Original Article

Management of renal caliceal diverticular stones: A decade of experience

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Abstract

Objective: The objective of this study is to evaluate our methods for management of renal caliceal diverticular stones (CDS).

Materials and Methods: We conducted a retrospective study from January 2005 to July 2015 and included patients who were treated for renal CDS. Patients were evaluated for treatment modality, puncture site (in case percutaneous nephrolithotomy [PCNL] attempted), operative time, stone clearance rate, and complications. During PCNL, if the infundibulum was found to connect the diverticulum to the calyx, then a double J stent was placed. No attempt was made to dilate the diverticular neck or to create a neoinfundibulum.

Results: Twenty-four patients were treated for CDS during the study period. Two patients underwent shockwave lithotripsy, and 22 were managed by PCNL. Mean stone size was 16.37 mm (range: 6–35 mm) and mean diverticulum size was 20.62 mm (range: 12–37 mm). No fulguration was done in initial 17 patients, while fulguration by Holmium Laser was performed in the last five cases treated with PCNL. Mean operative time was 70.31 min (range: 47–90 min). Mean follow-up was 34 months, diverticulum resolved in 14 patients and reduced in size in 7 patients.

Conclusion: Caliceal diverticular calculi can be treated most efficiently by PCNL. Stone-guided puncture and no attempt to dilate or create neoinfundibulum reduces operative time and morbidity while yielding high stone-free rate.

Key Words: Caliceal diverticular stone, caliceal diverticulum, percutaneous nephrolithotomy

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INTRODUCTION

Rayer described caliceal diverticulum (CD) in 1841 as a congenital cavity in kidney parenchyma lined by nonsecretary urothelium communicating with calyx.[1] CD is found more commonly in females (male:female = 37:63) and present in both sides equally.[2] CD results from failed degeneration of the third or fourth division of ureteral buds of Wolffian duct.[3,4] 0.21%–0.45% of all excretory urogram (intravenous pyelogram [IVP]) demonstrates CD and 9.5%–50% of them contain calculi.[2] Urine is accumulated in CD by passive retrograde filling from communicating calyx. CD is asymptomatic most of the times but may cause flank pain,

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hematuria, or urinary tract infections.[2] Management options for caliceal diverticular calculus include extracorporeal shock wave lithotripsy (ESWL), flexible ureteroscopy, laparoscopy, or percutaneous nephrolithotomy (PCNL).[5-9] PCNL achieves high stone-free rates and in many cases causes resolution of CD.[5,10] In the past, staged PCNL (access by interventional radiologist followed by stone removal in the operating room) along with dilation of infundibular neck or creation of a neoinfundibulum was performed.[6,10,11] Now, fulguration of the CD lining after removal of stone is considered adequate management without attempting to establish communication with the collecting system.[12] In the literature, there are different techniques described for PCNL, but there seems to be no consensus regarding the best method for caliceal diverticular stone (CDS) removal. Herein, we discuss our experience in managing CDS over a period of approximately 11 years.

MATERIALS AND METHODS

We conducted a retrospective study from January 2005 to July 2015 and included patients of renal CDS treated at our center. Patients were evaluated for the size of CD, location of CD, stone size, treatment modality, puncture site (in cases of PCNL), operative time, stone clearance rate, and complications. Informed consent was obtained from all the patients before treatment.

Preoperative IVP was performed in all cases to evaluate the diverticulum and stone. Contrast-enhanced computed tomography of kidney ureter and bladder (CECT KUB) was performed if diverticulum anatomy could not be assessed on IVP. Patients were counseled regarding merits and demerits of different treatment modalities either surgery or ESWL was opted for with their consent.

ESWL was performed using the Dornier compact alpha-K1025163 (Dornier MedTech) under fluoroscopy guidance. Maximum 4000 shocks were applied in a single session (rate – 60 shocks/min). The ESWL setting was stopped when the calculus broke, or 4000 shocks were given. If the fragmentation was inadequate, repeat setting was done after 7–10 days. Patients were assessed after 1 month and 3 months by IVP/CT scan for success of ESWL. If stone was unbroken after two sessions, ESWL was regarded as unsuccessful.

During PCNL, cystoscopy was performed, and ipsilateral 5 French (Fr) open-ended ureteric catheter was placed till the renal pelvis. PCNL was performed in the prone position under general anesthesia. The direct stone-guided puncture was performed under fluoroscopic guidance using bull's eye technique. After percutaneous access, a 0.035-inch guidewire (Terumo, straight tip) was coiled in CD. Sequential metallic dilators (Alken) were used for tract dilation (up to 26 Fr), and rigid nephroscope (24 Fr, Richard Wolf, Germany) was used. Pneumatic lithotripter (Swiss LithoClast® 2 - Richard Wolf) was used to fragment the stone. CD was inspected to identify a connection with the calyx after stone removal. If communication could not be identified, methylene blue dye was instilled through the ureteric catheter. The guidewire was negotiated through the communication, and 5 Fr double J stent (DJS) was placed over it. Diverticular neck was not dilated. If the neck could not be identified, no attempt was made to create neoinfundibulum. CD fulguration was performed since 2012 in every case after we procured Holmium Laser (Auriga® StarMedTec GmbH 30 W , end firing fiber). A nephrostomy tube (18 Fr) was placed after the procedure. Postoperative X-ray and ultrasound of KUB (USG KUB) were performed on postoperative day (POD) 1. Nephrostomy tube was removed when drainage was minimal, and the patient was stone-free. IVP/CT scan was performed for follow-up imaging after 3 months to evaluate CD resolution. Annual X-ray and ultrasound (KUB region) were performed to look for stone recurrence.

RESULTS

A total of 24 patients (11 males and 13 females with a mean age of 35.37 years), (13 right kidney, 11 left kidney) were admitted and treated for CDS during the study period [Table 1]. One patient had CDS in the left solitary kidney.

Presenting symptom was flank pain in 19 (79.16%) patients, six patients had recurrent urinary infection, and one patient was diagnosed incidentally. IVP was performed in all 24 cases, while CECT KUB was performed in 8 cases. The CD was situated in the upper pole in 12 (50%), mid pole in 7 (29.16%), and lower pole in 5 (20.83%) patients. Mean stone size was 16.37 mm (range: 6–35 mm), and mean CD size was 20.62 mm (range: 12–37 mm).

Three patients underwent ESWL as per their personal preference. Two patients had complete clearance of stone in ESWL group after one setting. In one patient, stone was not fragmented even after three settings of ESWL. This patient was subjected to PCNL later on. During follow-up, the two patients who had received ESWL had stone recurrence and were treated again by ESWL. Complete clearance was achieved after one setting of ESWL. Retrograde ureteroscopy and laparoscopy were not done in any case.

PCNL was performed in 22 patients (including one failed ESWL case). In PCNL, the puncture was infracostal in 16 and supracostal (between 11th and 12th rib) in 6 patients.

Table 1: Data of all patients of caliceal diverticular stone

Parameters	Outcome
Total number of patients	24
Male: female ratio	11:13
Mean age (range), years	35.37 (18-52)
Mean stone size (range), mm	16.37 (6-35)
Mean CD size (range), mm	20.62 (12-37)
Location of CD (%)	
Upper calyx	12 (50)
Middle calyx	7 (29.16)
Lower calyx	5 (20.83)
Procedure	
ESWL	2
ESWL F/B PCNL	1
PCNL	21
Access in PCNL (%)	
Supracaliceal	6 (27.27)
Infracaliceal	16 (72.72)
Connection to calyx (%)	
Present	13 (59.09)
Absent	9 (40.90)
Fulguration of diverticular mucosal lining (%)	
Performed	5 (22.72)
Not performed	17 (77.27)
Mean operative time (range), min	70.31 (47-90)
Stone clearance after PCNL (%)	21 (95.45)
Mean PCNL removal time (range), days	2.27 (2-4)
Complications	
Fever (Clavien-Dindo Grade I)	1
Hemorrhage (Clavien-Dindo Grade II)	1
Pneumothorax (Clavien-Dindo Grade IIIa)	1
Mean follow-up duration (range), months	34 (6-48)

PCNL: Percutaneous nephrolithotomy, ESWL: Extracorporeal shock wave lithotripsy, CD: Caliceal diverticulum

No fulguration was performed in initial 17 patients while fulguration by Holmium Laser was performed in the last 5 cases. Out of 17 cases without fulguration, we were able to identify caliceal opening in 9 cases, through which we placed DJS without dilating the connection and kept it for 4 weeks. In eight patients, we were not able to identify caliceal opening despite instilling methylene blue dye. We did neither fulgurate the caliceal lining nor create neoinfundibulum, and DJS was not placed. Of the five cases, in which Holmium Laser fulguration was performed, we identified caliceal opening in four patients and DJS was placed.

Of the 22 patients, who underwent PCNL, 21 patients achieved complete clearance (including failed ESWL case). Mean operative time was 70.31 min (range: 47–90 min). All nephrostomy tubes were removed on POD 2 except for three patients who had minor complications.

One patient had bleeding during PCNL; partial clearance could be achieved due to loss of vision. In this patient, the size of residual stone was 8 mm. This patient with partial clearance was subjected to ESWL (after 2 weeks), and complete clearance was achieved after one setting.

Complications occurred in three patients [Table 1]. One patient had fever (Clavien–Dindo Grade I) due to urinary tract infection, was treated by intravenous antibiotics. The second patient had significant bleeding (Clavien–Dindo Grade II), responded to nephrostomy clamping, and blood transfusion. Pneumothorax (Clavien–Dindo Grade IIIa) occurred in third patient who underwent supracostal puncture, intercostal drain (ICD) was placed. ICD was removed on 3rd day, and nephrostomy tube was removed on 4th day.

The average follow-up was 34 months (6–48 months) [Table 2]. Patients who were subjected to PCNL were followed up by IVP in 14 cases and by CECT scan in 8 cases at 3 months. CD resolved in 14 patients. CD size was reduced in 7 patients. One patient developed recurrence of stone (8 mm). He was subjected to ESWL with complete clearance after two sittings. Rests of the patients were symptom-free.

DISCUSSION

The etiopathogenesis of stone within CD is multifactorial. Urinary stasis and metabolic abnormalities (hypercalciuria and supersaturation with calcium oxalate) are described as etiologic factors for caliceal diverticular calculi.[13,14] Stone containing CD often become symptomatic; hence, active management is necessary. Management options include ESWL, flexible ureteroscopy, laparoscopy, and PCNL. ESWL is noninvasive outpatient treatment and provides pain relief in 36%–70% of patients.[5] The major drawback of ESWL is that stone-free rates are low (ranging from 4% to 20%) despite stone fragmentation (narrow infundibulum prevents clearance).[5] Second, concurrent treatment of CD is not possible. The patient number was low in ESWL group because most of our patients come from long distance; they preferred single-stage procedure like PCNL.

Flexible ureteroscopy had stone-free rate ranging from 19% to 58%, but CD obliteration rate is only 18%.[6,7] There are numerous disadvantages with ureteroscopic treatment including longer operative time compared to percutaneous technique and difficulty in managing lower pole CD.[6,7]

Another minimally invasive option is laparoscopy, but indications are limited to anterior diverticula with a thin layer of parenchyma.[8,9] The disadvantage of laparoscopy is longer operative time.[9]

Percutaneous management of CDS had stone-free rates of 87.5%–100% with diverticula obliteration rate of 76%–100%.[5,10,15] In our series, stone-free rate was 95.45%, and complete diverticular resolution was achieved in 95.45% of patients. We use stone-guided puncture technique to access the diverticula. Direct access to the diverticula provides the best opportunity for stone removal and simultaneous diverticula

Table 2: Follow up outcome

Parameters	Technique used (*n*=24)			
	ESWL (*n*=2)	PCNL without CD fulguration (*n*=17)		PCNL with CD fulguration (*n*=5)
		DJS placed (*n*=9)	No DJS (*n*=8)	
Diverticula resolution	0	4	5	5
Decrease in CD size	0	4	3	0
Symptom free	0	8	8	5
Stone recurrence	2	1	0	0

DJS: Double J stent, CD: Caliceal diverticulum, PCNL: Percutaneous nephrolithotomy, ESWL: Extracorporeal shock wave lithotripsy

treatment. This technique requires high degree of expertise because of small size of CD and high incidence of the upper pole diverticulum. Supracostal puncture (between 11th and 12th rib) is performed in many cases but can be managed with reasonable morbidity. The guidewire is difficult to stabilize because of limited space around the stone and narrow neck of the diverticulum. We use Terumo wire (0.035 inch, straight tip) because of its ability to coil in the limited space of a diverticulum and resistance to kinking during dilation. We use sequential metallic dilators since we have experienced that controlled sequential dilatation with these dilators causes less bleeding along the tract. In our series, only one patient had bleeding complication. Utmost care should be taken to avoid perforation of the back wall of CD during dilation. Trauma to the back wall can cause bleeding and obscure vision. Small stone fragments can also lodge in traumatized parenchyma and may be difficult to remove.

Few methods described in literature to deal with CD after stone removal. One of the methods is the creation of a large communication with the collecting system to promote drainage.[16] Another method is fulguration of the lining of diverticulum to obliterate it subsequently.[17] This is controversia because the CD is lined by nonsecretory endothelium. Hulbert *et al*. mentioned that trauma to the wall of the diverticulum during percutaneous dilation is sufficient to ablate the diverticular lumen.[18]

Monga *et al*. performed direct puncture with fulguration of the diverticular lining without cannulating the infundibular communication. Complete diverticular ablation was achieved in 100%, and all patients were symptom-free at 38 months of follow-up.[12]

Krambeck and Lingeman found higher stone-free rates, shorter hospital stay, and fewer complications in patients undergoing fulguration compared to patients undergoing diverticular neck dilatation.[19] Landry performed combined diverticular fulguration and neck dilatation with good results.[20]

In cases where the communication between CD and calyx could not be found, transdiverticular approach with creation of a neoinfundibulum is suggested.[21] After dilation of the infundibular neck or neoinfundibulum creation, nephrostomy tube should be kept *in situ* for prolonged period for epithelization of the channel. We neither perform infundibulum dilation nor create neoinfundibulum. We believe that there is substantial risk of bleeding which may obscure vision and jeopardize further surgery. Second, stenosis/obliteration of neoinfundibulum may occur and finally, to increase the possibility of diverticular obliteration, the infundibulum should not be dilated. We also believe in the fact that trauma to the wall of CD during percutaneous dilation is sufficient to ablate the lumen.

Our operative time is comparable to other reported series in literature.[22,23] The operative time was decreased by direct stone-guided puncture and omission of the step where dilation of the connection or creation of neoinfundibulum takes place. We removed nephrostomy tube early because no dilation of caliceal neck was performed, and bleeding was minimal.

Stone-free rate was 95.45%, and complete diverticular resolution was achieved in 95.45% of patients. All patients, except three, were discharged following nephrostomy removal on POD 2. These three patients had complications mentioned earlier which were managed conservatively. All three patients were discharged following nephrostomy removal on POD 4.

One patient developed pneumothorax because most of diverticulum located in the upper pole necessitating supracostal puncture rather than a technical issue. One patient had residual stone/recurrence (8 mm) with persistent diverticula (25 mm cavity decrease to 18 mm) on follow-up IVP. Diverticulum size ranging from 12 to 37 mm was successfully obliterated when complete stone was removed.

We suggest methods to deal with diverticulum after stone removal. If the neck of diverticulum is identified and cannulated, DJS should be placed to facilitate drainage. If the diverticular neck is not identified, fulguration of diverticular lining may be performed with external drainage by a nephrostomy tube. No attempt should be made to dilate the diverticular neck or create neoinfundibulum. These maneuvers may cause trauma to renal parenchyma that leads to increase morbidity. The main drawback of our technique is slippage of guidewire during dilation which may cause loss of access. We feel that this drawback may overcome with surgeon's experience and extreme care while establishing the tract.

The strength of our manuscript is the duration of our study. We have reviewed 11 years of data and included all the patients

treated for caliceal diverticular calculus. One review article had reviewed 13 articles.[24] Our sample size and duration of study is more than most of the studies mentioned in this article.

The limitation of our study is its retrospective nature. Prospective analysis and large sample size are difficult because CD is a rare disease.

CONCLUSION

Caliceal diverticular calculi can be treated in most effective manner by PCNL. Stone-guided puncture without dilation or creation of neoinfundibulum reduces operative time, reduces morbidity with higher stone-free rate.

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Conflicts of interest
There are no conflicts of interest.

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