Management of the Bladder and Calyceal Diverticulum

Options in the Age of Minimally Invasive Surgery

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KEYWORDS

• Bladder diverticulum • Calyceal diverticulum • Children • Minimally invasive surgery • Robotics • Laparoscopy • Ureteroscopy

KEY POINTS

- Bladder diverticulum is a protrusion of the urothelial mucosa at a weak site of the muscular layers of the bladder.
- A calyceal diverticulum is a cavity within the renal parenchyma caused by narrowing of the forniceal or infundibular neck.
- Most of these entities are asymptomatic and may not require surgical intervention.
- If surgery is indicated, various minimally invasive treatment options including laparoscopy, robotic surgery, ureteroendoscopy, and percutaneous procedures have success rates at least equivalent to those of traditional open surgery in the pediatric population.
- Reduced morbidity, decreased hospital length of stay, improved cosmesis, and reduced pain medication requirements are potential advantages of the minimally invasive treatment modalities.

INTRODUCTION

Bladder and calyceal diverticula are rare clinical entities in children. Bladder diverticulum is defined as protrusion of the urothelial mucosa at a weak site of the muscular layers of the bladder, whereas calyceal diverticulum is a cavity within the renal parenchyma caused by narrowing of the forniceal or infundibular neck. The true incidence of both situations remains unclear because most of them are asymptomatic and may not require intervention. The estimated percentage of bladder diverticula is approximately 1.7% of symptomatic children.[1] On the other hand, the incidence of calyceal diverticula was reported to be between 0.21% and 0.6% of in children who underwent intravenous urography.[2] In this review, these 2 different entities are discussed separately.

BLADDER DIVERTICULUM

There are 2 types of bladder diverticula in children: congenital (primary) and acquired (secondary). Although several theories for the congenital

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diverticula exist, the exact etiology still remains uncertain. One theory was proposed by Stephens[3] in 1979, who indicated that the diverticula occur because of "failure of muscle layer."[3] In that circumstance, either the complete absence or hypoplasia of detrusor muscle led to mucosal protrusion regardless of the normal voiding pressures. Garat and colleagues[4] examined the histologic appearance of the bladder diverticula in 7 children after surgical excision, and concluded that detrusor muscle fibers were present in all cases. Although the muscle fibers were histologically thin, these findings support the hypoplasia theory rather than the complete absence of the detrusor layer.

It has been reported that approximately 90% of congenital bladder diverticula are located adjacent to ureteral orifices.[5] These diverticula were first described by Hutch[6] in 1952 after his finding of a diverticula located superolaterally to the ureteral orifice. He also demonstrated the association of vesicoureteral reflux (VUR) and the diverticula in the same study. At present, diverticula in close proximity to the ureteral orifices are commonly referred to as Hutch diverticula in accord with this first description. The appearance of a Hutch diverticula is shown in **Fig. 1**. Previous reports have associated Hutch diverticula with VUR and varying degrees of renal dysplasia.[4,5] In addition, 10% of bladder diverticula can be located on the posterolateral wall of the bladder and are not associated with the ureteral orifices. These diverticula tend to be large and symptomatic, whereby children with posterolateral diverticula usually present with urinary stasis, retention, recurrent infections, and stone formation.

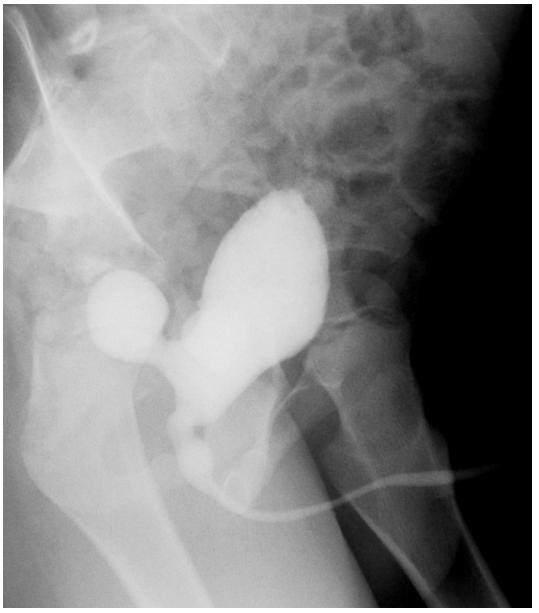

Fig. 1. Oblique appearance of a right-sided Hutch bladder diverticulum.

Secondary or acquired diverticula arise secondarily to high intravesical pressures of the bladder, which may be secondary to neurogenic diseases in children such as spina bifida. In addition, nonneurogenic diseases such as bladder outlet obstruction associated with posterior urethral valves (PUV) and urethral strictures can also lead to diverticula formation. Other causes may be iatrogenic as a result of previous bladder surgery.

Genetic predisposition and syndromic association of bladder diverticula have been described in the literature. Ehler-Danlos syndrome, Williams elfin facies, and Menkes kinky hair syndrome are some of the syndromes that may lead to higher risk for bladder diverticula in children.[7–9]

Most bladder diverticula are asymptomatic, small, and diagnosed incidentally during the clinical workup for urinary tract infections. The most common presentation in these children is recurrent urinary tract infections. Large diverticula may be associated with urinary stasis and incomplete emptying of the bladder,[10] which may lead to the urinary tract infections and bladder stones. Bladder diverticula may even present with pyelonephritis, whereby VUR was associated with the diverticula in a case report.[11] Lower urinary tract symptoms such as urinary frequency and nocturnal enuresis are other potential presenting symptoms, in addition to hematuria.[12] Although rarely seen, some children may present with urinary retention requiring clean intermittent catheterization.

Voiding cystoureterography (VCUG) is the gold-standard imaging method in the diagnosis of bladder diverticula. VCUG also provides additional information regarding the presence of VUR and the anatomy of the posterior urethra. Renal and bladder ultrasonography (US), computed tomography (CT), and intravenous pyelography (IVP) are other imaging modalities that may be helpful in diagnosing this rare clinical entity. In patients with affected upper urinary tracts, dimercaptosuccinic acid (DMSA) renal scan elucidates the differential function of the kidney and the presence of renal scarring.

Indications and Contraindications

The absolute indications for surgical management of bladder diverticula are still undetermined. For incidentally diagnosed asymptomatic small diverticula, close observation is an acceptable treatment option. As a general guideline, large