Ultrasound-Guided Totally Tubeless Mini-Percutaneous Nephrolithotomy for a Completely Excluded Caliceal Diverticulum Associated with Challenging Anatomy

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Abstract

Mini-percutaneous nephrolithotomy (mini-PCNL) has been described as a safe and effective technique to eliminate stones in patients in whom a less-invasive approach is desired. It was originally developed to treat stones in the pediatric population, but has since been adapted to serve a role in the adult urologic community. This approach has been reported to result in less blood loss and postoperative pain when compared with traditional PCNL. Herein, we present a case in which a recurrent caliceal diverticulum containing stones was managed using a mini-PCNL technique in a patient who previously failed multiple other retrograde endoscopic approaches.

Keywords: percutaneous nephrolithotomy, urolithiasis, CT imaging

Introduction

CALICEAL DIVERTICULA ARE OUTPOUCHINGS of the collecting system into the corticomedullary region of the kidney and they usually arise from the fornix of a calix. Typically found in the upper or lower pole, they are lined by transitional epithelium, are smooth walled and spherical in shape, and communicate with the pelvicaliceal system by a thin channel or neck. They can range from a few millimeters to several centimeters. Although most are congenital some can be caused by blunt trauma or obstruction of a caliceal infundibulum. Patients are most often asymptomatic unless a

stone forms within the diverticulum.¹ The incidence in the general population is reported to be between 0.5% and 4.5%.¹ Passage of stone into the diverticular neck can cause pain and hematuria.

Multiple treatment options have been documented for caliceal diverticular stones in symptomatic patients, including transperitoneal laparoscopy, retrograde endoscopy, shock-wave lithotripsy, and percutaneous nephrolithotomy (PCNL).^{1,2} Each of these has their own unique set of risks and benefits and should be considered based on the patient body habitus and characteristics of the stone and diverticulum such as size and location. We present this case as a demonstration of

FIG. 1. Coronal (A) and axial (B) CT images showing an isolated upper pole diverticulum with innumerable pooling calculi. CT, computed tomography.

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FIG. 2. Stone twinkle on ultrasound.

feasibility and efficacy of mini-PCNL in treating this condition without compromising the principles necessary for success.²

Clinical History

A 59-year-old woman was referred to our institution with a past medical history remarkable for hypertension, hyperlipidemia, nephrolithiasis, and recurrent urinary tract infections (UTIs). Her *Escherichia Coli* UTIs had occurred nearly continuously for 5 years. The patient underwent three separate retrograde endoscopic procedures by urologists at outside institutions for a caliceal diverticulum containing stones. In each instance stones were cleared. However, the caliceal diverticulum itself was never ablated during these procedures and thus there was recurrence of stone formation and UTIs.

The patient described a classic dull ache in her left flank region, which had been impacting her quality of life. Computed tomography (CT) urography demonstrated a relatively small residual bilobed left upper pole caliceal diverticulum, which could be classified as a type I diverticulum (Fig. 1) in the same location as her prior diverticulum. Within the out-pouching was a small clustering of radiopaque stones adjacent to the diaphragm and spleen with a retrorenal colon abutting the lateral aspect.

Physical Examination

The patient did not have costovertebral tenderness at the time of examination; however, she did complain of recurrent dull ache in her left flank. Her physical examination was otherwise unremarkable.

Diagnosis

Type I bilobed small caliceal diverticulum within the left upper pole of the kidney and clusters of radiopaque stones collected inside surrounded by the spleen, diaphragm, and colon; in a patient with nephrolithiasis, recurrent UTIs, hypertension and hyperlipidemia.

Intervention

The patient, who was an operating room nurse, was counseled regarding alternative options, and ultimately opted for mini-PCNL. The patient was placed in the prone and renal ultrasonography was used to identify the diverticulum and stones within it. Figure 2 demonstrates the “stone twinkle” seen within the diverticulum. A retrograde pyelogram demonstrated no contrast going into the diverticulum, indicating that it had become completely excluded from the collecting system. Ultrasonography in prone position showed the relationship of the diaphragm, spleen, and colon in juxtaposition to the diverticulum. By careful and precise maneuvering, an 18-gauge needle was placed with ultrasound guidance into the diverticulum, avoiding injury to the diaphragm, spleen, or colon (Fig. 3A). A guidewire was used to pierce through and through the diverticulum to create a straight and fixed pathway for dilatation (Fig. 3B). Next, a metallic mini-percutaneous sheath (size 16.5–17.5 French; Karl Storz, Germany) was advanced into the diverticulum using fluoroscopy (Fig. 3B). Several small stones were then removed using vortex effect.

The lining of the caliceal diverticular cavity was fulgurated by using a 5F Bugbee electrode on coagulation current at 10 W. The neck of the diverticulum was not identified even with retrogradely instilled methylene blue, confirming that it had become completely excluded from the collecting system, likely because of scarring from prior surgery. A totally tubeless procedure was performed, with no need for stent or nephrostomy, and the patient discharged on postoperative day 1. There were no intra- or postoperative complications.

Follow-Up

In follow-up the patient reported feeling well and the original flank pain present before the procedure had completely

FIG. 3. (A) Fluoroscopic image of caliceal diverticulum and stone within it, located at the arrow. Note dilated colon lateral to kidney. (B) Fluoroscopic image showing the mini-percutaneous sheath within the diverticulum.

FIG. 4. Ultrasound image of kidney post-treatment, demonstrating stone-free results.

resolved. A renal ultrasonography was obtained, which showed no identifiable stones or diverticulum (Fig. 4).

Discussion

Caliceal diverticula are often misdiagnosed and can mimic other pathology reports on various imaging modalities. On unenhanced CT scan they have been mistaken for a complicated renal cyst, whereas on a PET-CT they have been interpreted as a possible malignant tumor caused by their increased fludeoxyglucose uptake.¹

Diagnosis can be made with a multiphase contrast-enhanced CT with delayed images, where the cavity will be seen filling through retrograde reflux of the contrast from the caliceal system through a narrow neck on the delayed images. It is this anatomical property that also leads to false diagnoses on PET scan caused by accumulation of the tracer and the suggestion that there is increased metabolic activity in the area. For these reasons there must often be a high suspicion of a diverticulum in order for accurate diagnosis.¹

Although there are multiple treatment options available for caliceal diverticula, PCNL is an attractive option. It was initially developed to treat large stones in the pediatric population, but has since been adopted as a technique used in the adult population as well to provide a less-invasive approach. It may reduce morbidity associated with larger instruments as well as blood loss, postoperative pain, and renal damage.³ Mini-PCNL, being purportedly less invasive than PCNL, is an attractive option for this condition. To our knowledge there is one retrospective study out of China suggesting that mini-PCNL can be an effective method of treatment of caliceal diverticular calculi.⁴ Ding et al. retrospectively compared results of symptomatic caliceal diverticular calculi treated with mini-PCNL versus flexible ureteroscopy. They found that both were valid therapeutic approaches. However, it was found that a larger number of patients treated with mini-PCNL were

asymptomatic at follow-up when compared with the flexible ureteroscopy patient population (71.4% vs 46.7%). Likewise the mini-PCNL group achieved higher stone-free rates.

Our case further demonstrates the utility of mini-PCNL, but in addition shows ultrasound-guided access can make this an attractive option, particularly in cases where the diverticulum is deep in the collecting system or not easily seen on fluoroscopy, or where there are surrounding organs that could easily be injured with fluoroscopic access.

Conclusion

This case highlights the role of ultrasound-guided mini-PCNL as a therapeutic approach to treating caliceal diverticula and the stones that may collect within them, particularly in challenging cases with unusual anatomical features. It should be considered when a less-invasive technique is warranted and when patients have previously failed other approaches.

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Abbreviations Used

CT = computed tomography
PCNL = percutaneous nephrolithotomy
UTI = urinary tract infections

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