Original Article

Efficacy and safety of ultrasound-guided percutaneous nephrolithotomy for kidney calculi patients with ankylosing spondylitis: a retrospective single center analysis

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Background: To investigate the efficacy and safety of ultrasound-guided percutaneous nephrolithotomy (PCNL) in kidney calculi patients with ankylosing spondylitis (AS).

Methods: The data of 22 renal stone patients (25 kidney units) with AS who underwent PCNL in our institute from January 2008 to December 2019 were analyzed retrospectively. General information of these patients, intraoperative and postoperative data were recorded. The primary parameter for efficacy was initial and final stone free rates (SFR) with X-ray kidney, ureter, and bladder (KUB) were performed 1st or 2nd day and 1 month after surgery. Preoperative and postoperative laboratory results, surgical procedures and the occurrence of postoperative complications were used to identify the safety PCNL intervention.

Results: Most PCNLs were performed with general anesthesia (76%) and prone position (64%). The initial SFR and final SFR were 80% (20 kidney units) and 88% (22 kidney units) respectively. Haemoglobin decreased after PCNL occurred in 22 patients (88.0%) and the mean postoperative hemoglobin drop was 1.32±0.76 g/L (range, 0.10–3.10 g/L), with one patient received blood transfusion. One patient developed postoperative fever (T >38.5 ℃). No other complications such as colon injury, extravasation of urine, perinephric infection and urosepsis occurred.

Conclusions: The result of ultrasound-guided PCNL for kidney stone patients with AS is satisfactory with high SFR and security. Operative position, anesthesia method and damage caused by drugs used in the treatment of AS should be considered to achieve better result.

Keywords: Kidney calculi; ankylosing spondylitis (AS); percutaneous nephrolithotomy (PCNL); efficacy; safety

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Introduction

Ankylosing spondylitis (AS) is a chronic and progressive disease with inflammatory factors invading both articular and extra-articular organs. In recent years, for the reason of nephrolithiasis being found more frequently in AS patients, some scholars have studied the relationship between AS and nephrolithiasis. A prospective study based on Swedish national population revealed that patients with AS had more than two-fold risk of nephrolithiasis compared with the general population (1). Korkmaz *et al.* summarized the previous research on the incidence rate of urolithiasis in patients with AS from 1972 to 2015 and found that the rate ranged from 1.6% to 29.11% with 0.7% to 12.5% in general population. They eventually concluded that urolithiasis was an extra-articular manifestation of AS (2).

Although the relationship has gradually been clarified,

there is little report on the treatment of urolithiasis in AS patients. For AS patients with nephrolithiasis, high blood and urinary calcium was more common (3) and functional disability [Bath Ankylosing Spondylitis Functional Index (BASFI)] and disease activity [Bath Ankylosing Spondylitis Disease Activity Index (BASDAI)] scored higher (4). Hormone drugs for AS may facilitate this possibility of urinary tract infections caused by struvite stone. Jakobsen *et al.* compared the rate of surgical interventions for nephrolithiasis in AS patients and the general population, which were 29% and 24%, respectively (5). In their study, AS patients with increasing age, prior nephrolithiasis diagnosis and atherosclerotic cardiac disease were more likely to receive surgical intervention and extracorporeal shockwave lithotripsy (ESWL) with the ratio of 64% was the primary procedure. In comparison, percutaneous nephrolithotomy (PCNL) was performed in only 6% of AS patients (5).

To our knowledge, PCNL is a first-line treatment for kidney calculi larger than 20 mm or complicated upper urinary tract calculi. While related reports on PCNL in AS patient with urolithiasis were limited. Spinal deformity, uncontrolled inflammation due to AS and adverse effects of medication for AS, such as osteoporosis, immunosuppression and renal function impairment further increase the difficulty of PCNL. In view of this point, we retrospectively analyzed the clinical data of AS patients underwent PCNL since 2008 in our hospital to evaluate its feasibility, efficacy and safety. We present the following article in accordance with the STROBE reporting checklist (available at http://dx.doi.org/10.21037/apm-20-2304).

Methods

Patients

All the kidney calculi patients with AS who underwent PCNL in our institution from January 2008 to December 2019 were retrospectively analyzed. Patients without the data of computed tomography (CT) of urinary system or a definite diagnosis of AS were excluded. A total of 22 kidney calculi patients (25 kidney units) with AS who underwent PCNL were included in this study with ipsilateral kidney stones and ureteral stones being found in 8 kidney units and bilateral kidney calculus in 3 patients. The data of basic characteristics, laboratory examination, AS duration and imaging data of kidney stones before and after treatment were collected. The maximum diameter was measured for each kidney stone as the stone size with the sum of maximum diameters of all the stones in one kidney for multiple kidney stones.

Surgical procedure and safety measures

Most of PCNLs were done under general anesthesia with the rest under epidural anesthesia which was decided by the condition of patients. After successful anesthesia, 5-Fr ureteric catheter was retrogradely placed in lithotomy position to fill with collecting system. For some patients with middle or lower ureteral calculi, ureteroscopic pneumatic lithotripsy or holmium laser was used to break stone into pieces and removed stone fragments before the placement of ureteric catheter. Then a 16-Fr Foley catheter was inserted into bladder and the patients were placed in proper position (prone, lateral, oblique supine). A percutaneous access was done with the guidance of ultrasound using a puncture needle and guidewire. Then the percutaneous tract was dilated to 16–28 Fr and a peel-away sheath was retained as a working channel. Through working channel, a nephroscope was inserted into calyx and all the accessible kidney stones were fragmented using ultrasonic lithotripsy. According to the concrete condition of the stone, ultrasonic lithotripsy combined with pneumatic lithotripsy or holmium laser would be used. Grasp the fragments as much as possible with grasping forceps. Decision to establish additional percutaneous access was made depending on lithotripsy efficiency with one access and guidance of real time ultrasound (6). At the end of operation, ureteric catheter was removed and a 6-Fr D-J stent was anterogradely placed. A 14-Fr silicone nephrostomy tube was placed for drainage in most patients. Anesthesia mode, American Society of Anesthesiologists (ASA) grade, position, site of puncture and operative time were recoded for all the patients.

Urine culture was performed preoperatively in most patients and antibiotics were used immediately to prevent infection after surgery based on the outcome of urine culture and drug sensitivity test. Blood count and serum biochemistry were conducted immediately after surgery to detect the occurrence of complications including bleeding, acute kidney injury and so on. First aid measures for different acute complications were available. The time of removing nephrostomy tube was based on the drainage of nephrostomy tube, outcome of X-ray kidney, ureter, and bladder (KUB) and postoperative renal function. The D-J stent was removed after 4 weeks. In addition, postoperative

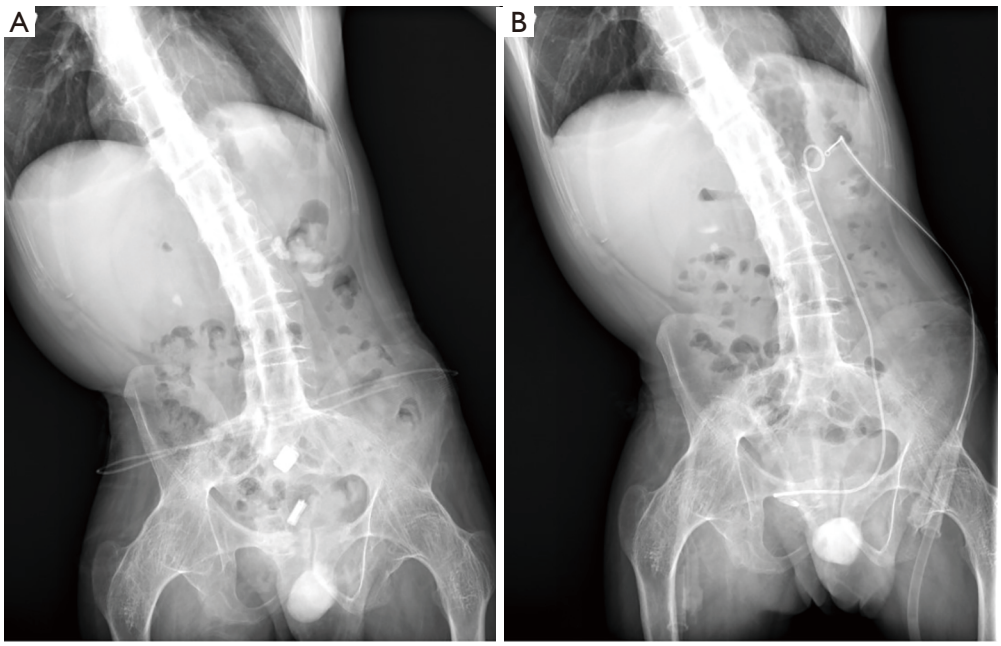

Figure 1 The data of plain film of kidney-ureter-bladder. (A) Preoperative data; (B) postoperative data.

hospital time, the drop of hemoglobin and complications were also counted.

Examination of efficacy

The stone free rates (SFR) were the primary parameter to exam the efficacy of PCNL in the treatment of kidney calculi in AS patients. X-ray KUB was performed on the 1st or 2nd day after surgery to access the residual fragments and recoded the initial SFR (*Figure 1*). No residual fragments presented on X-ray KUB was identified as stone free. For the reason of residual fragments less than 4 mm can be excreted with urine, residual fragments less than 4 mm presented on X-ray KUB were also identified as stone free. For patients with residual fragments less than 4 mm, conservative treatments including drinking more water (urine volume greater than 2,000 mL/d), alkalizing urine and medicine treatment were adopted. X-ray KUB was re-performed 1 month after surgery to assess whether the residual fragments were cleared and calculate the final SFR.

Ethical consideration

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by institutional board of the Peking University People's Hospital (No. 2020PHB177-01) and individual consent for this retrospective analysis was waived.

Statistical analysis

IBM SPSS Statistics Version 25.0 was used for all the data analysis. Mean ± standard deviation and No (%) were used to describe different variables. Student's *t*-test or Mann-Whitney U Test for continuous variable and Fisher's exact test for classified variable were performed. The standard for statistical difference was P value less than 0.05.

Results

Patient characteristics

Twenty-two patients were involved in this study with 25 kidney units underwent PCNL being studied. The majority patients enrolled were men (90.9%). The duration of AS varied significantly from 0.5 to 40 years with the average time of 18.73±11.30 years. Therefore, the manifestation of AS varied. There were 11 (50.0%) patients with obvious spinal deformity which was diagnosed by radiography. The rest patients manifested morning stiffness and mild symptoms such as low back pain and rigidity, but no performance of spinal deformity in radiography.

The size of kidney stones larger than 20 mm was

Table 1 The preoperative characteristics of AS patients with urolithiasis

Parameters	No. (%)	Mean (range)
Patients	22	–
Kidney units	25	–
Sex male/female	20 (90.9)/2 (9.1)	–
Age (year)		49.77±11.62 (27.00–77.00)
BMI		23.96±5.03 (16.89–33.56)
AS duration (year)		18.73±11.30 (0.50–40.00)
Stone size (mm)		41.69±20.33 (13.00–97.30)
Kidney left/right	11 (44.0)/14 (56.0)	–
Stone type		–
Single stone	2 (8.0)	
Multiple stones	21 (84.0)	
Staghorn stones	2 (8.0)	
Stone location		–
Pelvis	1 (4.0)	
Inferior pole of kidney	5 (20.0)	
Multiple locations	19 (76.0)	
Hydronephrosis	18 (72.0)	

BMI, body mass index; AS, ankylosing spondylitis.

presented in the most of kidney units with only 1 kidney unit exception (kidney stone, 13 cm). The mean stone size was 41.7 mm, ranging from 13.0 to 97.3 mm. The kidney stone was characterized by multiple types (84.0%) and multiple locations (76.0%). Single stone and single location accounted for very little. The data details are represented in *Table 1*.

Intraoperative and postoperative outcomes

Most PCNLs were performed with general anesthesia (76.0%) and prone position (64.0%). A total of 23 kidney units performed a single percutaneous access and 2 kidney units performed multiple percutaneous access (middle pole + lower pole and upper pole + lower pole). Twenty kidney units met the criteria of stone free immediately and 22 kidney units got final stone free 1 month after surgery.

Table 2 The intraoperative and postoperative outcome of PCNL

Parameters	No. (%)	Mean (range)
Anesthesia mode		–
General anesthesia	19 (76.0)	
Epidural anesthesia	6 (24.0)	
ASA grade		–
I	2 (8.0)	
II	20 (80.0)	
III	3 (12.0)	
Patient position		–
Prone	16 (64.0)	
Lateral	8 (32.0)	
Oblique supine	1 (4.0)	
Puncture site		–
Upper pole	4 (16.0)	
Middle pole	13 (52.0)	
Lower pole	6 (24.0)	
Multiple site	2 (8.0)	
Operative time (min)	–	66.67±32.59 (25.00–165.00)
Postoperative hospital time (d)	–	5.82±3.01 (3.00–9.00)
Postoperative hemoglobin drop (g/dL)	–	1.32±0.76 (0.10–3.10)
Initial SFR	20 (80.0)	–
Final SFR	22 (88.0)	–
Major complications		–
Fever (>38.5 ℃)	1 (4.0)	
Blood transfusion	1 (4.0)	

PCNL, percutaneous nephrolithotomy; ASA, American Society of Anesthesiologists; SFR, stone free rate.

Twenty-two cases (88.0%) had the haemoglobin decreased after PCNL and the mean postoperative hemoglobin drop was 1.32±0.76 g/L (range, 0.10–3.10 g/L), with one case received blood transfusion. One case manifested as fever (>38.5 ℃) on the 2nd day after surgery and the symptom was relieved with the treatment of antibiotic and antipyretic drugs. No other complications such as colon injury, extravasation of urine, perinephric infection and urosepsis occurred. The data details are represented in *Table 2*.

Discussion

AS is a chronic inflammatory disease involving many factors. It mainly involves articular manifestations including sacroiliac joint, spine and peripheral joint (7), renal as extraarticular organ is also vulnerable, with an incidence of 5–13% (8). Recently, urolithiasis was found more frequently in patients with AS. Some studies showed that the increasing incidence of kidney calculi in AS patients may attribute to many factors including the male gender, history of inflammatory bowel disease, and previous history of kidney calculi (1,4,9-11). Compared with the general population, AS patients were more likely to receive surgical intervention (5). However, stone management is a challenge for AS patients. A study on the distribution of procedures for nephrolithiasis in AS patients found that almost 64% patients got ESWL, 25% got ureteroscopic procedures and 6% got PCNL (5). To our knowledge, skeletal deformity, stone size larger than 20 mm, obesity might make ESWL difficult. For lager kidney stone (>20 mm) and complex kidney calculi, the preferred surgical procedure is PCNL (12). In our study, the mean BMI was 23.96±5.03 kg/m^2 (16.89–33.56 kg/m^2) which did not qualify as obesity, while the mean stone size was 41.69±20.33 mm larger than 20 mm. Therefore, PCNL was preferred for these patients. Only one patient got stone <20 mm underwent PCNL in this study due to pyonephrosis and ureteral polyps. PCNL has the advantage of high success and SFR in the treatment of renal calculi (13), it also has many complications including bleeding, surrounding structures damage, infection, positioning-related injuries, thromboembolic disease, and even death (14). Although PCNL is safe in general, its use in patients with AS has been rarely reported.

Osteoporosis due to the increase of inflammatory factors was common in AS patients (15), which led to the formation of kidney stone (3). Reduced mobility and deformity of the spine as the common manifestation of AS may make PCNL difficult. Spinal deformity may lead to changes in internal anatomy and affect cardiopulmonary function, especially in patient with thoracic spinal deformity. Thus, the choice of surgical position may be a challenge. Some scholars believed that epidural anesthesia and prone position would further restrict cardiopulmonary function and led to potential ventilation difficulties and increased cardiopulmonary burden (16,17). While in a study conducted by Izol *et al.*, all of 16 patients with spinal deformities underwent PCNL in the prone position, no significant damage of cardiac function and pulmonary ventilation were observed (18). Although the supine position had advantages in the protection of cardiorespiratory function and the convenience of combining with the treatment of ureteroscopy, prone position which can provide the access of retroperitoneal approach and enough puncture space was still preferred in PCNL. In our study, 12 (50%) patients were found to have spinal deformities including scoliosis, lordosis, kyphosis and disappearance of lumbar physiological curvature due to bamboo-like spine, with the rest found to have sacroiliac arthritis and mild limitation of joint movement. On the other side, there were only 3 patients had ASA grade III. Finally, prone position was performed successfully in the most of cases (64%). Considering osteoporosis and spinal deformity, no matter which position was placed, the space between the body and the operating table should be filled additional structural support to avoid nerve injuries or pressure ulcers (18).

In additional to prone position, general anesthesia (76%) was performed in the most of cases in our study. Tangpaitoon *et al.* compared epidural anesthesia with general anesthesia in patients underwent PCNL and got the similar result in the aspect of efficacy and safety, but more patient satisfaction, less early postoperative pain and less adverse effects were concluded in epidural anesthesia group (19). In our study, there was 24% patients received epidural anesthesia successfully and the result was satisfied. Although the efficacy and safety of general anesthesia and epidural anesthesia for PCNL in general patients was similar, there may be many difficulties for the performance of epidural anesthesia in AS patients due to spinal deformity represented by bamboo-like spine. Thus, general anesthesia was the primary selection in our study.

There are many techniques including ultrasound, fluoroscopy and CT which can provide the guidance during the procedure of puncture in PCNL (20). Spinal deformity is a common manifestation in AS patients which may change the anatomy of the upper urinary tract, cause renal malrotation and lead to abnormal adjacent relationship between the kidney and surrounding organs. Under this condition, the image of fluoroscopy may be affected adversely due to the interference of surrounding structures. Hence, the difficulty of puncture and the risk of visceral injury increased in these patients with the guidance of fluoroscopy (21). Compared with the widely utilization of fluoroscopy in western countries, Chinese urologists preferred to use ultrasound to guide renal puncture. Ultrasound has many advantages including reduction of radiation exposure, real-time imaging, improvement of visualization of adjacent viscera over fluoroscopy in

PCNL (22). It can accurately present the renal structure and distinguish the relationship between kidney calculi and calyces, which can help urologists to choose the best puncture site to manage as many stones in different calyces as possible with minimal damage. In additional, doppler flow imaging can also help avoid the damage of blood vessels. To realize this advantage, experience and skill are needed. For instance, bowels might locate on the renal puncture route due to changes of adjacent structures of kidney. In this situation, the bowels could be pushed away from the puncture route by the press of ultrasound probe on the body surface. In this study, all the procedure of puncture was guided under ultrasound and no complications of colon and vascular injury were found during the procedure of puncture. Postoperative fever is a frequent manifestation in PCNL. Previous studies found that the incidence of fever after PCNL ranged from 11.4–32.1% (23-25). In our study, several patients had temperature increased, but only 1 (4.0%) person had postoperative temperature greater than 38.5 ℃ (the temperature was 38.7 ℃ on the third day after PCNL). Compared with previous studies, the incidence of postoperative fever was relatively low. There were many factors that contributed to this consequence. Utilization of sensitive antibiotics based on drug sensitivity test could be one factor. Other factors might be the placement of silicone nephrostomy and the standard percutaneous tract which could decrease the pressure in renal pelvis and improve drainage.

In addition, postoperative bleeding is another complication in patient who underwent PCNL. Compared with single access, multi-tract access and prolonged operative time can increase the risk of postoperative bleeding in pediatric patients, but no significant relationship was found between puncture site and haemoglobin drop in cases with single access tract (26). For some patients with significant haemoglobin drop, blood transfusion might be necessary. Wollin *et al.* reviewed the previous papers and summarized the blood transfusion rate after PCNL due to postoperative bleeding ranging from 1% to 34% (14). While in AS patients, study on postoperative bleeding after PCNL was limited. To our knowledge, drugs such as non-steroidal anti-inflammatory drug (NSAID), conventional synthetic disease-modifying anti-rheumatic drug and hormone drug are necessary to control the progress of this disease. However, a study on renal involvement due to drugs in Chinese AS patients found that NSAID, conventional synthetic disease-modifying anti-rheumatic drug and TNF-α inhibitor made the risk of renal involvement including proteinuria and haematuria in 907 Chinese AS patients increased significantly (27). Thus, it's worth thinking that whether there are some relations between the utilization of these drugs for AS patients and haemoglobin drop after PCNL. In this study, 22 patients (88.0%) had the haemoglobin decreased after PCNL. The value of haemoglobin decrease ranged from 0.1 to 3.1 g/dL with the mean value of 1.32±0.76 g/dL. Among these patients, 1 (4.0%) patient received blood transfusion. No other complications such as extravasation of urine and perinephric infection occurred.

For large and complex renal stones (>2 cm), the reported SFR in general person after PCNL were 74–100% (12). In this study, the initial SFR and final SFR was 80.0% (20 kidney units) and 88.0% (22 kidney units) respectively which was in line with the previously reported outcome.

However, there were several limitations to our study. Firstly, this is a retrospective and descriptive study with no groups for controlled studies. Secondly, the number of cases is limited due to single center study. Since the kidney stones of AS patients are mostly treated with ESWL, the data of PCNL in AS patients is limited, more cases and multicenter study are needed. Thirdly, some factors such as eGFR and renal function on the operative side were excluded due to incomplete data.

Conclusions

In general, the result of ultrasound-guided PCNL for kidney stone patients with AS in our institute is satisfactory with high SFR and security. Operative position, anesthesia method and damage caused by drugs used to treat AS should be considered to achieve better result.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at http://dx.doi.org/10.21037/apm-20-2304

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uniform disclosure form (available at http://dx.doi.org/10.21037/apm-20-2304). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by institutional board of the Peking University People's Hospital (No. 2020PHB177-01) and individual consent for this retrospective analysis was waived.

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