduction

Transperineal sonography has been used as an adjunct scanning technique in a number of clinical situations [1-5], and as such , is also known as translabial sonography.. Additional uses in adults include the evaluation of pelvic floor disorders with two-, three- and four-dimensional techniques [6]. The pediatric literature includes the use of transperineal US for the evaluation of vaginal atresia [7], posterior urethral valves [8], imperforate anus [9, 10], perianal inflammatory disease [11] and vesicoureteral reflux with the aid of US contrast [12].

Transperineal US is best performed with a high-frequency linear array transducer (8 MHz or higher), with a thick coating of gel over the perineum to eliminate air artifact. Microcase sector and curved transducers may also be useful. The transducer may be covered in a thin plastic sheath with gel over the faceplate. Superficial lesions may be better evaluated with a stand-off gel pad. Some practitioners may choose to invert the sonographic image on the screen to correspond with the standard orientation used with voiding cystourethrograms (VCUGs). At our institution, the radiologist and sonographers leave the image as it is acquired. Either approach works; the key is to be consistent so that normal structures are familiar and abnormalities are quickly recognized.

The patient is placed supine and the transducer is initially placed longitudinally on the perineum. In boys, the transducer is placed just below the scrotum and includes the ventral aspect of the base of the penis. Older children can be placed in the modified lithotomy position to facilitate the position of the legs. The midsagittal plane is identified by the presence of the pubic symphysis and urethra on the same image. In boys, the urethra, corpora cavernosa, anterior rectal wall and bladder base are included in the field of view (Fig. 1). In girls, the vagina is additionally seen between the rectum and bladder (Fig. 1).

There are special considerations and pitfalls when performing transperineal sonography. Care must be taken when scanning a boy as urethral anatomy can be distorted by excessive pressure by the transducer. Urethral obstructions or strictures may be missed if the child is catheterized or is not actively voiding, although multiple urethral strictures can still be missed despite adequate distention. Positioning the child obliquely or on his side may be necessary so that he can void into a container. The Credé maneuver (downward pressure on the lower abdominal wall) can express urine from the bladder to distend the urethra if the child is too young to void voluntarily. In girls, excessive transducer pressure can cause artificial reflux of urine into the vagina.

Contrast-enhanced US, which relies heavily on transperineal US for the evaluation of vesicoureteral reflux, the urethra and the genital tract, will not be discussed as this technique is not routinely used at our institution.

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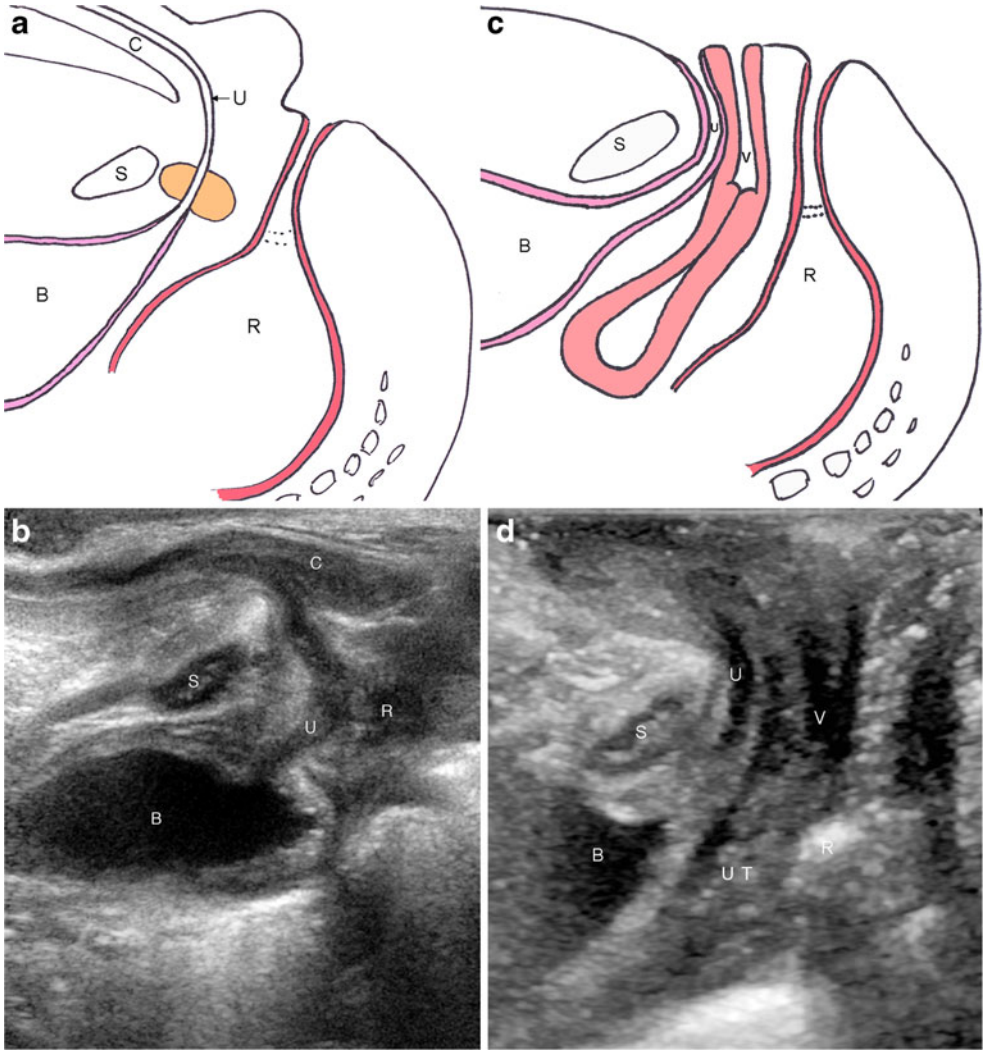

Fig. 1 Normal male and female anatomy. Cartoon of midsagittal male perineal anatomy (**a**) and corresponding transperineal US images of a normal 1-month-old boy (**b**). Cartoon of midsagittal female perineal anatomy (**c**) and corresponding transperineal US images of a 1-month-old girl (**d**). Normal anatomy is oriented to match the view typically seen on the US screen while scanning transperineally in the midsagittal plane. *B* bladder, *S* pubic symphysis, *U* urethra, *C* corpora, *R* rectum, *UT* uterus, *V* vagina

Indications

Transperineal US is best suited to assess abnormalities involving the urethra and surrounding soft tissues, anus and rectum and, in girls, distal gynecological structures. As such, it provides additional information when used in conjunction with transabdominal US and should not, in most cases, be performed in isolation.

Urethral and periurethral lesions

While voiding cystourethrogram (VCUG) or retrograde urethrogram is the standard for urethral evaluation, advances in transducers and increasing use of transperineal US have made sonography a more common option [2, 3, 6].

Urethral lesions are relatively uncommon in children. They include polyps (Fig. 2), stones, tumors, granulomas, strictures, diverticula (Fig. 3) and syringocoele of the bulbourethral duct [13]. For urethral diverticula, a fluid-filled, distended urethra can aid in identifying the connection from the urethra to the diverticulum differentiating it from periurethral cysts, which do not communicate with the urethra. In boys, a prostatic

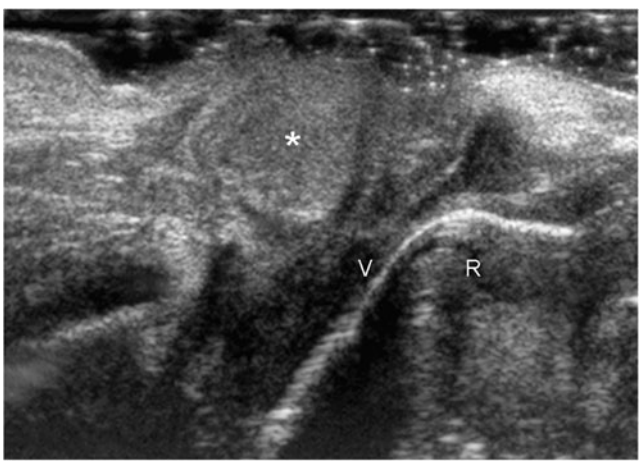

Fig. 2 Prolapsing urethral polyp in a 3-week-old girl with a protruding urethral mass. Transperineal US in the sagittal plane demonstrates a homogeneously echogenic mass (*asterisk*) superior to the vagina (*V*) and rectum (*R*)

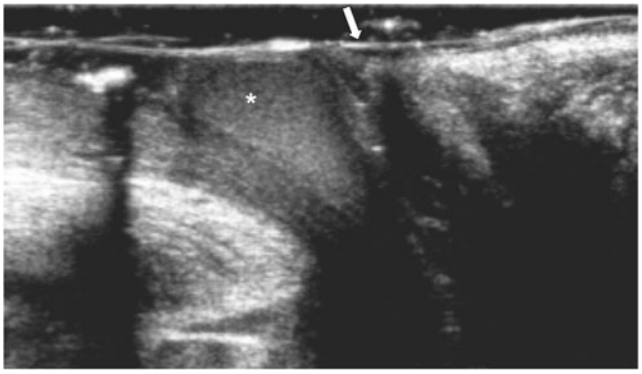

Fig. 3 Urethral diverticulum in a 15-year-old girl with a periurethral lesion that occasionally drained fluid. Transperineal US in the sagittal plane demonstrates a mass (*asterisk*) at the anterior aspect of the vaginal introitus (*arrow*) with peripheral vascularity only (color Doppler sonogram not shown). A urethral diverticulum filled with mucopurulent material was drained at surgery

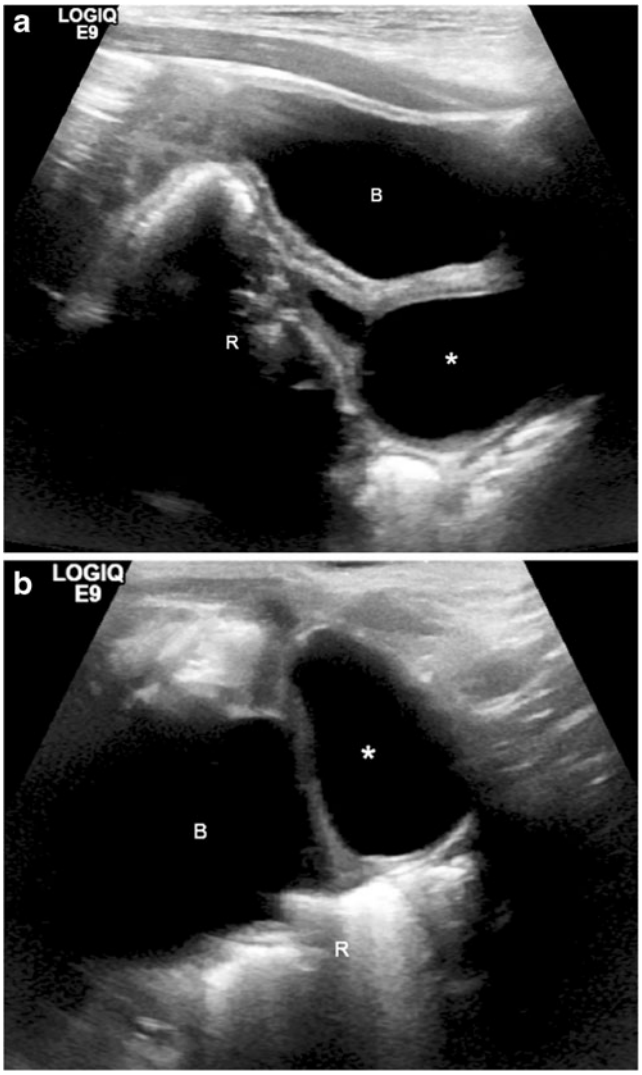

Fig. 4 Prostatic utricle cyst in a 19-month-old boy with history of hypospadias repair. VCUG (not shown) demonstrated mass effect on the bladder. Sagittal transabdominal US (**a**) demonstrates a cystic structure (*asterisk*) posterior to the bladder (*B*). A large amount of stool in the rectum (*R*) also contributed to the mass effect on the bladder seen on the VCUG. Sagittal transperineal ultrasound slightly to the left of midline (**b**) shows the inferior aspect of the large prostatic utricle cyst abutting the bladder base

utricle cyst (Fig. 4) is an additional entity to consider. And while VCUG is the standard for the evaluation of posterior urethral valves (Fig. 5), its identification and appearance with transperineal US has been described in the literature [8].

Transperineal US is also useful in the intraoperative evaluation of posterior urethral strictures in boys. This is best achieved by simultaneously distending the proximal and distal urethra with the Credé maneuver and retrograde instillation of saline, respectively, during sonography. This technique helps clearly identify the location, length and characteristics of the urethral obstruction (Figs. 6 and 7). We have also used transperineal US to evaluate penile postoperative complications after hypospadias or epispadias repair (Fig. 8).

Transperineal US may reveal the insertion site of an ectopic ureter into the urethra (Fig. 9). Following the Weigert-Meyer rule, the upper pole ureter of a duplex kidney most often inserts medial and inferior to the orthotopic ureter. Identifying the insertion site of an ectopic ureter in an incontinent girl may have enormous quality of life ramifications as the ectopic ureter can insert below the bladder sphincter in girls [14]. Enuresis does not occur in boys as the ectopic insertion is always above the external sphincter.

Periurethral cysts (Fig. 10) include vaginal cysts (mullerian, Gartner duct and epidermal inclusion cysts), Skene duct cysts and Bartholin gland cysts. Transperineal US is helpful in determining the location and size of urethral and periurethral cysts, although it should be noted that their sonographic appearance is often nonspecific.

Gynecological abnormalities

Transperineal US is most useful in evaluating the American Fertility Society class I mullerian duct anomalies, which include segmental or complete agenesis or hypoplasia of the vagina, cervix, fundus and fallopian tubes in any combination; Mayer-Rokitansky-Küster-Hauser syndrome is the most common entity in this category (Fig. 11) [15]. The ovaries and external genitalia are usually normal in cases of mullerian duct anomalies as these structures are derived separately [16]. Imperforate hymen (Fig. 12) is not a mullerian duct anomaly and should be distinguished from a transverse vaginal septum [17].

Transperineal US works particularly well in female neonates due to their small size and prominent uterus, cervix and vaginal mucosa from maternal hormonal stimulation (Fig. 13) [4, 18].

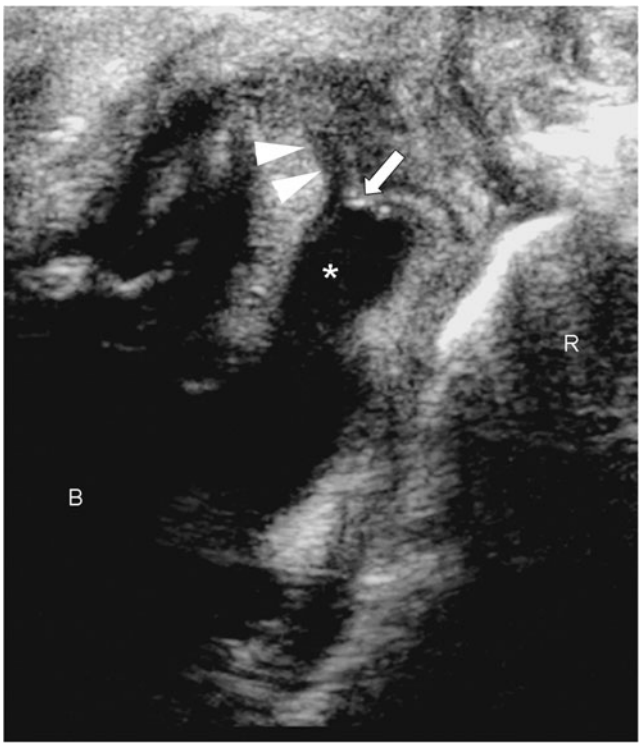

Fig. 5 Posterior urethral valves in an 11-day-old boy with acute renal failure. Transperineal US in the sagittal plane demonstrates a dilated posterior urethra (*asterisk*), and collapsed distal urethra (*arrowheads*). Linear echogenicity (*arrow*) was thought to represent a valve leaflet. *B* bladder, *R* rectum

An unusual diagnosis we have made with transperineal US is clitoral thrombus (Fig. 14). While a rare occurrence, US can make the diagnosis and prevent further imaging or intervention.

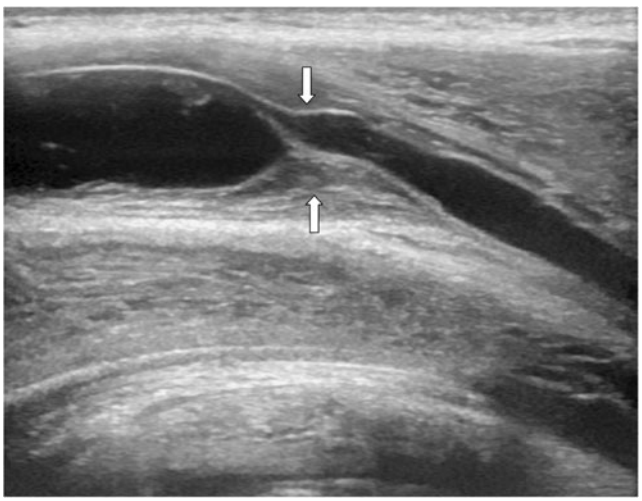

Fig. 6 Posterior urethral stricture in a 17-year-old boy with a history of trauma. Intraoperative transperineal US with retrograde distention of the urethra shows a focal area of narrowing and irregularity (*arrows*) of the bulbar urethra

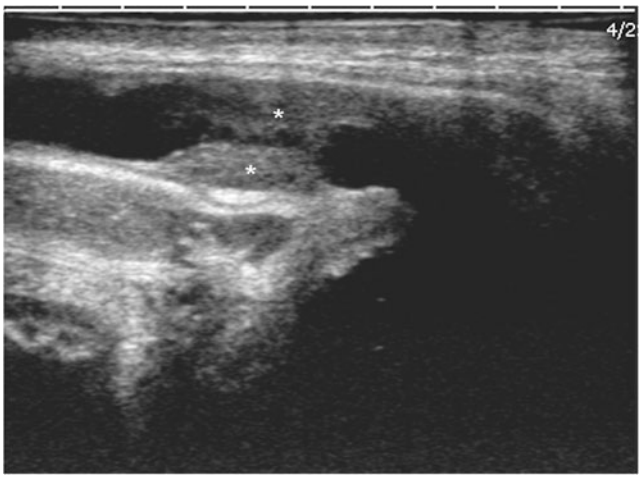

Fig. 7 Posterior urethral stricture in a 12-year-old boy with a history of posterior urethral valves repair. Intraoperative transperineal US shows a stricture in the posterior urethra associated with soft-tissue thickening (*asterisks*). There was antegrade and retrograde distention of the urethra with saline during the study

Anorectal malformations

Anorectal malformations encompass a number of congenital anomalies that affect the anus, rectum and, in many cases, the urinary and genital tracts. Most cases involve an imperforate anus

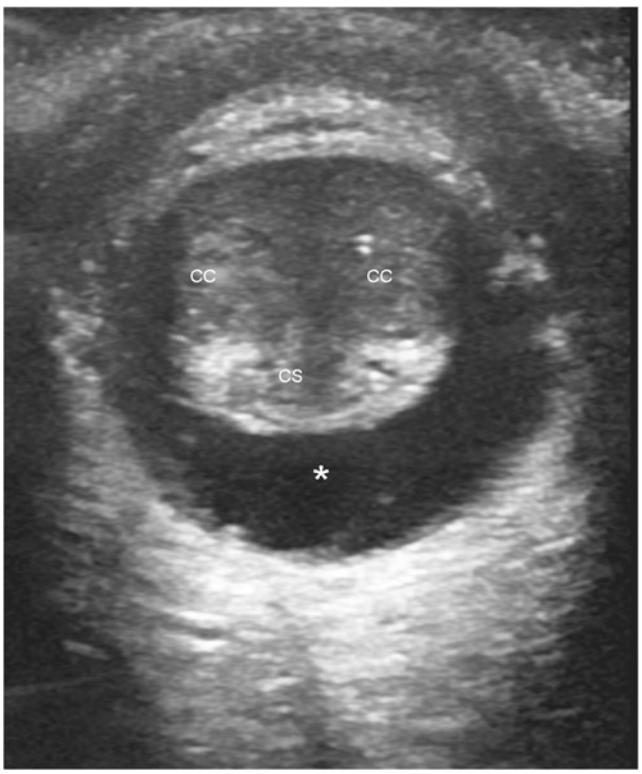

Fig. 8 Urine leak in a 6-month-old boy who underwent distal hypospadias repair. Transperineal US of the penis in transverse plane shows a collection of fluid (*asterisk*) along the ventral aspect of the penis. *CC* corpora cavernosum, *CS* corpora spongiosum

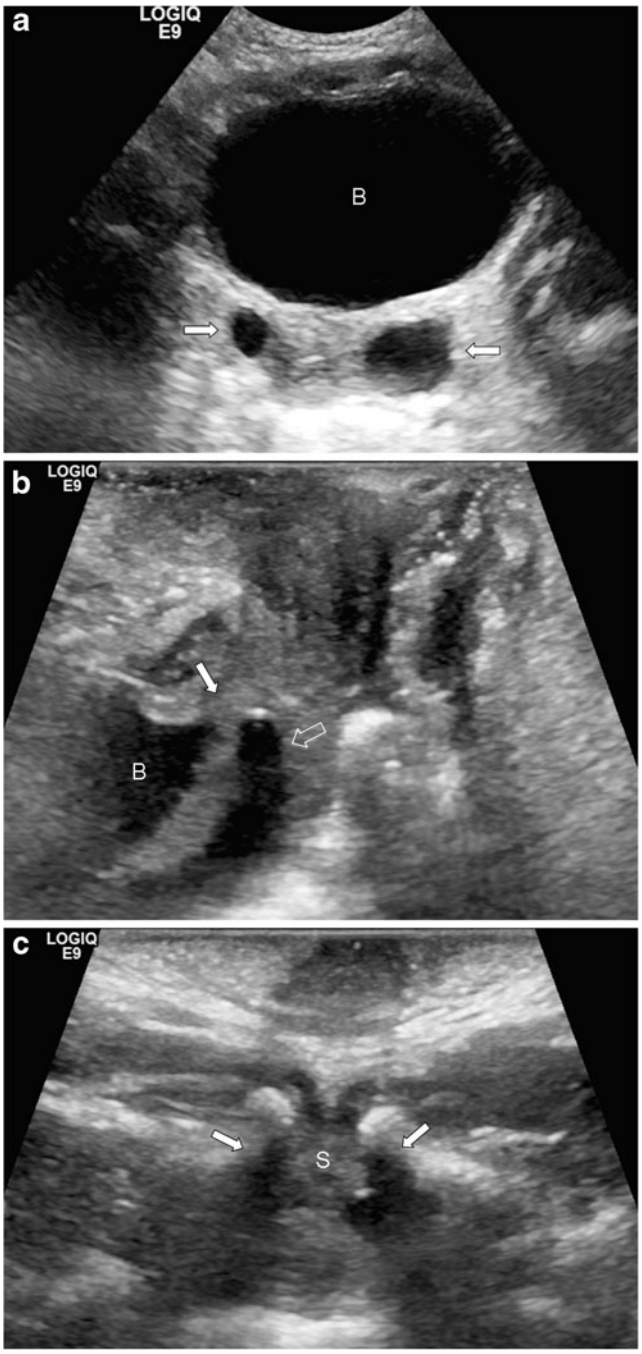

Fig. 9 Bilateral ectopic ureters in a 32-day-old girl. Transabdominal US of the kidneys (not shown) demonstrated upper pole hydronephrosis. Transverse transabdominal US (**a**) of the bladder shows dilated distal ureters (*arrows*). Transperineal US in the sagittal plane slightly to the right of midline (**b**) shows the upper pole ureter (*open arrow*) inserting beneath the level of the bladder neck (*arrow*). The left ureter (not shown) had a similar appearance. Transverse transperineal US (**c**) shows both upper pole ureters (*arrows*) inserting into the urinary sphincter (*S*). *B* bladder

(IA) [9, 10, 19]. Ultrasound is preferred for the preoperative evaluation of anorectal malformations, as there is no need for sedation or anesthesia and it lacks ionization radiation.

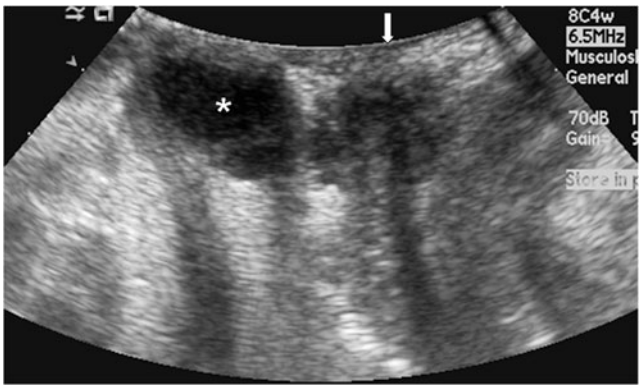

Fig. 10 Periurethral cyst in a 3-day-old girl with an interlabial lesion. Transperineal US using a stand-off pad in the sagittal plane demonstrates a well-defined rounded structure with homogeneous echotexture (*asterisk*) anterior to the vaginal introitus (*arrow*). At surgery, the cyst contained mucopurulent material

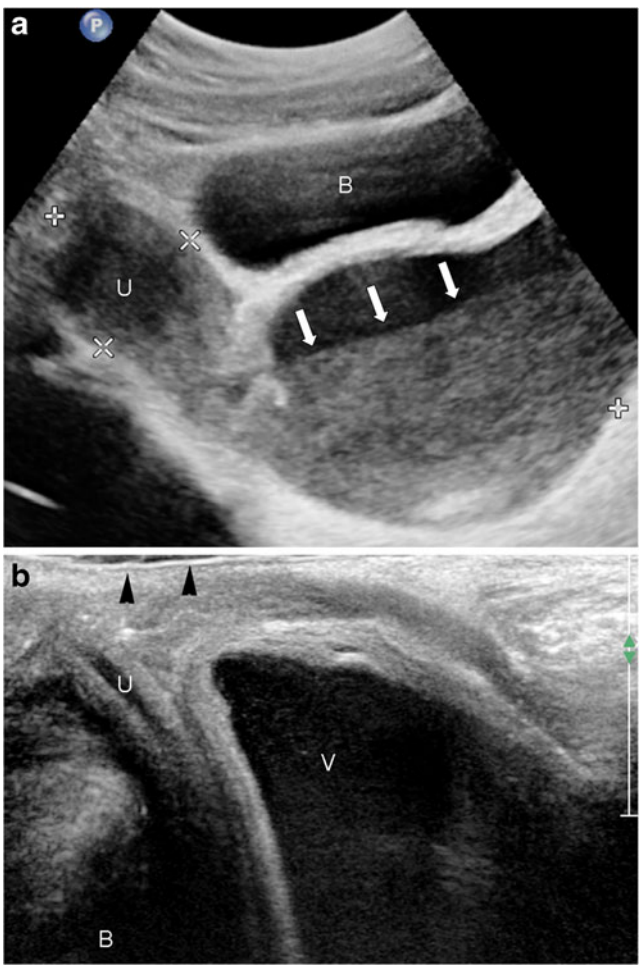

Fig. 11 Distal vaginal atresia in a 12-year-old girl with increasing abdominal pain. Sagittal transabdominal US (**a**) shows hematometrocolpos with layering echogenic blood (*arrows*) in a dilated vagina. Sagittal transperineal US (**b**) shows a fluid-filled, tapering, blind-ending vagina separated from transducer face (*arrowheads*) by a thick septum. *B* bladder, *U* uterus, *V* vagina

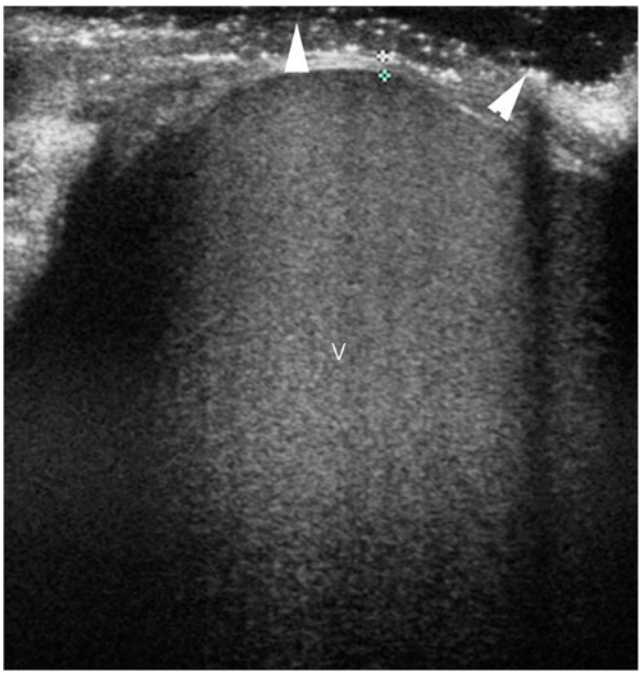

Fig. 12 Imperforate hymen in a 13-year-old girl with increasing abdominal pain. Sagittal transperineal US demonstrates a distended, non-tapering vagina containing echogenic blood products. Note thin hymenal band (*calipers*) close to sonographic gel (*arrowheads*). *V* vagina

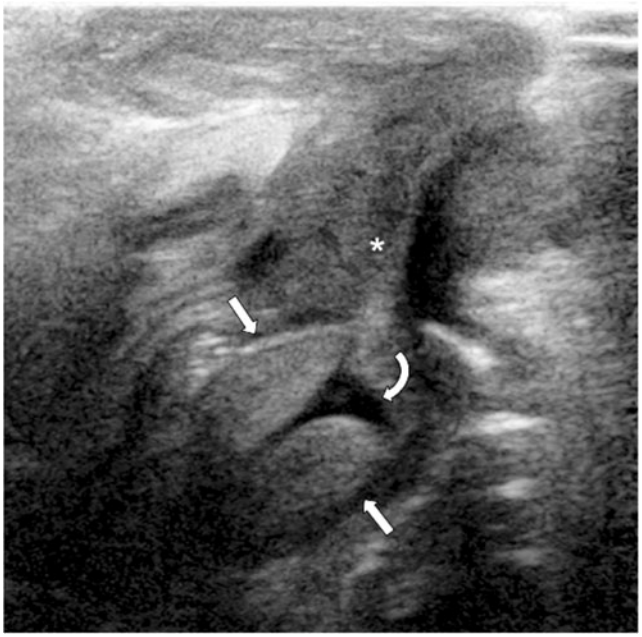

Fig. 13 Normal anatomy in a 1-day-old girls. Sagittal transperineal US shows a prominent distal cervix (*arrows*) and echogenic vaginal mucosa (*asterisk*) due to maternal hormonal stimulation. A small amount of anechoic fluid (*curved arrows*) is present at the external os

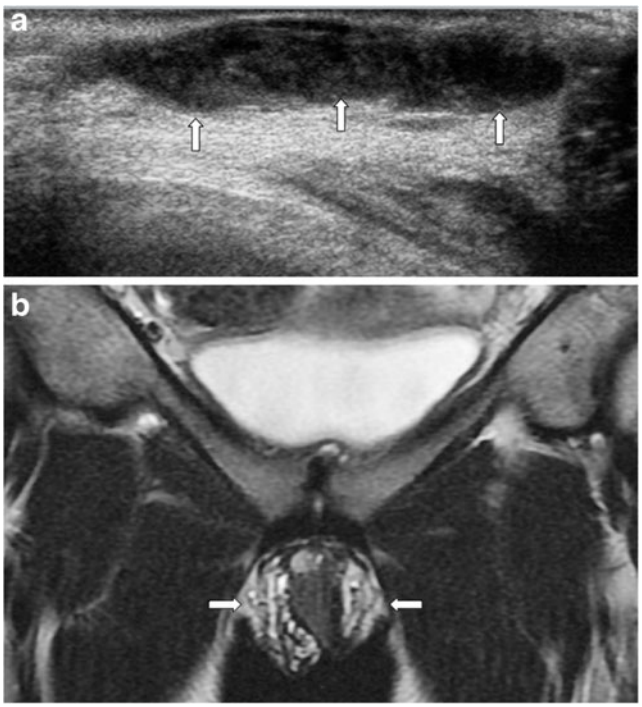

Fig. 14 Clitoral thrombus in an 11-year-old girl with pain. Sagittal, gray-scale transperineal US of the clitoris (**a**) demonstrates a non-compressible, enlarged clitoris (*arrows*). Color Doppler scan (not shown) showed no flow within the clitoris. T2-weighted MRI of the pelvis in the coronal plane (**b**) shows a venous malformation involving the labia and clitoris (*arrows*), the predisposing factor of the patient's thrombus

The distance between the perineum and distal rectal pouch (Fig. 15) can differentiate low-type from intermediate- or high-type imperforate anus [9, 10]. This distinction is important as the type of IA dictates surgical approach [20]. The boundary of the distal rectal pouch is identified by meconium or air. Minimal

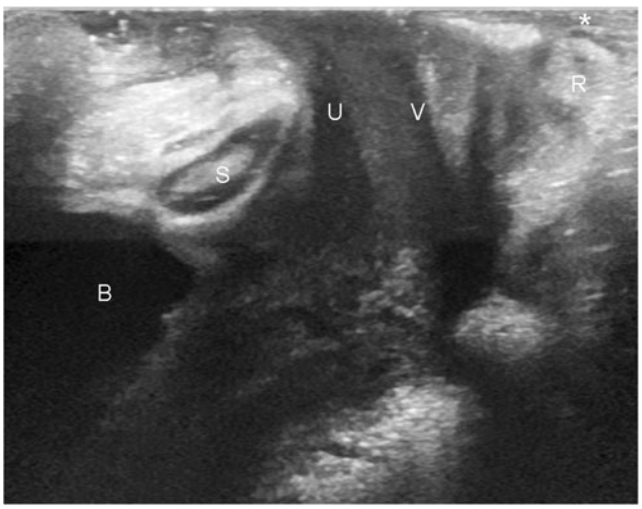

Fig. 15 Imperforate anus in a 1-day-old girl. Sagittal transperineal US demonstrates the rectum ending 2 mm from the perineum (*asterisk*). *B* bladder, *U* urethra, *V* vagina, *R* rectum, *S* pubic symphysis

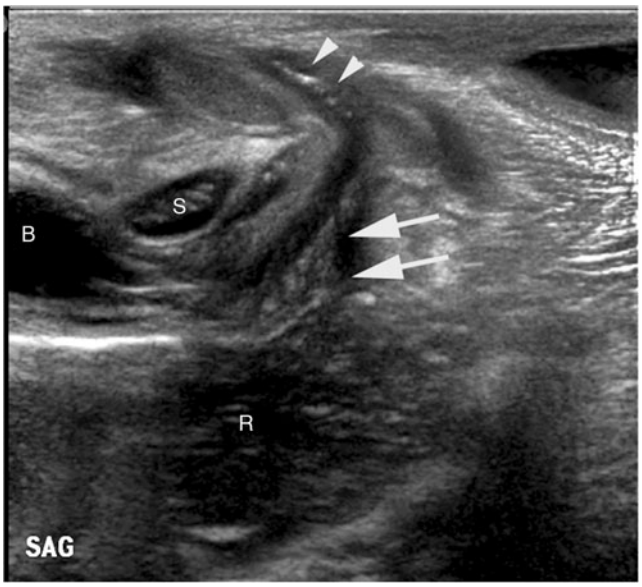

Fig. 16 Imperforate anus with rectourethral fistula in a 2-day-old boy. Transperineal US in the sagittal plane shows a rectourethral fistula (*arrows*) near the verumontanum. Note gas bubbles in urethra (*arrowheads*). *B* bladder, *R* rectum, *S* pubic symphysis

pressure on the transducer will prevent erroneously decreasing the measured distance. Associated internal fistulas can often be identified with high-resolution transducers (Fig. 16) [10].

Ambiguous genitalia

In cases of ambiguous genitalia, US is used to identify internal reproductive organs and a potential urogenital sinus. The evaluation for internal reproductive organs is best accomplished with transabdominal US. However, inguinal or transperineal US can help locate gonads in the groin (Fig. 17) or labia [4]. In addition, transperineal US may be able to identify the commonly associated urogenital sinus (Fig. 18).

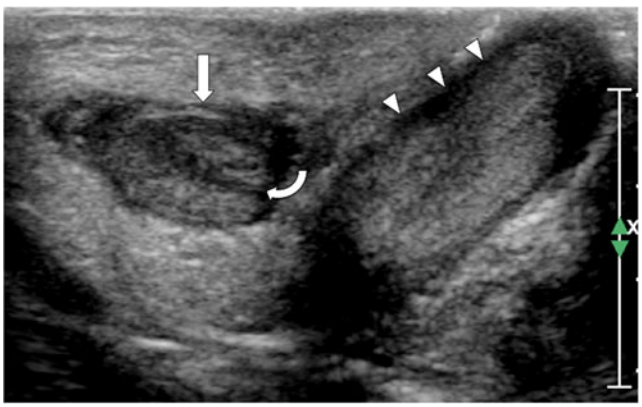

Fig. 17 Ambiguous genitalia in a 1-day-old who was subsequently identified as a boy with 46,XY, hypospadias and bilateral inguinal testes. Transperineal US in the transverse plane shows an ovoid structure (*arrow*) in the right groin. A central hypoechoic linear structure (*curved arrow*) is consistent with a mediastinum testis. A similar structure was identified in the left groin (not shown). Centrally within the perineum, a homogeneously echogenic soft-tissue structure was recognized as the abnormally small penis (*arrowheads*)

Miscellaneous perineal soft-tissue masses

Perineal soft-tissue masses seen in both boys and girls include perianal abscesses and vascular or lymphatic malformations (Fig. 19).

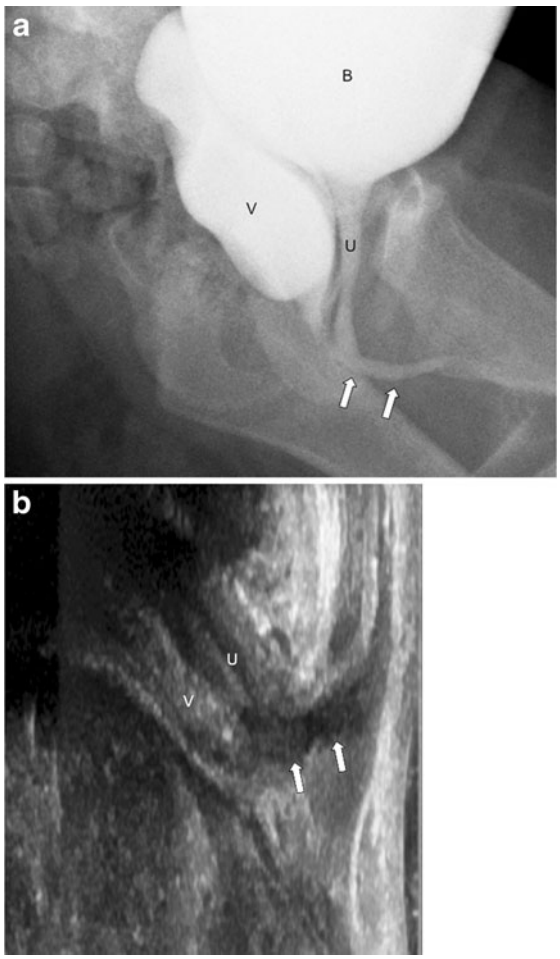

Fig. 18 Urogenital sinus in a 13-year-old girl with congenital adrenal hyperplasia born with ambiguous genitalia. Genitogram and VCUG (**a**) show a common urogenital sinus (*arrows*) approximately 2.5 cm in length with a fairly low confluence between the urethra (*U*) and vagina (*V*). *B* bladder. Sagittal transperineal US (**b**), with image rotated 90° clockwise to match the orientation of the fluoroscopic study, was performed approximately 1 h later and shows the confluence (*arrows*) of the urethra and vagina. The vagina contains echogenic fluid after the VCUG

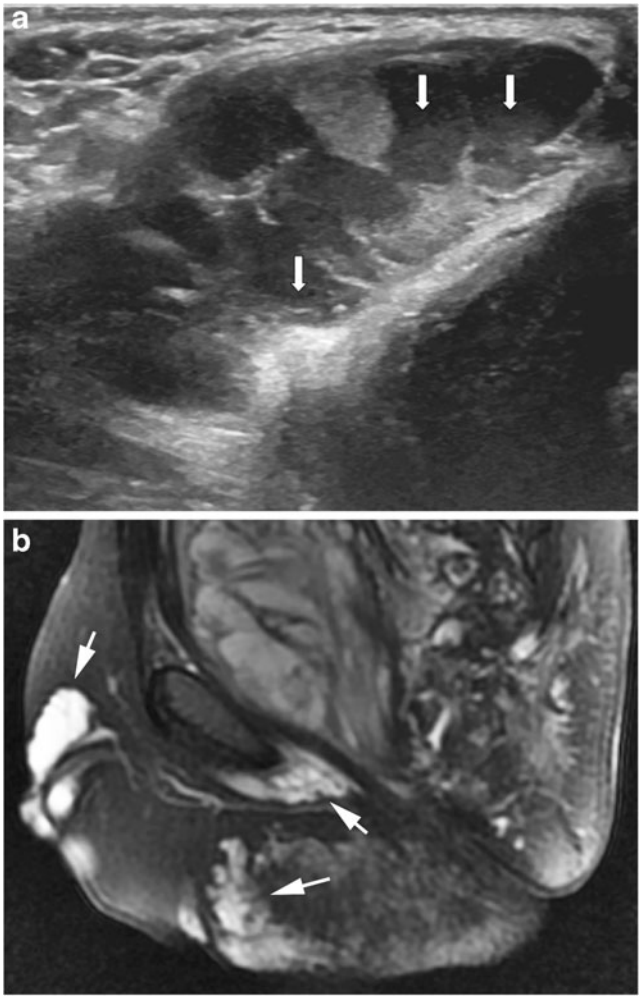

Fig. 19 Penile venous malformation in a 15-year-old boy. Transperineal US in the sagittal plane (**a**) at the base of the penis shows a well-demarcated, heterogeneous mass with multiple cavities, many with layering echogenicity (*arrows*) corresponding with hemorrhage. T2-weighted MRI of the pelvis with fat saturation in the sagittal plane (**b**) shows the involvement of the pelvis and perineum in this extensive venous malformation (*arrows*)

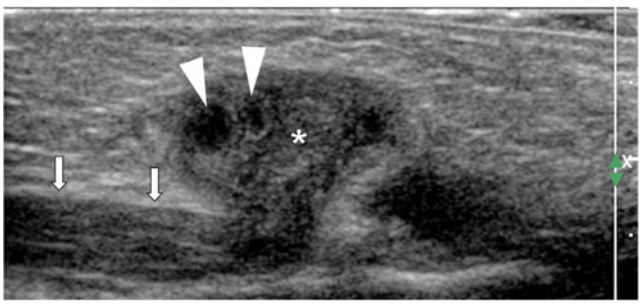

Fig. 20 Patent canal of Nuck in a 3-week-old girl with right labial swelling. Sagittal transperineal US shows a normal ovary (*asterisk*) in continuity with the inguinal canal (*arrows*) in the right labia. Two follicles (*arrowheads*) help identify this structure as an ovary

In girls, one should consider a hernia through a patent canal of Nuck as a cause for a labial mass. The canal of Nuck is an abnormal opening in the parietal peritoneum extending into the labia majora in girls. Normally, this canal obliterates during the first year of life, but if it remains patent an indirect inguinal hernia can occur [21]. Pelvic organs (Fig. 20) can herniate or hydroceles can form [22]. It is important to also scan the groin to establish continuity with the peritoneal cavity.

Conclusion

A number of abnormalities affecting the urethra and surrounding soft tissues, anus, rectum and distal gynecological structures can be better assessed by transperineal ultrasonography rather than with transabdominal ultrasonography. Careful application of this technique may aid in the further evaluation of a wide range of congenital and acquired processes affecting children.

Conflicts of interest None

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