Radiological and clinical findings of calyceal diverticula in children

Poster No.: C-1982
Congress: ECR 2016
Type: Educational Exhibit
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Keywords: Diverticula, Diagnostic procedure, Ultrasound, MR, CT, Paediatric
DOI: 10.1594/ecr2016/C-1982

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Learning objectives

· Explain and illustrate the typical and atypical presentations of pyelocaliceal diverticulum in the pediatric patient.

· Describe and illustrate the imaging appearances of calyceal diverticula across the spectrum of imaging modalities.

· To review the radiological and clinical aspects of the different types of pyelocaliceal diverticulum, with special reference to the differential diagnosis and pitfalls associated.
Background

Pyelocaliceal diverticula are cystic eventrations of the upper urinary tract lying within the renal parenchyma that are lined by urothelial epithelium and communicate through a narrow channel into the main collecting system (1-4). Their anatomy often leads to urinary stasis, which promotes bacterial growth and stone formation. The formation of calculi within a calyceal diverticulum occur secondary to a combination of urinary stasis and recurrent infection within the diverticulum (3, 5).

Epidemiology

They occur equally in men and women and are seen in children and adults and there is no predilection for the left or right side. Although the incidence in children mirrors that of adults, children are more likely to present with symptoms that include pain, stone formation, and infection. Some children with complications may need surgical treatment to obliterate the diverticulum before clearance of calculi, if present (4,5).

Calyceal diverticulum is likely underdiagnosed because it often appears as a simple renal cyst on ultrasound and non-delayed contrast CT studies (2). However the increasing use of cross-sectional imaging, in particular CT urography, has resulted in the increased detection of calyceal diverticula, although the majority of calyceal diverticula can be diagnosed by ultrasound (3).

Etiology

The exact etiology of calyceal diverticula is unknown, although the majority of investigators have favored congenital over acquired origins, due to ureteric bud regression failure, furthermore, the similarity in incidence in children and adults is consistent with an embryologic cause (1,5,6). Acquired calyceal diverticula have also been reported in adults after fibrosis from infection causing stenosis of a calyceal infundibulum or a ruptured renal cyst (2,4).

Classification

Calyceal diverticula are classified as type I, those communicating with a minor calyx or an infundibulum, and type II, those emanating from the renal pelvis or a major calyx. Type I is the more common form calyx and is usually found in the upper pole. Type II diverticula are larger, tend to be symptomatic, and are located in the interpolar region of the kidney (1,5,6).
Diagnosis

The majority of patients with calyceal diverticula are asymptomatic, and diverticula are frequently found incidentally on routine imaging studies performed for other reasons. One-third to one-half of patients, however, present with flank pain, hematuria, abscess or recurrent urinary infections, thus the diagnosis is not always easy (1,4). A frequent and potentially serious complication associated with calyceal diverticulum is stones (1,2,5). Stones form within calyceal diverticula in up to 50% of cases (1,5).

Although usually benign and uncomplicated themselves, calyceal diverticula may mimic other conditions on radiological imaging. Thus knowledge of calyceal diverticula is important so that they can be distinguished from other more serious pathology (2,5).

Imaging findings

In general, calyceal diverticula have the appearance of a well-defined, thin walled structure containing urine. Up to 50% contain calcifications in the form of milk of calcium or more formed calculi, which lie within the diverticulum itself (5,7). Characteristically these calcifications move with changes in position (3,5).

Calyceal diverticula is not seen on plain radiography. If calcifications are present, these may be visible, as with other renal calculi (5).

Ultrasound examination is the basic examination in children, may reveal presence of renal cyst, but will not visualize its connection to the pelvicalyceal system. Demonstration of echogenic sediment, resizing, irregular morphology of wall and material inside may suggest a diagnosis of diverticulum (3,8). The presence of mobile hyperechogenic material within a cystic structure is diagnostic of a calyceal diverticulum (5,9).

Diagnostic problems are related to similarities between diverticulum and solitary renal cysts, which do not necessitate extended diagnostics in children. Diverticula mimic solitary or multiple fluid-filled spaces located within one or both kidneys requiring additional diagnostic procedures in case of complications or diagnostic difficulties (2,8,10).

On early phase contrast computed tomography (CT), calyceal diverticula appear as small, round, low- attenuation areas adjacent to the calyces. CT without late phase does not suffice for proper diagnosis. Moreover, slight increase in density of diverticular content in the parenchymal phase may be misdiagnosed as solid tumor enhancement (1,8). For that
reason, diagnostics of cystic renal lesions in computed tomography in children should include imaging in the excretory phase (1,2,5,8,11).

Due to the increasing use of ultrasound and CT, intravenous urography (IVU) is used less commonly. However, calyceal diverticulum may be readily demonstrated on IVU and may be diagnostic (5,6,9).

MRI could offer an alternative that avoids the use of ionizing radiation, similar to reconstructed CT images, multiplanar MRI can delineate calyceal diverticula and their infundibulum (3,6).

Calyceal diverticula may be misdiagnosed as renal tumors using fluorodeoxyglucose F-18 positron emission tomography (FDG-PET) (8). Tracer may accumulate in the diverticulum, leading to intense areas of focal uptake on the scan. With the increasing use of PET-CT as an imaging modality, it is important to recognize this as a potential pitfall, and to correlate the PET findings with the CT component of the examination (5).

Connection between fluid collection and collecting system confirmed by imaging studies is the key diagnostic finding.

**Differential diagnosis** Table 1 on page 7

Differential diagnoses, which must be distinguished from calyceal diverticula on imaging include: hydrocalyx, simple cyst, parapelvic cyst, tubercular cavity, papillary necrosis, abscess renal tumor as well as autosomal dominant polycystic kidney disease (2,3,6,8,12).

Hydrocalycosis is simply hydronephrosis of a calyx secondary to infundibular obstruction. Simple cysts are unilocular and do not connect with the pelvicalyceal system. Parapelvic cysts are found adjacent to the renal pelvis; like simple cysts, they do not communicate with the collecting system (5,6,9,10). Papillary necrosis is found in the renal medulla and is associated with nonsteroidal anti-inflammatory drug abuse and systemic conditions, such as sickle cell disease or diabetes mellitus. Renal abscess may exhibit an irregular enhancing wall, gas within the mass, hypooattenuation in the surrounding renal parenchyma, renal fascia thickening and obliteration of the perinephric fat and the difference with renal tumors lies in the recognition that apparent enhancement represents delayed filling of a calyceal diverticulum from the collecting system, rather than vascular supply to a cystic mass (1,3,5,6,9,10).
Treatment

Standard management of calyceal diverticula in children includes ultrasonographic follow-up and conservative treatment and rarely requires surgical intervention removal (6,8,11).

Management depends on symptoms; if uncomplicated and asymptomatic there is usually no need for intervention. If symptomatic, for example with recurrent urinary tract infection or pain, then intervention is considered. (6,8,13). Indications for operative intervention include chronic pain, recurrent urinary tract infection, gross hematuria, or decline in renal function (1,13).

Historically this included open surgery, however current practice involves less invasive techniques, including stone removal via shock wave lithotripsy, ureteroscopic lithotripsy, percutaneous nephrolithotomy, or laparoscopic removal (2,5,6,11).

The endoscopic approach should is suggested 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 (13).

The diagnosis of CD is important for planning the interventional approach, as communication between the cyst and the collecting system may enable the surgeon to approach the cyst using endoscopy rather than addressing it percutaneously (2).
Table 1: Differential diagnosis table for calyceal diverticulum.

Findings and procedure details

Clinical and imaging data of 7 patients with pyelocalyceal diverticulum were retrospectively examined. We reviewed presenting symptoms, diseases, complications, and all radiological examinations. Different forms of presentation were found, abscess, hematoma, stones, urinary tract infections, hematuria and asymptomatic cases. All patients underwent ultrasound as the initial imaging study; the suspicion diagnostic was established with features like: resizing, hyperechoic wall without calcium, irregular morphology and material inside. Then the diagnostic was confirmed by CT or MIR demonstrating a connection between this fluid-filled space and pelvicalyceal system.

Fig. 1: 10 year old girl with histiocytosis. US shows fluid filled structure with thin wall and stone inside. CT delayed phase imaging demonstrates infilling of the diverticulum, later than the pelvicaliceal system, confirming the diagnosis of a stone-bearing calyceal diverticulum.

References: Radiology, Hospital Universitario y Politecnico LA Fe, B - Valencia/ES

Fig. 1 on page 13
Fig. 2: 9 year old female with a history of abdominal pain. Longitudinal image from ultrasound demonstrates a cystic lesion in the upper pole of the right kidney. The lesion contains area of hyperechogenicity with posterior acoustic shadowing suggestive of calcification. CT scan confirmed ultrasound findings of a cystic area in the upper pole of the right kidney, precontrast axial image demonstrates focal area of internal calcification. TC examination revealed contrast filling of the cyst, delayed phase demonstrates level of the contrast and increased enhancement of fluid within the cyst, confirming communication between the renal cyst and the collecting system.

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Fig. 2 on page 13
Fig. 3: 5 year old girl with a history of fever, laboratory tests revealed elevated inflammatory markers and urinary tract infection. Ultrasound examination demonstrated a fluid-filled space with thick, heterogeneous content forming a fluid-sediment level, which was initially interpreted as abscess, patient was subsequently referred for abdominal CT, which confirms communicating with the pelvicalyceal system.

References: Radiology, Hospital Universitario y Politecnico LA Fe, B - Valencia/ES

Fig. 3 on page 14
**Fig. 4:** Calyceal diverticulum with hematoma inside in a 9-year-old boy who had abdominal trauma.

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**Fig. 4 on page 17**

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**Fig. 5:** 13 year old boy. US shows cystic renal lesion in close proximity to the renal sinus with curvilinear wall which alerts radiologist to the potential presence of calyceal diverticulum. MIR reveals contrast filling of the cyst, delayed phase demonstrates level of the contrast and increased enhancement of fluid within the cyst, confirming communication between the renal cyst and the collecting system.

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**Fig. 5 on page 15**
**Fig. 6:** 12 year old boy with testicular pain. Ultrasound examination showed a thin-walled cyst filled with non-echogenic fluid, with hyperechoic wall and irregular morphology in the upper pole of the left kidney suggesting presence of a diverticulum. Intravenous urography was performed in order to verify these findings.

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**Fig. 7:** An 18-month-old girl presented with a urinary tract infection and right upper pole renal cyst in US, the suspicion diagnostic was established with hyperechoic wall and irregular morphology of cyst. Contrast CT demonstrates a cystic lesion at the upper pole of the right kidney, delayed phase shows level of the contrast and increased enhancement of fluid within the cystic cavity when compared with the normally enhancing renal parenchyma confirms the presence of an upper pole calyceal diverticulum.

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Images for this section:

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Fig. 4: Calyceal diverticulum with hematoma inside in a 9-year-old boy who had abdominal trauma.
Conclusion

- Calyceal diverticula are rarely diagnosed in children. They can mimic other renal cystic lesions, connection between fluid collection and collecting system confirmed by imaging studies is the key diagnostic finding.

- Calyceal diverticulum can have many forms of presentation.

- A calyceal diverticulum can often be misinterpreted as a complex cystic lesion however it can be differentiated by ultrasound appearances (resizing, morphology, wall features and material inside).

- Correct diagnosis is important for guiding management and prevents complications.

- Standard management of calyceal diverticula in children includes ultrasonographic follow-up and conservative treatment and rarely requires surgical intervention.


