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Ureterocele: an ongoing challenge in infancy and childhood

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Introduction

Ureteroceles may present both diagnostic and treatment challenges, particularly among paediatric urologists. The diagnosis of ureterocele may be obvious, but at times it is less clear and is then only diagnosed with a high index of suspicion. The management of ureterocele varies according to its effects on obstruction, reflux, continence and renal function. Therefore, it is imperative for the urologist to be aware of the variable clinical and radiological presentations and treatment options of ureterocele to yield the best possible results. We discuss ureteroceles and address areas of confusion and controversy.

Definition and classifications

A ureterocele is defined as a cystic dilatation of the terminal ureter within the bladder, urethra, or both. Different authors have tried to establish a classification based on various anatomical and pathological criteria. In 1954, Ericcson [1] was the first to classify ureterocele as simple or ectopic depending on the location of the ureteric orifice. The orifice in a simple non-duplex ureterocele is on the trigone, while the orifice in an ectopic ureterocele is at the bladder neck or posterior urethra. Nevertheless, the term 'simple' was not accepted because of the confusion concerning single-system ectopic ureteroceles and duplex intravesical ureteroceles [2]. In 1968, Stephens [3] developed a pathophysiological classification which divided ureteroceles according to the size and location of the ureteric orifice into four categories:

- Stenotic, narrow orifice within the bladder;
- Sphincteric, wide orifice within the internal sphincter;
- Sphinctero-stenotic, narrow orifice within the internal sphincter;
- Caeco-ureterocele, blind-ending (caecal) ureterocele extending down the urethra.

Thereafter, Churchill *et al.* [4] proposed a functional classification based on the total amount of renal tissue or renal units at risk of damage from obstruction or high-grade reflux as follows:

- Grade 1, ureterocele segment only affected;
- Grade 2, both segments of one kidney affected;
- Grade 3, both kidneys affected.

Because of their complexity, both the Stephens and Churchill *et al.* classifications have gained little popularity. Currently, the most frequently used system of classification is that established by the American Academy of Pediatrics [5], which classifies ureteroceles as intravesical (entirely within the bladder) or ectopic (some portion is situated permanently at the bladder neck or in the urethra).

The ureterocele may vary in size from a tiny cystic dilatation of the submucosal ureter to that of a large balloon that fills the bladder. Histologically, the wall of the ureterocele contains varying degrees of attenuated smooth muscle bundles and fibrous tissue. The ureterocele is covered by vesical mucosa and lined with ureteric mucosa [6].

Demographics

Although the incidence of ureterocele at autopsy is as high as 1 in 500 [7], there is less recognition as a clinical entity. Malek *et al.* [8] reported the clinical incidence of ureterocele to be 1 in 5000–12 000 paediatric admissions. This urinary malformation has a particular predilection for race and gender, occurring almost exclusively in Caucasians and being 4–6 times more frequent in girls than in boys [9]. An ectopic ureterocele is four times more common than an intravesical ureterocele [10]. A ureterocele is more likely to be discovered in children because of prenatal ultrasonographic screening or postnatal UTIs. When found in adults, it is usually intravesical, associated with a simple collecting system, and is less likely to alter the function of the involved kidney [11,12]. The ectopic ureterocele is most commonly encountered in the paediatric setting, usually develops with ureteric duplication and is often responsible for serious complications. According to Coplen and Duckett [2], 80% of infantile ureteroceles occur with ureteric duplications and 60% of these have a drainage orifice in an ectopic location. A ureterocele is found as frequently on the right as on the left side, with bilaterality in 10% of cases.

Aetiology and embryology

The aetiology of ureterocele is unknown; Chwalla [13] first described a membrane closing the 'mouth of the

ureter' in the embryo and suggested that the development of a ureterocele is related to obstruction by this membrane. This theory would explain most ureteroceles that are stenotic, but it does not explain the development of ureteroceles with a patulous ureteric orifice in the urethra. Moreover, unlike obstruction of the ureter, which leads to diffuse dilatation and thinning of the ureter, a ureterocele is a cystic dilatation of the intravesical ureter alone and there is actually an abnormal abundance of ureterocele musculature. These facts and the association of ureterocele with the upper pole of a duplicated collecting system prompted Tanagho [14,15] to suggest that ureterocele formation may be related to the timing of absorption of the mesonephric (Wolffian) duct into the urogenital sinus. The higher ureteric bud associated with the upper pole system will have delayed absorption into the urogenital sinus. This might allow ingrowth of an abnormally large amount of mesenchyme, leading to muscular dilatation.

In contrast to most ureteroceles in children, those in adults insert in a normal position on the trigone. There is usually only slight dilatation of the lower ureter. It is likely that the ureteroceles of single ureters are not all congenital but may be acquired in adulthood [2]. Inflammation or trauma that would narrow the ureteric orifice could result in ureteric prolapse into the bladder lumen, leading to the typical 'cobra-head' adult ureterocele [16]. There remain many unanswered questions about the origin of ureteroceles and it is clear that no one theory explains all types of ureteroceles.

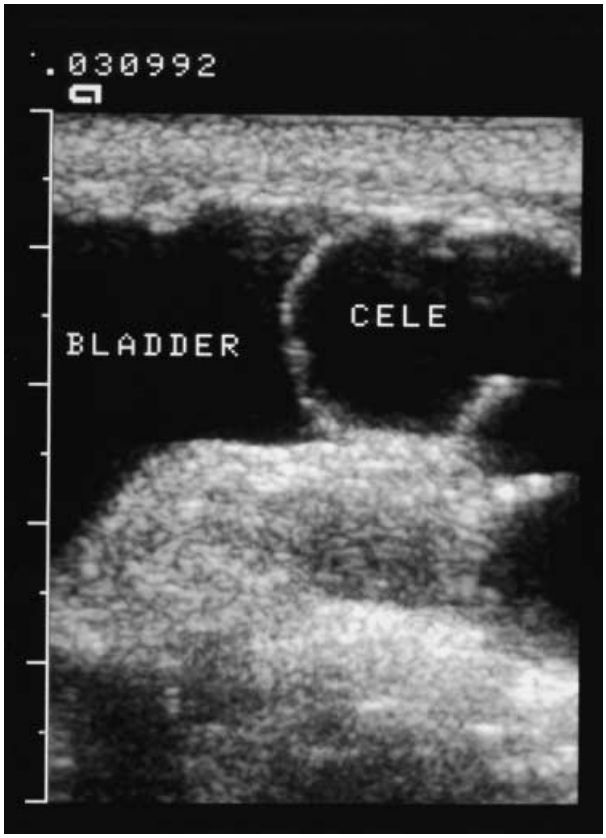

Fig. 1. An ultrasonogram easily detects the ureterocele as a cystic deformity in the bladder.

Diagnosis

Children with ureteroceles can present in various ways, from the asymptomatic patient with an antenatally discovered ureterocele to those with life-threatening urosepsis. A high index of suspicion and an experienced examiner are essential to make an accurate diagnosis. Abdominal ultrasonography (US) is generally the initial screening study for children with urological symptoms (Fig. 1). IVU and radioisotope renography are valuable studies in evaluating a ureterocele. Moreover, a VCUG is an important complementary study in the diagnosis of ectopic ureterocele, as many have VUR into the ipsilateral lower pole ureter or of the contralateral system. Finally, cysto-urethroscopy can confirm the radiographic findings.

Clinical presentations

Symptoms are diverse and range from a life-threatening combination of septicaemia and azotaemia to none whatever. The latter has become common with the advent of prenatal US. The number of neonates with prenatally detected ureteroceles has increased from 2% to 28% during the past two decades [17,18].

Ureteroceles in young children may have an insidious clinical course and result in no specific urological symptoms, but manifest themselves only as a failure to thrive, or as abdominal or pelvic pain. Usually a lengthy evaluation of other organ systems ensues before the problem is correctly located in the urinary tract [16]. The most common presentation is a UTI [19–21]. A palpable abdominal mass from an obstructed renal unit may be present. In general, BOO is rare as most ureteroceles decompress during voiding [2]. However, an ectopic ureterocele can prolapse and may cause urethral obstruction, and in girls may present as a vaginal mass [16]. Some degree of urinary incontinence may occur in a girl with a large intraurethral ectopic ureterocele that has rendered the external urinary sphincter lax and inefficient. Infrequently, a child with a ureterocele presents with haematuria.

Ureteroceles in older children and adults are usually simple with a normal or mildly dilated single collecting system. They may be incidentally discovered with no symptoms, but most children with simple ureteroceles present with symptoms of UTI. Stasis and infection may

predispose the patient to stone formation in the ureterocele and upper urinary tract.

US

Finding a duplex system on US should alert the examiner to image the bladder to determine whether or not a ureterocele is present. Typically, a well defined cystic intravesical mass associated with the posterior bladder wall is identified, which can be followed into a dilated ureter in the bony pelvis [2]. Hydronephrosis of the upper moiety of a duplex system is commonly present. The thickness and echogenicity of the renal parenchyma should be evaluated, as dysplasia and poor function are commonly associated with a ureterocele [2].

There are several pitfalls in the US diagnosis of ureterocele. If the bladder is overdistended, the ureterocele may collapse and only a dilated ureter may be seen entering the bladder. In the setting of a clear duplication at the level of the kidney, an ectopic ureter rather than an actual ureterocele would be suggested. If the duplication is not recognized, a primary megaureter would be suggested.

If the bladder is not full, the dilated ureterocele may fill the entire bladder, giving the impression of a partially full bladder with no ureterocele. Occasionally, a large ureterocele is associated with a diminutive ureter and collecting system. The corresponding upper pole parenchyma can be so small as to be not visualized. The diagnosis of ureterocele may be overlooked because the duplicated collecting system cannot be identified. This entity has been termed 'ureterocele disproportion' [6,22]. Occasionally, the dilated lower end of an ectopic ureter, an ectopic ureter draining into a mesonephric duct cyst, or megaureter may elevate the trigone and be confused with an ectopic ureterocele (a so-called pseudo-ureterocele) [2,23]. The difference between these entities is that a ureterocele is separated from the bladder space by its thin wall, whereas the ectopic ureter has the thicker (bladder)wall separating it from the intravesical space [6].

IVU

As the function of the affected unit is usually poor, a negative shadow of the non-opacified ureterocele is present in the bladder (Fig. 2). Characteristically, in ectopic ureteroceles the negative shadow is situated off-centre and always appears on the bladder outline rather than as a complete circle within the bladder shadow, as in an intravesical ureterocele. In most cases of ectopic ureteroceles, the upper pole has poor or no excretion of the contrast medium. Because of hydronephrosis, the upper pole is deviated laterally and pushes the lower pole laterally and inferiorly, giving the appearance of a 'drooping lily'. Because only the lower pole calyces are seen, there are fewer calyces than in a normal kidney. A lower pole ureter may be displaced laterally and may be looped around the dilated upper ureter near the sacrum. An ectopic ureterocele may impinge on the contralateral ureteric orifice or obstruct the bladder neck and cause hydronephrosis of the opposite kidney.

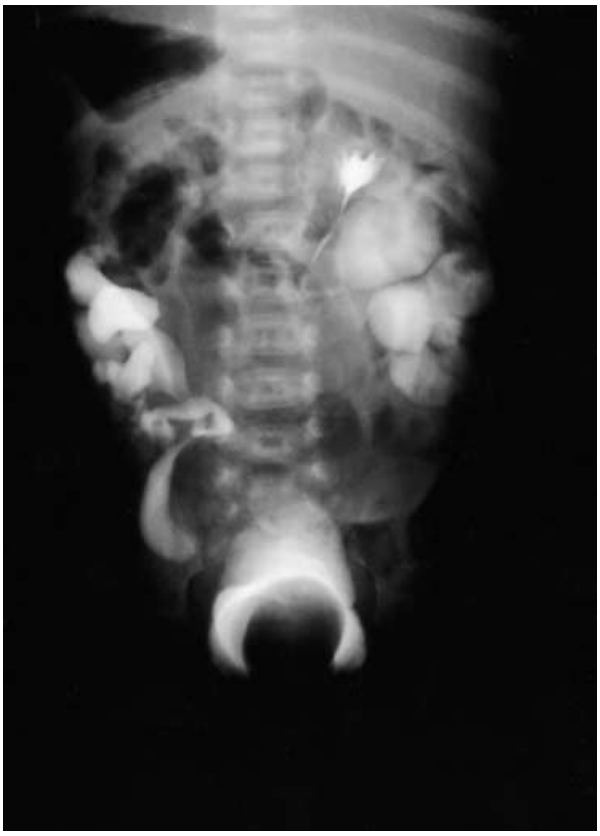

Fig. 2. Although IVU is superfluous in most cases with a ureterocele, this case clearly shows the cystic mass in the bladder, belonging to the non-functioning upper pole of the right kidney. The left side is also duplicated, but this upper pole shows normal visualization.

In adults with good function, the lumen of a ureterocele fills with contrast material and is separated from the medium in the bladder by a thin lucent halo (the ureterocele wall); giving the appearance of a 'cobra-head' or 'spring-onion' deformity.

VCUG

Although the VCUG is an important complementary study in the diagnosis of ectopic ureterocele, the ureterocele itself may often be obscured by the dense contrast material used for the study. The most useful information that can be gained from the VCUG is the presence or absence of VUR in association with ureterocele. It is unusual to have reflux into the ureterocele unless there

has been a spontaneous or iatrogenic perforation of the ureterocele. Ipsilateral lower pole reflux occurs in about half of the cases and may be massive, while contralateral VUR may occur in 25% if there is significant distortion of the bladder base by the ureterocele itself [24]. Occasionally, VCUG shows eversion of the ureterocele during urination, in which case the ureterocele has the appearance of a diverticulum. This presentation is most commonly seen with small ureteroceles and may be the indication to search for a ureterocele [2].

Radionuclide renal scan

By renography, the contribution of the upper pole to overall renal function is estimated, to determine whether the upper pole moiety is worth saving. The function of other renal segments is also evaluated. Nevertheless, radionuclide scintigraphy is not helpful as a predictor of the degree of recovery of renal function in the obstructed segment [25].

Cysto-urethroscopy

Cystoscopy confirms the radiographic findings and is usually undertaken during the same anaesthesia for definite treatment. It is important to evaluate the bladder when full and empty, because a compressible ureterocele may become completely decompressed in a full bladder. Pressure on the flank may distend the ureterocele, making it more readily identifiable [2]. If the bladder is overfilled at endoscopy, the ureterocele may be effaced and appear like a wide-mouthed diverticulum. When the typical radiological features of a renal duplication are not apparent, it is sometimes helpful to inject the ureterocele with contrast medium through a fine endoscopic needle to delineate the characteristics of the upper pole kidney and ureter.

Treatment

Once the ureterocele is diagnosed management should proceed in a logical sequence. Factors that influence the choice of management include the presentation of the patient (i.e. antenatally detected or symptomatic), the age of the patient, the type of ureterocele (i.e. ectopic or intravesical), the function of each renal segment if associated with a duplex system, the presence or absence of reflux in other segments, or infection [17,26]. Because of these many clinical variables, no single method of treatment suffices for all cases and the management of each patient with ureterocele must be individualized. Nevertheless, the general goals of ureterocele treatment can be applied to all patients. These include maximal preservation of renal function, prevention and treatment of VUR, unobstructed drainage of all functioning parenchyma, prevention of BOO, prevention of any bladder wall defects, e.g. diverticula, maintaining continence and the removal of any potential source of infection [4,26]. Minimizing surgical morbidity is a goal that must be added to these considerations.

The timing of the surgical intervention is also critical. The benefits of early treatment of the ureterocele should be weighed against the risks of anaesthesia in newborns and the technical difficulties of complex lower urinary tract reconstruction in small children [26].

From these clinical, functional and anatomical variables the treatment decision will be aimed at either preservation of the upper tract or upper-pole heminephrectomy. The upper tract could be preserved by endoscopic incision with or without surgical reconstruction of the urinary tract. Upper pole heminephrectomy is also carried out with or without lower tract reconstruction. Other treatment options include expectant treatment and total nephroureterectomy. Comparing these methods is difficult because they are appropriately applied to patients with different clinical presentations. Skill in all methods of management is important and an understanding of when to apply these methods is critical [26].

Endoscopic incision

Initial techniques of complete endoscopic resection of ureterocele resulted in VUR in up to 100% of patients [27–31]. Therefore, an endoscopic incision was initially reserved for emergency draining of infected ureteroceles. In 1985, endoscopic treatment was revived by Monfort *et al.* [18], who observed that puncture or limited incision are less likely to create VUR than unroofing of the ureterocele. Since then the indications for endoscopic treatment have gradually broadened among urologists.

For an intravesical ureterocele, the small opening is made at the lowest level above the bladder neck. For an ectopic ureterocele, two openings are made, one at the lowest level above the bladder neck and another in the urethral segment. Alternatively, a longitudinal incision is extended from the distal extent of the ureterocele through the bladder neck sufficiently proximal to ensure that bladder neck closure does not occlude this opening [17]. The puncture or the limited incision can be made by a 3 F Bugbee electrode or the metal stylet of a ureteric catheter which is extended just beyond the catheter. Some authors prefer using the potassium titanyl phosphate laser with a small fibre (0.4–0.6 mm) and lower energy (4–8 W) to incise the ureterocele [26].

Endoscopic incision or puncture carries the advantages of being simple, minimally invasive, requires only a short anaesthetic and usually can be undertaken as an outpatient procedure. Most urological reports agree that endoscopic treatment of intravesical ureteroceles is likely

to be successful and definitive [17,32–34]. Blyth *et al.* [17] showed that this technique was definitive, enabling treatment in 93% of intravesical ureteroceles. In a recent study, Pfister *et al.* [34] reported that endoscopic treatment alone proved effective in 14 of 16 intravesical ureteroceles in neonates.

Although the role of endoscopic treatment has been established in the management of intravesical ureteroceles, there is no consensus on its effectiveness for treating ectopic ureteroceles. Some authors consider it as the first-line treatment in all neonates and in older children, and others limit its use for specific indications only. Proponents of primary ureterocele puncture argue that it relieves the obstruction of not only the involved segment, but also the lower pole ureter and bladder neck if they are affected. This allows recovery of function in the involved segment and prevents infection. If an endoscopic incision does not result in a cure, it allows the delay of definitive treatment until the child is larger, when the now decompressed system can be more easily reconstructed [18,35–37]. On the other hand, authors against the early endoscopic treatment of ectopic ureterocele argue that this approach is problematic as it rarely constitutes definitive therapy or improves overall renal function significantly, and it may commit the patient to future lower tract reconstruction that might not otherwise be necessary [38]. This approach failed to decompress the involved system in 10–25% of cases and new persistent VUR was created in 30–47% of patients [17,37]. Husmann *et al.* [32] avoided the endoscopic approach in patients with no pre-existing VUR for this reason, but recommend its routine use in newborns with high-grade VUR. In one recent study, although secondary surgery is frequent in ectopic ureteroceles (18/21, 86%), the authors suggest early endoscopic incision as the first-line treatment of ectopic ureterocele [34]. Nevertheless, most urological investigators agree that endoscopic puncture of an ectopic ureterocele is indicated mainly for uncontrolled sepsis and azotaemia with BOO with or with no ureterocele prolapse.

Upper pole heminephrectomy with no lower tract reconstruction

This is called the upper tract or simplified approach, in which the upper pole segment is removed and the ureterocele aspirated from above. This is usually effective in achieving decompression, otherwise an endoscopic incision is carried out. Proponents of this approach argue that the contribution of the involved segment to total renal function is usually low (< 10%). In the study by Vates *et al.* [39] of ectopic ureters and ureteroceles, heminephrectomy did not significantly reduce ipsilateral differential renal function and the segment removed was frequently dysplastic or scarred. Moreover, there is evidence that renal duplication is associated with supranormal function [40]. Therefore, there is little support for salvage of a segment with negligible function [38]. Patients with ureteroceles who have a non-functioning upper segment and low-grade or no VUR are amenable to this approach. In some patients, no further reconstruction is necessary or at least reconstruction is delayed until the size of the patient allows greater chance of technical success [28,41,42].

Upper pole heminephrectomy with lower tract reconstruction

This approach is termed the 'combined approach' or complete reconstruction, and includes upper pole heminephrectomy through a flank incision, ureterocele excision and ipsilateral lower pole ureteric reimplantation via a separate lower incision. All management objectives can be met in one operation. The primary application of this technique is in patients who clearly have no function of the upper pole system but high-grade reflux into the ipsilateral lower pole ureter or contralateral ureter [26]. If an initial partial reconstruction is undertaken in this setting (i.e. upper pole heminephrectomy with partial ureterectomy), there is a higher risk that a secondary procedure will be required [4,42,43]. Scherz *et al.* [43] compared the need for further surgery in patients treated with the upper urinary tract approach alone, with those who had a combined upper and lower urinary tract approach in children with ectopic ureteroceles. Of 19 evaluable patients who had the upper urinary tract approach alone, nine required reoperation for recurrent reflux or infection. In contrast, of 28 patients who were treated with the combined approach, only four (14%) required reoperation, all for VUR. These authors consider that the combined approach is better because of its lower reoperation rate.

Despite complete reconstruction achieving all treatment objectives in one operation, it can be a formidable reconstruction, especially as most ureteroceles present at a very young age. The operation is technically challenging, particularly in neonates. The bladder level operation may require the repair of a sizeable defect in the bladder base, and tapering or plication of the lower ureter may be needed for successful reimplantation. Because of these difficulties some surgeons recommend a two-stage approach [44]. Upper pole heminephrectomy can be performed initially, followed by lower tract reconstruction at a later, safer age. King *et al.* [28] reported improved success with delayed ureteric reimplantation after initial ureterocele decompression with heminephrectomy. None of their patients required reoperation for reflux, compared with a 43% reoperation rate when reimplantation was part of the initial procedure. Endoscopic incision also can be used as an initial procedure in these patients, as described previously.

Upper tract preservation

The frequent use of prenatal US allows the earlier detection of patients with ureteroceles who may have some function of the upper pole segment. If the goals of management can be met with lower tract reconstruction alone, this would be the ideal approach. The ureterocele is dissected off the bladder to the point where it joins the lower pole ureter. Then the ureters are dissected as a unit, the upper and/or lower pole ureters tapered as needed, and both ureters reimplanted submucosally [6]. To prevent kinking of the ureters the bladder is usually hitched to the psoas muscle; this technique also stabilizes the submucosal tunnel.

However, in patients with severe anatomical abnormalities of the bladder or ureter, this may not be possible. Under such condition, ureteropyelostomy or ureteroureterostomy may be used [28,45]. This should be reserved for patients with no reflux into the ipsilateral lower pole ureter. Ureteropyelostomy is preferable to a distal uretero-ureterostomy because the latter is prone to the 'yo-yo' reflux that can detrimentally affect urinary drainage and lead to stasis, infection and ureteric dilatation.

Expectant management

Non-operative management has been proposed by some authors in asymptomatic neonates with antenatally detected ureteroceles [9,46]. Rickwood *et al.* [9] reported on five patients with antenatally diagnosed ureteroceles who were managed expectantly. They remained asymptomatic and had stable upper urinary tracts on serial US, with a mean follow-up of 2.3 years. Likewise, Jee *et al.* [46] expectantly managed 10 neonates with antenatally detected ureteroceles for a mean (range) of 34 (12–84) months, during which the anatomy and function of the upper renal tracts remained stable. Although it appears that expectant management may be useful in some asymptomatic neonates with antenatally or incidentally discovered ureteroceles, further data on the natural history of these ureteroceles are necessary before this can be suggested as a reasonable option.

'Cobra-head' adult ureteroceles are often incidental findings that require no treatment. They may contain a small calculus which can be easily extracted endoscopically by ureteric meatotomy and are less likely to have postoperative reflux in the incised ureterocele.

Total nephroureterectomy

In a few children with massive lower pole ureteric reflux and no visualization and function of both upper and lower renal segments, excision of the ureterocele and complete nephroureterectomy are indicated.

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Abbreviations: **US**, ultrasonography.