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Pediatric calyceal diverticulum treatment: An experience with endoscopic and laparoscopic approaches

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Introduction
The symptomatic calyceal diverticulum is a rare event in the pediatric population. In adults, surgical options include ureteroscopy, percutaneous ablation, and laparoscopic decortication but there is a lack of experience in the literature with these techniques.

Objective
We present our experience with both the ureteroscopic and laparoscopic approach to treating the pediatric calyceal diverticulum.

Study design
We performed a retrospective case series looking at patients who underwent treatment for calyceal diverticulum at our institution from January 2009 to May 2014. We reviewed patient demographics, indications for intervention, radiographic appearance, type of intervention, and perioperative outcomes. Ureteroscopic approach included dilation of infundibulum and ablation of diverticular cavity. Laparoscopic approach included ablation of the diverticulum with argon diathermy with or without surgical closure of the ostium.

Results
There were 13 patients who underwent 15 procedures for symptomatic calyceal diverticulum (Table). Median age was 11 years. Indications for intervention were: pain and increasing size of diverticulum (8/15, 55%), hematuria (3/15, 20%), UTI (3/15, 20%), and calculi (1/15, 5%). 11/15 (73%) procedures were managed endoscopically and 4/15 (27%) were managed with laparoscopic decortication. Ureteral stent was left in all patients for a mean duration of 51 days (15–120 days). Follow up imaging at median of 2.1 years (0.5–4 years) revealed an initial success rate of 85% (11/13 patients). Two patients failed initial intervention (persistent pain/increasing size) necessitating successful secondary minimally invasive procedures. There were 2 (13%) complications: a perinephric hematoma post endoscopic ablation which resolved spontaneously and a deep venous thrombosis in a patient with a coagulation disorder in the laparoscopic group.

Discussion
Limitations of our study include its retrospective design, lack of standardization of the treatment approach amongst the four treating surgeons, and the small number of patients requiring intervention for this relatively rare diagnosis. Our study is the largest to date in the pediatric population and is the first to report outcomes with ureteroscopic management of the calyceal diverticulum.

Conclusions
We found that the pediatric calyceal diverticulum can be successfully treated in a minimally invasive manner. The endoscopic approach should be the first line option for patients with small, endophytic diverticula, particularly those located in the upper and mid pole. The laparoscopic approach is more invasive but should be considered for large diverticula that are exophytic with thin overlying parenchyma.

Table Summary of patient data. Complications classified according to clavien-dindo system.

	Endoscopic	Laparoscopic
Number of patients	9/13 (73%)	4/13 (27%)
Size: median cm (range)	2.3 (1.3–3.5)	5.8 (2–10)
Median decrease in size (cm)	1.0 (0–2)	3.0 (2.4–7.2)
Median OR time, minutes (range)	69 (13–97)	172 (107–197)
Median length of stay, days (range)	0.25 (0.2–1.2)	2 (1.9–4)
Failure of initial therapy	2/9	0/4
Complications	Repeat procedure 2 (Clavien IIIb) Perinephric hematoma 1 (Clavien I)	DVT 1 (Clavien II)

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Introduction

A calyceal diverticulum is an outpouching of the collecting system, which is lined with transitional epithelium that is non-secretory [1,2]. The connection with the collecting system allows passive filling and the cavity can enlarge due to narrowing of the infundibulum and urine stasis, which can result in stone formation and infection. The exact etiology of calyceal diverticulum development is unknown, but it is thought to be either congenital due to ureteric bud regression failure or secondary to an inflammatory or obstructive process in response to infection or reflux [1,3,4]. Two anatomic types have been described in the literature: Type 1 is more common, arising from a minor calyx and more likely to be asymptomatic lying in the polar region of the kidney; Type 2 arises directly from the renal pelvis or major calyx and the diverticular are more likely to be larger in size and symptomatic [2]. Although a rare entity [1,4,5], surgical intervention is warranted when the patient presents with symptoms including pain, stones, infection, and increasing size.

Methods of intervention in the adult literature include endoscopic, laparoscopic, and open approaches [6,7]. Extracorporeal shock wave lithotripsy and open surgery have been surpassed by other more-effective minimally invasive techniques [8]. The endoscopic approaches include either retrograde ureteroscopy, direct percutaneous ablation [7,9—11] or a combination of the two [12]. Direct percutaneous ablation is accomplished in a similar manner to percutaneous nephrolithotripsy (PCNL), with stone removal, if needed, and ablation of the diverticulum cavity [9]. The ureteroscopic approach can be utilized if the tract to the diverticulum is accessible in a retrograde fashion. Postoperative management typically includes an internal ureteral stent. Laparoscopic or open intervention involves removal of the wall or roof of the diverticulum and closure of the neck or infundibulum by fulguration or suture ligation [13,14]. Postoperative management typically includes bladder drainage with a Foley catheter, a ureteral stent, and a perinephric drain in the laparoscopic approach.

To date, calyceal diverticulum management in the pediatric literature is limited to two studies utilizing the laparoscopic, open, and PCNL approaches [5,14]. There is no consensus within the pediatric literature regarding ideal calyceal diverticulum management and no experience with the ureteroscopic approach. The present study hypothesized that pediatric calyceal diverticulum can be successfully treated with minimally invasive surgery. Herein, experience with the endoscopic and laparoscopic approaches is presented.

Materials and methods

The prospective, internal-review-board-approved database was searched to identify patients who had undergone treatment for calyceal diverticulum from January 2009 to May 2014. Demographic information including age, sex, and laterality were recorded. Indications for intervention included pain, increasing size of diverticulum, stones within the diverticulum, hematuria, and infection. Preoperative imaging included renal bladder ultrasound (RBUS), magnetic resonance urography (MRU), and/or CT urography (CTU). Diverticula were characterized by polarity (upper, mid, lower pole) and degree of endophycity, which was defined as $<$50% of the lesion outside the border of the kidney (endophytic) or $>$50% outside the border of the kidney (exophytic). At the time of intervention all procedures began with a retrograde pyelogram to confirm the presence of a calyceal diverticulum (if no CTU or MRU was performed pre-operatively) and to place a ureteral stent. If no connection with the collecting system was identified, the lesion was treated as a simple cyst and was treated with laparoscopic decortication, if symptoms warranted intervention.

Either a ureteroscopic or laparoscopic approach was used to treat the calyceal diverticulum. The antegrade percutaneous approach was not used as it is felt that this is an inferior approach compared to URS and laparoscopic intervention [5].

The ureteroscopic approach was as follows: a cystoscopy and retrograde pyelogram were performed to delineate the anatomy, including the location and length of the diverticular infundibulum. A soft-tip wire was passed directly into the diverticulum (if feasible) and balloon dilation of the tract was performed. When unable to pass the wire directly into the lumen due to a narrow infundibulum, an initial attempt was made under direct vision with the ureteroscope. If the lumen was too narrow, the tract was incised with the holmium laser. Once sufficiently dilated, an 8-Fr flexible ureteroscope was then advanced into the diverticulum and the cavity was ablated with either cautery or the holmium laser. After dilation and ablation, one or two double J stents were left across the dilated tract and removed 2—8 weeks later (at the present institution the median stent duration was 45 days). For younger children, a 4.6-Fr ureteral stent was used, while in adolescents, a 6-Fr ureteral stents was used. The decision to place two ureteral stents was based upon the capacity of the tract and ureter to accommodate increased stent size; the preference at the present institution was to place two stents, if possible.

The laparoscopic approach was performed via both traditional and single port techniques. Prior to obtaining laparoscopic access, a retrograde pyelogram was performed to confirm the presence of a calyceal diverticulum and to localize the infundibulum. An internal double J stent was left in the renal pelvis. Patients were placed in the flank position and access was obtained via the Hasson technique for both approaches. Single port access was within the umbilicus and the entire procedure was performed via this port. For traditional laparoscopy, subxiphoid and ipsilateral lower abdominal ports were placed in addition to the umbilical port. Once the kidney was exposed, the roof of the diverticulum was incised and, if visible, the neck of the infundibulum was either sutured closed or fulgurated. The bed of the diverticulum was then ablated with the argon beam, and a perinephric drain was left in place. Postoperatively, the Foley catheter was removed when minimal drain output was noted, and the internal double J stent was removed 2—8 weeks post excision (median stent duration was 41 days). If the perinephric drain demonstrated a urine leak after Foley catheter