Case Report

DOI: 10.6966/EDMJ.202209_9(3).0003

Three Stone-Containing Calyceal Diverticula Treated with Da Vinci Xi Surgical System with Intraoperative Sonography: A Case Report

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There are different surgical strategies for the treatment of renal calyceal diverticular calculi with different success rates. For patients with complex calyceal diverticular calculi, using a robotic surgical system with intraoperative ultrasound enables rapid and accurate localization of the diverticulum, thereby improving the success rate. The plain X-ray of the kidney, ureters, and bladder (KUB) of a 56-year-old man who complained of right flank pain for over one year showed multiple small renal stones in right lower kidney. Abdominal computed tomography (CT) confirmed the presence of right calyceal diverticula with multiple sandy stones. Stones extraction was conducted together with robot-assisted laparoscopic diverticulectomy. Renal hilar vascular control was not necessary because of the peripheral locations of the diverticula. Intraoperative laparoscopic ultrasound was used to help meticulously identify each diverticulum. After the extraction of a total of 130 stones, postoperative KUB showed no residual stones. Using da Vinci Xi Surgical System with intraoperative ultrasound can help manage complex calyceal diverticular stones with satisfactory outcomes.

Key words: calyceal diverticular calculi, robotic surgical system, intraoperative ultrasound

Introduction

Calyceal diverticulum is a cavity protruding from the collecting system with non-secretory urothelium. It may be congenital or acquired due to infection, renal cyst rupture or vesicoureteral reflux, but the exact etiology is still unknown. Because of the narrow neck connecting to the collecting system and urinary stasis, recurrent infection and nephrolithiasis are common with the incidence rate of the latter being 10 – 50%.[1]

There are several therapeutic options for calyceal diverticular stones, including shock wave lithotripsy (SWL), retrograde intrarenal surgery (RIRS), percutaneous nephrolithotomy (PCNL), and laparoscopic/robot-assisted

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Received: November 5, 2020 Accepted: February 3, 2021

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approach.[2] The laparoscopic approach, especially robot-assisted laparoscopic management, has been reported to be an effective treatment with a low morbidity and high success rates.[3] This report describes a 56-year-old man with multiple calyceal diverticular stones who received robotic nephrolithotomy with the assistance of robotic ultrasound probe.

Case Report

This 56-year-old man (height: 160 cm, body weight: 69.7 kg, BMI: 27.2) presented to our hospital with a history of right flank for over one year. He had a history of ureterolithiasis for which ureteroscopic lithotripsy was performed. He also had a history of hypertension and diabetes under control.

He visited our outpatient clinic due to persistent dull right flank pain refractory to medical treatment. His physical examination was unremarkable and laboratory examinations were normal. Preoperative serum creatinine was 1.3 mg/dL. A pre-operative plain abdominal radiograph and a contrast-enhanced abdominal computed tomography (CT) scan revealed three cystic lesions with nodular calcifications over right renal lower anterior pole with

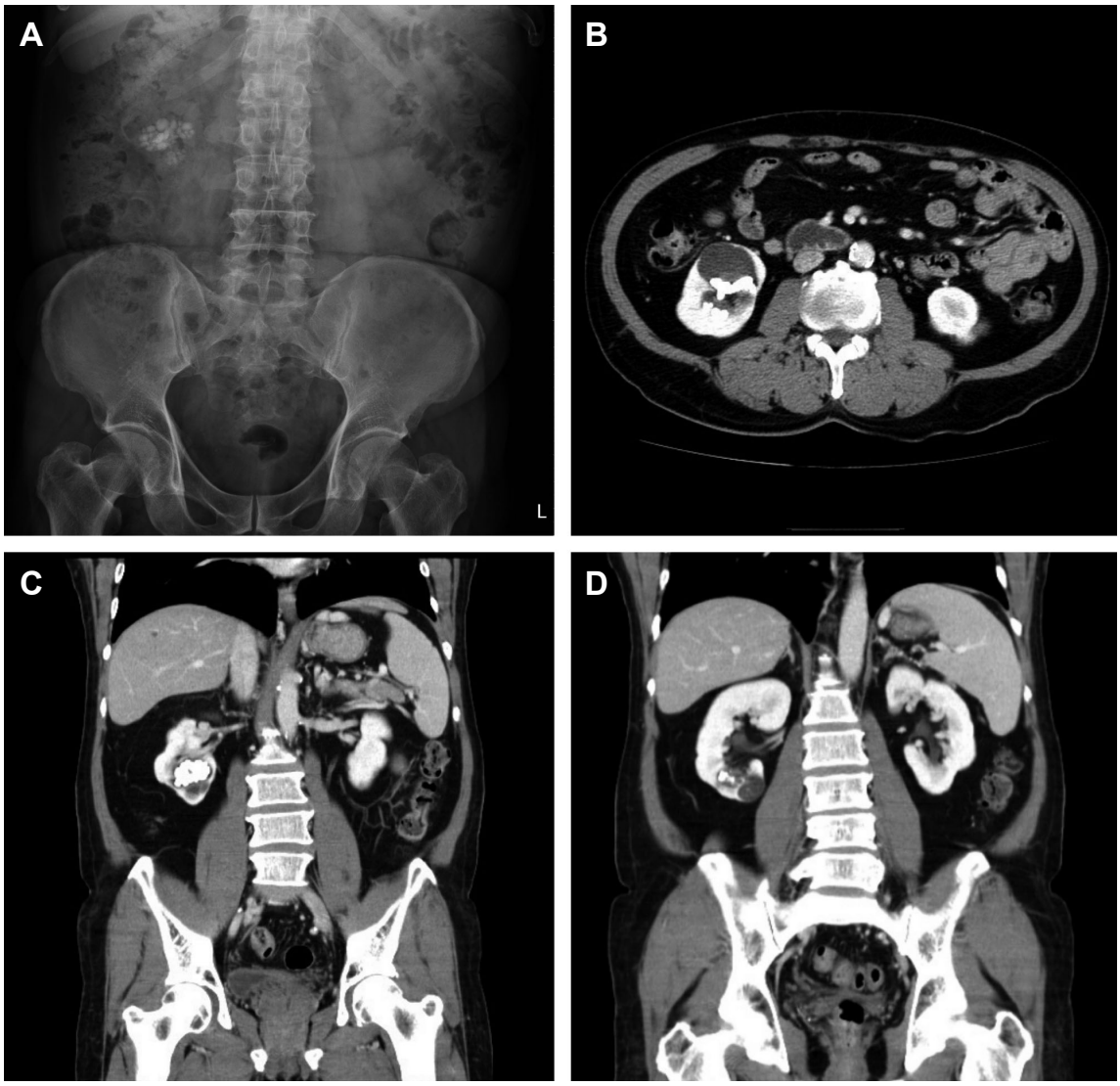

Fig. 1 Pre-operative plain abdominal radiograph and a contrast-enhanced abdominal computed tomography scan revealing a cluster of cystic lesions with nodular calcifications over right renal lower anterior pole with delayed contrast filling. (B) The largest diverticulum with thin overlying parenchyma. (C,D) The other two diverticula buried in renal parenchyma at a distance of 0.7 cm and 0.5 cm, respectively, from the surface of parenchyma. All three diverticula could not be presented in a single cross-sectional image.

delayed contrast filling (Fig. 1). The diverticula were 3.7 cm, 2.3 cm, and 1.7 cm in diameter, respectively. The preliminary diagnosis was calyceal diverticula type I according to Dretler classification complicated with urolithiasis. After weighing the benefits and disadvantages of different surgical approaches, he finally decided to receive robot assisted laparoscopic diverticulectomy and stones extraction.

The operation was performed under general anesthesia and the patient was placed in Galdakao-modified supine Valdivia (GMSV) position. Following the insertion of a No 5 retrograde ureteral stent, one para-umbilical skin incision for the introduction of camera port and another 12 mm incision over the lower right quadrant were made.. Three other 8 mm working ports were placed over the right mid-clavicle line (Fig. 2A). We deployed four robotic arms with the patient cart on his right side.

Transperitoneal laparoscopic technique was employed with the ascending colon medially reflected off the right kidney after an incision on the Gerota's fascia for identification and mobilization of the kidney. Exploration of the lower pole of the kidney revealed cyst-like lesions. The largest diverticulum had a thin pa-

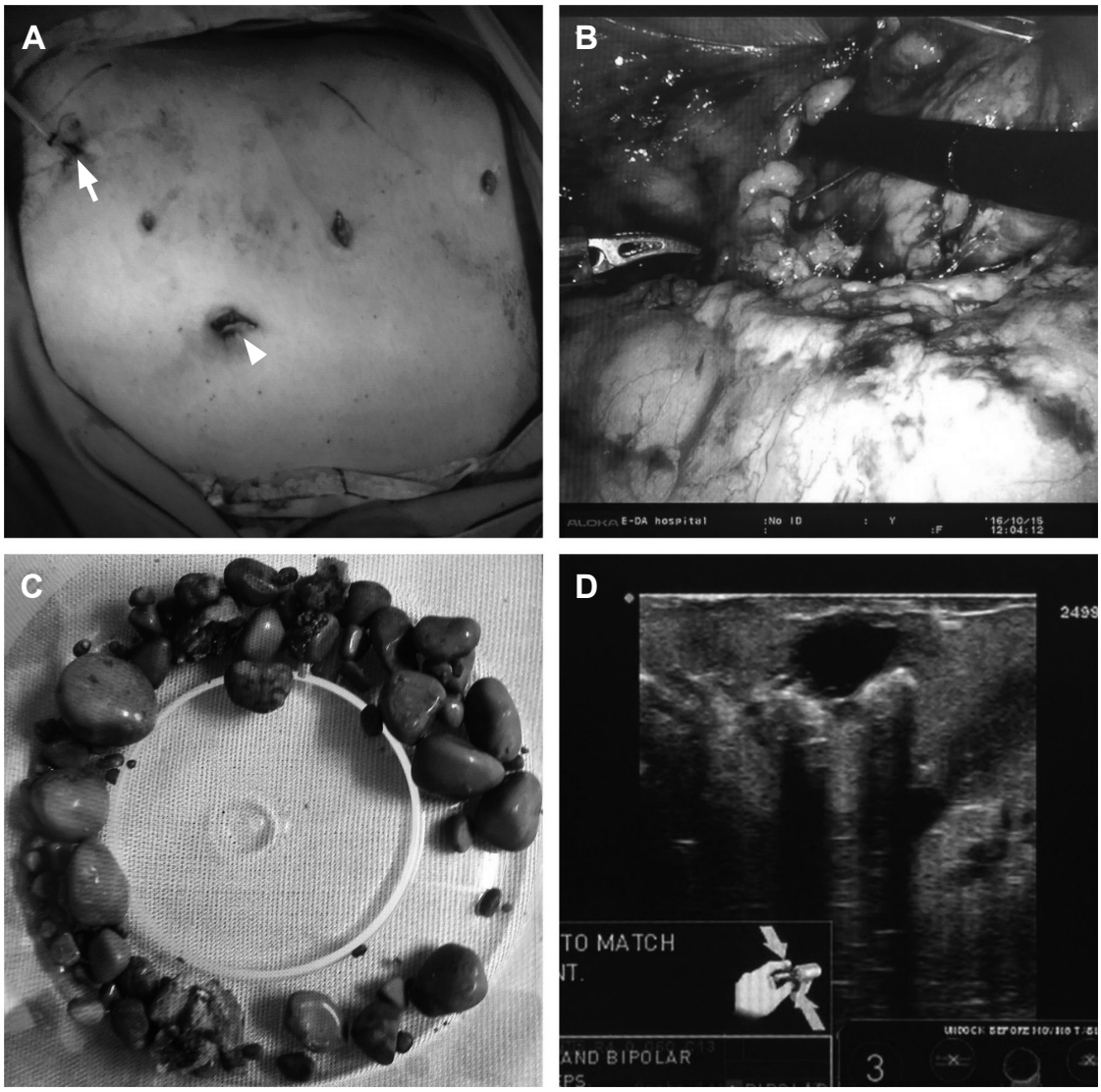

Fig. 2 (A) Patient was placed in GMSV position with a camera port (white arrowhead) being introduced through a para-umbilical incision and an assistant port (white arrow) being introduced through another incision over the right lower quadrat. Other incisions were made for 8 mm working ports. (B) Laparoscopic ultrasound was used to identify the location of diverticular calculi in renal calyx using a robotic system. (C) A total of 130 stones were removed from calyceal diverticula.

renchyma overlying and was easily to identify. The other two diverticula were buried in renal parenchyma at a distance of 0.7 cm and 0.5 cm from the surface of parenchyma, respectively (Fig. 1C & 1D). Therefore, identification of these two diverticula under laparoscopic vision was challenging. A laparoscopic ultrasound probe (Hitachi, UST-5418) was then used under the surgeon's control (Fig. 2B).

Because the three diverticula were in the peripheral area and only limited renal parenchyma needed to be excised, no pedicle control of the right renal artery was performed before unroofing the diverticula. Clear urine was noted in these three diverticula. All stones were removed by forceps smoothly and put in an Endo-bag. The narrow diverticulum neck was identified after instilling vitamin B complex from ureteral catheter and was closed by vicryl 3-0 suture and SPONGOSTAN Powder. A 6Fr 26 cm Double-J stent was retrogradely placed to prevent urine leakage and an 18 Fr three way Foley catheter was indwelled. The total operative time was 330 minutes without warm ischemia, including 120 minutes of console time and 10 minutes of docking time. The estimated blood loss was less than 100 mL. In the end, 130 stones were removed in total (Fig. 2C). The procedure was performed without intraoperative or postoperative complications. Foley and drainage tube were removed on postoperative Days 2 and 5 respectively. He was discharged under stable condition on post-operative Day 6. No postoperative urine leakage occurred and he needed no readmission. No postoperative acute kidney injury was noted. Double-J stent was removed two weeks after the operation at the outpatient clinic. We followed his condition one year after with KUB and no stone recurrences were noted.

Discussion

Cases about treating calyceal diverticular stones have been reported, no matter by robotic-assisted system or with intraoperative ultrasound. However, calyceal diverticula containing more than 100 stones are extremely rare. Merigot de Treigny et al. included 142 cases and, among them, 80 cases had more than one stone in calyceal diverticula. These 80 patients only had an average of 3.85 stones per kidney.[4] Therefore, chance to treat a kidney containing 130 stones in calyceal diverticula is unusual.

The choice of therapeutic option depends on the size and location of the diverticulum and the stone burden. In this case, flexible ureteral renal stone manipulation, PCNL, SWL and laparoscopic surgery were all options because there were no contraindications like bleeding tendency or uncontrolled infection. The advantages of ureteroscopy include lower complication rates in comparison to PCNL as well as suitability for anterior upper pole diverticula with small to medium stone burdens. Ureteroscopy can also achieve a 76 – 85.7% stone-free rate. However, one disadvantage includes the limited ureteroscopy bending angle for the residual stones at the middle or lower pole.[5,6] In this case, it would be challenging to find the small calyx opening under a small ureteroscopic visual field and difficult to achieve lithotripsy at the lower pole due to limited ureteroscopy bending angle.

Using PCNL to treat large diverticula with large stone can reach a 81.6 – 84% stone-free rate. PCNL, on the other hand, is more invasive and has a higher complication rate than ureteroscopy.[5,6] The limitations of percutaneous treatment include anterior diverticula and a high probability of intraoperative loss of percutaneous channel due to inadequate cavity containing the guidewire.[5,7] In this case, because it is hard to determine the relative location of calyceal diverticulum stones under C-arm fluoroscopy, and his stones were in three calyxes, PCNL was not our first option.

SWL has also been used to achieve symptomatic relief, but its stone-free rate is only 20 – 58% in a selected group of patients.[8]

However, SWL is inappropriate for this patient considering poor drainage of the lower pole diverticula. Endoscopic Combined IntraRenal Surgery (ECIRS) is a new way to treat large or complex renal stones. However, there are currently no publications focusing on the use of ECIRS to treat calyceal diverticulum stone.

Compared with other minimal invasive procedures, laparoscopy is more suitable for anterior or large diverticulum with previous treatment failure.[2,9] Among all the laparoscopic steps, suturing the diverticulum opening can be difficult and time-consuming. The robotic system provides a three-dimensional vision and can improve the precision of surgery. Therefore, treating these patients using robotic platform can facilitate this task. Fabio et al. also reported a case of calyceal diverticular calculus receiving robot-assisted laparoscopic management after two times of unsuccessful flexible ureterorenoscopic treatments.[3] Oktay et al. also reported a case series of patients with peripheral and intraparenchymal diverticulum with previous treatment failures.[10] In this case, with diverticula at renal lower anterior pole and thin overlying renal parenchyma, the robot-assisted approach may be more suitable than other options.

Under laparoscopic vision, it is difficult to directly identify the buried diverticulum, especially when the overlying renal parenchyma is thick. Using intraoperative ultrasound can help identify the stones within the kidney. Stones in diverticulum have an acoustic shadow under ultrasound which can help identify the diverticulum location. It is also helpful in planning the incision when decorticating the diverticulum. Akca et al. used intraoperative ultrasound for diverticulum margin assessment, especially for intraparenchymal diverticulum.[10]

Many factors could affect the therapeutic options for treating a diverticulum stone. For anterior lower pole diverticulum stones, laparoscopic surgery may be the best option compared with ureteroscopy and PCNL. Using a robotic system or intraoperative ultrasound can make the surgery more delicate. Therefore, treating this complex calyceal diverticular stones by using da Vinci Xi Surgical System with intraoperative ultrasound is a good option with satisfactory results.

Conclusion

There are several therapeutic options for calyceal diverticular stones. The best option for each patient with a different type of calyceal diverticulum should base on the size and location of the diverticulum and the stone burden. In this rare case of 130 stones within three diverticula, using da Vinci Xi Surgical System with intraoperative sonography has a promising outcome.

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