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Original Article

Percutaneous nephrolithotomy under ultrasound guidance in treating allograft stones

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Abstract: Objective: Allograft stones are rare but can cause rapid and severe obstruction of the graft, significantly decreasing graft and patient survival rates. Because allograft kidneys are solitary and patients are in an immunosuppressed state, minimally invasive techniques, rather than open surgery, should be the treatment modality for allograft stones. Percutaneous nephrolithotomy (PCNL) is an optimal option for treatment of these patients. Material and methods: Records of patients with allograft stones, undergoing PCNL, under ultrasound guidance in our hospital from January 2007 to September 2017, were retrospectively reviewed. Results: This study identified 11 patients with allograft stones, treated with PCNL under ultrasound guidance. Presentation symptoms included hematuria in 18.2% of cases, pain in 27.3%, fever in 9.1%, and 45.5% were symptom-free. Average stone size was 1.43 cm (range 0.7 to 2.6 cm). KUB radiography or NCCT, 3-4 days after the procedure, demonstrated that 9 patients (81.8%) were stone-free. One patient needed medical expulsion therapy for residual stones and another underwent unsuccessful PCNL. Postoperative complications developed in 3 patients, including bleeding and fever. Conclusion: PCNL is an acceptable, safe, and reliable method for treatment of allograft stones. Puncture and dilation during percutaneous access of uniquely located grafts, however, remains a major challenge for successful PCNL.

Keywords: Percutaneous nephrolithotomy, ultrasound guidance, allograft stones, retrospective study

Introduction

Renal transplantation is the best treatment option for patients with end-stage renal disease, despite a shortage of kidneys and possible transplant-related complications. Optimization of immunosuppressive protocols and short-term complication treatments significantly increase graft and patient survival rates, resulting in rare and relatively long-term graft complications. Allograft stones are a rare complication in transplanted kidneys, with an incidence of 0.4-1% of renal transplantation patients [1]. Although it is quite rare, if obstruction occurs, it can lead to rapid and severe deterioration to graft function [2]. Due to the medical complexity of these cases and extra-anatomic location of the allograft renal, management of allograft stones has become very difficult. Allograft stones are considered a transplant-related complication that requires minimally invasive surgeries including extracorporeal shock wave lithotripsy (ESWL), ureteroscopic lithotripsy (URSL), and percutaneous nephrolithotomy (PCNL) [3]. This study examined the efficacy and safety of PCNL, under ultrasonographic guidance, used to manage cases with allograft stones.

Materials and methods

This study retrospectively reviewed records of cases with allograft stones undergoing PCNL from January 2007 to September 2017.

PCNL procedure

Patients were placed in the supine position. A convex abdominal probe was placed parallel to the long axis of the kidney and all possible calices from superior to inferior poles were scanned. Preoperatively, non-contrast-enhanced computed tomography (NCCT) scans were used to evaluate the calyxceal anatomy. A suitable calyx for percutaneous access was identified during the intraoperative ultrasonog-

Table 1. Patient demographics and presentation symptoms

Overall	11	
Gender (%)		
Male	8	(72.7)
Female	3	(27.2)
Mean age (range)	40.7	(19-57)
Mean years between transplantation and diagnosis of allograft stones (range)	5.0	(0.5-14)
Mean μmol/L preop serum creatinine (range)	395	(160-803)
Mean ml/min/1.73 m^2 preop estimated glomerular filtration rate (range)	23.3	(6.3-42.9)
Mean μmol/L preop serum uric acid (range)	387.8	(278.4-594.2)
Presentation symptoms (%)		
Hematuria	2	(18.2)
Pain	3	(27.2)
Fever	1	(9.1)
Symptom-free	5	(45.5)

Table 2. Stone characteristics

	No.	(%)
Overall	11	
Size (cm)		
1 or Less	3	(27.3)
Greater than 1 and less than 2	6	(54.5)
2 or Greater	2	(18.2)
Mean (range)	1.43	(0.7-2.6)
Location		
Pelvis	2	(18.2)
Caliceal	1	(9.1)
Ureteropelvic junction	4	(36.4)
Ureter	1	(9.1)
Mutiple	3	(27.3)

raphy scan. The targeted calyx was punctured with the tip of a needle and tracks were continuously monitored and confirmed by ultrasonography. The obturator was removed and clear urine escaping from the needle confirmed the presence of the needle in the pelvicalyceal system. A super rigid guidewire was passed through the needle into the collecting system and confirmed by ultrasonography. Skin and fascia over the puncture site were incised and a 18Fr fascial dilator was pushed over the guidewire to establish the access tract. During the procedure, rotating the dilator with angular shearing force facilitated easy passage from the renal capsule into the collecting system. Clear urine flowing from the dilator confirmed the presence of the dilator in the collecting system. Holmium laser lithotripsy was performed for allograft stones and stone fragments were washed out along with irrigation fluid. At the end of the procedure, a 7Fr double J tube was placed over a zebra guide-wire and a 10Fr nephrostomy tube was inserted for drainage through the tract and fixed to the skin. A routine KUB radiograph or NCCT was taken 3-4 days after surgery to assess residual stones. Nephrostomy tubes were removed within 5-7 days and Double-J tubes were removed 4-5 weeks after discharge by cystoscopy.

Results

This study identified 11 patients with allograft stones, treated with PCNL under ultrasound guidance. Patient demographics and presentation symptoms are shown in **Table 1**. Most patients came to the hospital because of renal failure or hydronephrosis at follow up, without any symptoms (45%). Hyperuricemia was found in 4 patients (36%).

Stone characteristics are shown in **Table 2**. Average stone size was 1.43 cm. Most stones were greater than 1 cm (73%), some even greater than 2 cm (18%). The most common stone location was the ureteropelvic junction (36%), however, there were still many multiple stones (27%).

Operative and postoperative characteristics are shown in **Table 3**. "Stone-free" was considered when patients were completely cleared of stone fragments or stone fragments were less than 4 mm. One patient with a residual

Table 3. Operative and postoperative characteristics

Overall	11	
Number of tracts (%)		
1	9	(81.8)
More than 1	2	(18.2)
Modalities (%)		
Flexible nephroscopy	4	(36.4)
Rigid nephroscopy	7	(63.6)
Stone-free (%)	9	(81.8)
Postop complication (%)	3	(27.3)
Bleeding	2	(18.2)
Fever	1	(9.1)
Median days of postop hospital stay (range)	7	(6-24)*

*A patient underwent two unsuccessful PCNL.

stone of about 5 mm needed medical expulsion therapy.

Figure 1 shows a case of unsuccessful PCNL in the treatment of allograft stones. The patient was a 49-year-old male. His first-stage PCNL was terminated because of severe intraoperative bleeding. Unfortunately, after 6 days, second-stage PCNL was also terminated because of severe intraoperative bleeding and pelvis perforation. In addition, the nephrostomy tube was found, by NCCT scan, to be inserted deep into the parenchyma protruding 22.37 mm from the opposite surface of the transplanted kidney (see **Figure 1C**). He also suffered severe postoperative bleeding and a high selective angioembolization was arranged. Hemodialysis was arranged until renal function recovered. The patient was finally discharged. Two months later, the allograft stones were cleared by another PCNL through the existing percutaneous access.

Discussion

Allograft stones are a very rare complication and treatment remains a major clinical challenge. Because allograft kidneys are isolated, it is very important for early effective diagnosis and treatment of allograft stones that obstructions are relieved as soon as possible. Because of denervation of transplanted grafts [4], more than half of the patients present with no symptoms of pain or other associated symptoms, thus, delaying diagnosis and treatment. Hematuria, oliguria, and anuria are the most common symptoms. Asymptomatic patients can be diagnosed through laboratory tests and imaging examinations [5]. In view of this, routine follow up examinations of the urinary system by ultrasonography are necessary and helpful for early detection of urinary calculi in patients undergoing renal transplantation.

Allograft stones may be already placed *in situ*, called donor-gifted allograft lithiasis, or they may be the result of new stone formation after transplantation [6]. Predisposing factors for allograft stone formation include urinary stasis, reflux, recurrent urinary tract infections, renal tubular acidosis, pH changes, supersaturated urine, decreased inhibitor activity, tertiary hyperparathyroidism, hypercalcemia, and hypercalciuria [7, 8]. Immunosuppressive therapy with calcineurin inhibitors may cause direct tubular damage and decrease renal filtration, resulting in hyperuricosuria in 50% to 60% of patients [9, 10]. Because uric acid stones are radiolucent, ultrasonography should be used as the primary diagnostic imaging tool for renal transplant patients.

The extra-anatomic location of allografts is unique, making the management of allograft stones complicated. In addition, allograft kidneys are solitary and patients are in an immunosuppressed state. Therefore, minimally invasive methods, rather than open surgery, should be the treatment of choice for allograft stones. These patients have poor ability to resist infections and immunosuppressive agents will affect wound healing. Management of allograft stones includes observation, ESWL, URSL, PCNL, and open surgery. Successful treatment of allograft stones with ESWL has been reported [3, 7, 11, 12]. However, because of the usual position of allograft kidneys in the pelvis, shockwaves may be hindered and attenuated by the bony pelvis [13] and overlying bowel [3, 14]. Besides, once complications like obstruction or steinstrasse formation occur, postoperatively, they necessitate endoscopic treatment techniques [15].

URSL is a commonly used endoscopic method for treatment of urinary calculi. If used properly, it will give very satisfactory results. According to reports, the success rate of treat-

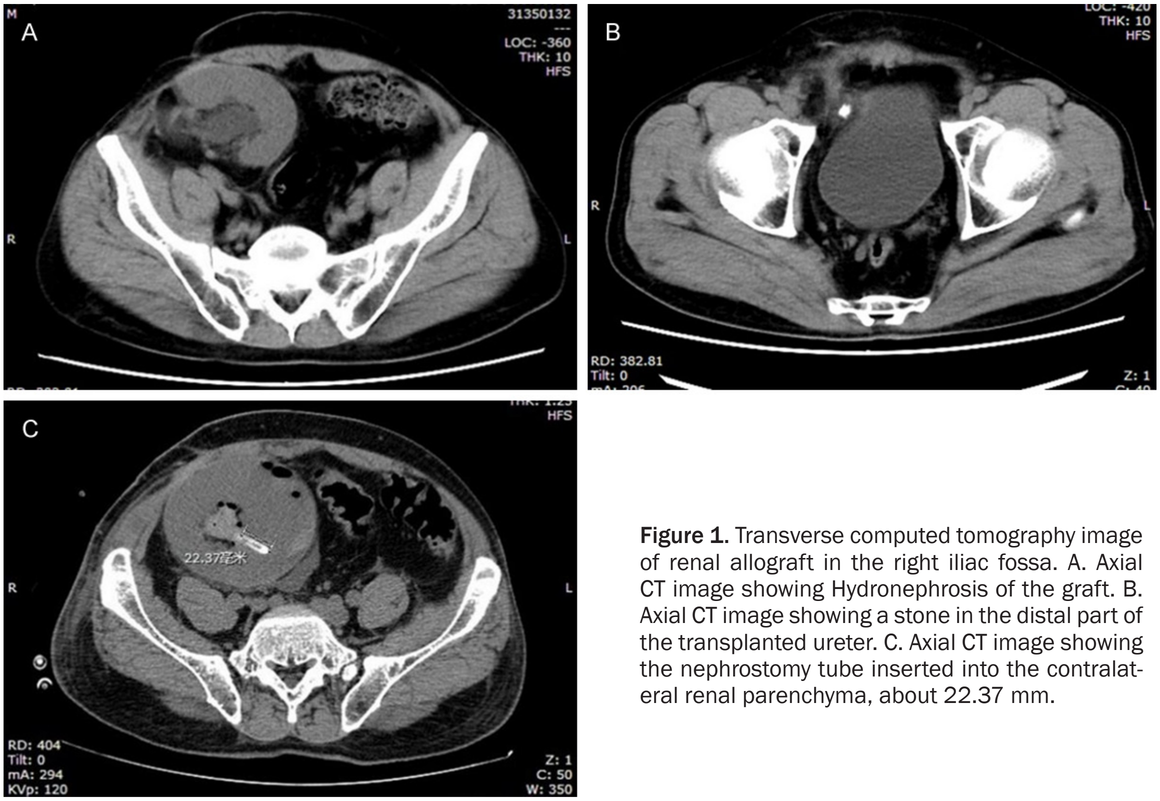

Figure 1. Transverse computed tomography image of renal allograft in the right iliac fossa. A. Axial CT image showing Hydronephrosis of the graft. B. Axial CT image showing a stone in the distal part of the transplanted ureter. C. Axial CT image showing the nephrostomy tube inserted into the contralateral renal parenchyma, about 22.37 mm.

Table 4. Cohort studies about PCNL in treatment of allograft stones in the past 10 years

Study	Cases	Mean age, yrs	Access	Guidance	Mean diameter of stone, cm	Stone free rate	Mean Hb decline, g/dL	Complications
He et al. 2007 [26]	7	40.7	16Fr	US	1.7	100%	0.51	None
Krambeck et al. 2008 [22]	13	49.5	28Fr	US and RF	1.36	76.9%	Not mention	1, sepsis
Rifaioglu et al. 2008 [24]	15	48	14Fr to 30Fr	US alone or US and RF	1.3	100%	Not mention	None
Wyatt et al. 2009 [23]	16	37.5	30Fr	RF	Not mention	100%	0.35	1, bleeding
Oliveira et al. 2010 [25]	7	44	30Fr	US and RF	3.28	85.7%	Not mention	None
Yuan. 2015 [27]	6	37	24Fr	US	2.35	100%	Not mention	None

US, Ultrasonography; RF, Radio Fluoroscopy; Hb, hemoglobin.

ment of ureteral calculi in allograft kidneys has been as high as 78% [16]. Success of URSL depends on the tortuosity of the ureter and ability to obtain access to the ureter. Since the ureterostoma is usually anastomosed to the dome, anterior wall, or posterior wall of the bladder, placement of the ureteroscope can be very difficult and failure rate is high. In this case series, PCNL was adopted due to failure of placement of the ureteroscope in 5 cases. A combination of PCNL and flexible ureterorenoscopic approach for treatment of allograft stones, when ureteroscopy alone is inadequate, has been reported [17].

Since Fisher et al. [18] reported the successful management of allograft stones with percutaneous nephrolithotomy in 1982, PCNL has been widely used for treatment of urolithiasis in transplanted kidneys. The superficial location of transplanted kidneys makes PCNL the best treatment option for management of large allograft stones or after failure of ESWL because it allows rapid relief of obstruction and effective infection control [19-22]. Several isolated successful cases and a small series of studies [3, 22-27] have been published regarding urolithiasis on transplanted kidneys (see **Table 4**). These studies have indicated that PCNL is safe and effective for treating allograft stones. This procedure, however, has limitations due to the risk of injuring intraperitoneal content and major abdominal vessels adjacent to the graft during establishment of the percutaneous tract. In addition, it is more difficult to puncture a calyx due to the special location and

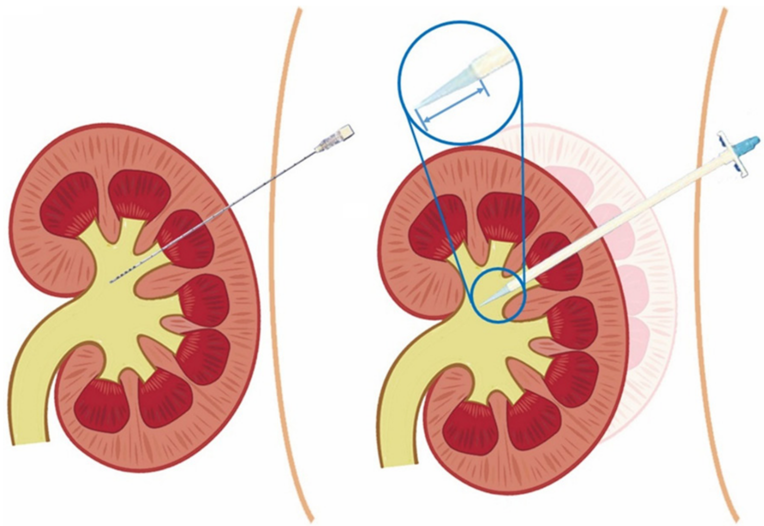

Figure 2. Schematic diagram of shift of kidney during dilation and distance between the outer sheath and pointed end.

Figure 3. Super rigid guidewire in ureteroscope when guiding placement of nephrostomy tube.

orientation of transplanted kidneys. Based on clinical experience of the failure case, this study summarized some key points regarding PCNL in transplanted kidneys. First, for native kidneys, the dilation sheath needs to be pushed deeper than the initial length measured by the needle because of the mobility of kidneys during dilation and potential distance between the outer sheath and its pointed end (see **Figure 2**). However, the puncture and tract dilation of transplanted kidneys may be more difficult as perirenal reactive tissue often develops a fibrous sheath around allograft kidneys after transplantation. Therefore, the normal breakthrough sensation during puncture and dilation of the renal capsule during establishment of the percutaneous tract may not be felt in transplanted kidneys. In addition, due to the superficial location and relatively fixed nature of allograft kidneys, compared to normal kidneys, this study advocates, during the first attempt of puncture or dilation, it is better to remain superficial rather than too deep, thus, preventing unnecessary iatrogenic complications. This also helps to avoid injuries to the contralateral renal parenchyma and if noted, intraoperatively, the procedure should be terminated immediately. Second, a rubber nephrostomy tube is superior to silica gel tube because the latter is stiffer and may cause secondary damage to the renal parenchyma (see **Figure 1C**). Third, during placement of nephrostomy tube, it is recommended that introduction of the super rigid guidewire through the ureteroscope is in retrograde fashion (see **Figure 3**) and the nephrostomy tube should be advanced over the guide wire for safe and accurate placement of the tube. Fourth, postoperative renal function should be monitored daily. In case of poor drainage and progressive decline in renalfunction, patients should be scheduled for hemodialysis. Fifth, if a progressive drop in hemoglobin is detected, bedside ultrasonography should be performed to rule out any perirenal hematoma. Sixth, stable patients with no signs of active bleeding during general activity, with return to normal renal function and urine volume, and with perirenal hematoma having been absorbed can be considered for discharge. After discharge, nephrostomy tubes should be continued for a month since immunosuppressive agents delay wound healing and may lead to urine leakage or bleeding. Stable patients can be considered for second stage PCNL.

Conclusion

Although incidence of allograft stones is low, they are more likely to cause serious complications like loss of graft function and morbidity. They are more difficult to treat than calculi in native kidneys. PCNL is a safe and effective minimally invasive treatment modality for allograft stones. However, problems associated with puncture and dilation during establishment of the percutaneous tract of uniquely located allografts remain. Therefore, further multi-center and large sample studies are necessary to support and improve the PCNL technique in treatment of allograft stones.

Disclosure of conflict of interest

None.

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