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Original Article

Role of Pcnl in the Management of Horse Shoe Kidney Calculi: 10 Years Study

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ABSTRACT

Introduction: Horse shoe kidney (HSK) is considered as the most common fusion anomaly with an incidence of 1 in 400-666 births. According to AUA and EAU guidelines, PCNL is the surgical modality of choice for renal calculi more than 2 cms even in case of HSK. In this case series, we describe our experience with prone PCNL in the management of nephrolithiasis in HSK over the last 10 years.
Methods: Retrospective analysis of hospital records yielded data of 22 patients who underwent prone PCNL for HSK calculi between June 2012 and May 2022. Patient characteristics and stone characteristics were recorded. Procedure related outcomes like number of tracts established, total procedural time, need for auxiliary procedures, stone free rate and postoperative complications according to modified Clavien Dindo classification were tabulated and analyzed.
Results: Mean age of patients in this study was 44.2 years ranging from 9 to 70 years. Mean stone surface area was 376.54 mm2. Single subcostal upper pole calyceal puncture and tract was able to clear the calculi in 18 cases. Supracostal punctures were required for 4 patients. Auxiliary procedures like redo-PCNL and ESWL were needed in 1 and 2 patients respectively. Blood transfusion was done in 2 patients. Primary stone free rate of82.7% and final stone free rate of 95.5% was achieved.
Conclusion: Prone PCNL is equally safe and efficient management strategy for the treatment of calculi in horse shoe kidneys comparable to PCNL in normal kidneys.

Key Words: *Horse shoe kidney, Renal calculi, PCNL, Outcomes*

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INTRODUCTION

Berengario da Carpi was the first to mention the horseshoe kidney in 1552 [1]. Horseshoe kidney (HSK) is the most common fusion anomaly with an incidence of 1 in 400 [2] in case of autopsy studies to 1 in 666 births in case of radiological studies with a 2:1 male-to-female ratio [3]. HSK is characterized by fusion of the kidneys at the lower poles, with consequent failure to ascend and malrotation of the kidneys. Most of the HSK calculi are asymptomatic. Vascular supply to horse shoe kidney is variable with various combinations of vasculature from aorta, aortic bifurcation or common iliac arteries [4]. This aberration in vascular supply is associated with difficulty while performing renal surgeries [5]. High insertion and lateralization of the ureter occurs in horse shoe kidneys. This causes improper urinary drainage from the collecting system leading to stasis of urine within PCS and high incidence of kidney stones (35%) [6]. Stone formation in the HSK was proven to be the most common concomitant urological disorder in few studies with a mean reported incidence of 20% (ranging from 1% to 67%) [3, 7].

Historically, HSK calculi were treated with open surgical methods. With the latest advancements in endourology, more number of HSK calculi is treated with minimally invasive procedures like ESWL, URSL, RIRS or PCNL. Stein after careful review of literature has proposed that, PCNL had better stone free rate than ESWL in ectopic kidneys including HSK [8]. According to AUA and EAU guidelines, PCNL is the surgical modality of choice for calculi more than 2 cms even in case of HSK [9, 10]. PCNL in HSK calculi was proposed to have comparable stone free rates to that of calculi in normal kidneys with few studies showing more bleeding complications requiring blood transfusion and angioembolization in few cases particularly those with refractory hematuria or hypotension [11]. In this case series, we describe our experience with prone PCNL in the management of renal calculi in HSK over the last decade.

MATERIALS ANDMETHODS

We retrospectively evaluated the hospital records of patients with HSK calculi and compiled the data of 22 patients who had calculus disease in HSK and underwent prone PCNL between June 2012andmay 2022 in Department of Urology, Gandhi hospital, Secunderabad after attaining approval from institutional ethical committee (IEC).

Inclusion criteria:

Patients with horse shoe calculi with failed ESWL or stone size more than 1.5 cms were included in our study.

Exclusion criteria:

Patients with calculi in normal renal anatomy, HSK calculi less than 1.5 cms, calculi amenable to ESWL or other auxiliary procedures, patients with co-morbidities like severe coronary artery disease or cerebrovascular disease unfit for surgery, coagulopathy disorders and acute pyelonephritis were excluded from the study.

METHODOLOGY

Recorded variables included age at presentation, gender, presenting complaints like loin pain, hematuria, recurrent UTI, fever and side involved. Creatinine level and hemoglobin level at the time of admission and following the procedure were recorded. Stones were characterized based on radiological investigations like ultrasound, IVP and NCCT KUB. Stone characteristics included stone size, stone density and Guys stone score. Procedures were done under general/regional anaesthesia with intravenous antibiotic cover. The procedure started with retrograde ureteric catheterization using 5 Fr ureteric catheter and pelvicalyceal system delineated with diluted iodinated contrast (Urograffin 60%) while the patients were placed in lithotomy position. Percutaneous renal access was then established under fluoroscopic guidance after repositioning the patient from lithotomy position to prone position. The initial puncture was done by IP needle (18G) followed by 0.035 inchguide wire insertion. This was followed by dilatation of tract upto 24 Fr to 28 Fr using Amplatz dilators depending on stone volume. Finally Amplatz sheath of 24 Fr to 28 Fr was placed through which 24 Frnephroscope (Wolffe ™) was passed. Time taken from needle puncture to establishing the percutaneous tract was recorded and considered as the 'time taken for fluoroscopic access'. Pneumatic lithoclast (Swiss Lithoc last™) was used for stone fragmentation in all cases. The fragmented pieces were removed by means of triprong graspers. Additional punctures and tract were used in case of incomplete stone clearance due to inadequate access to calculi or difficult manipulation of nephroscope through the initial tract. At the end of the procedure nephrostomy tube (14 Fr foley catheter) was placed in all tracts along with 5 Fr DJ stent. Time taken from the time taken for fluoroscopic access to completion of procedure was recorded and considered as 'total procedural time'. Nephrostomy tube was blocked and removed when post operative plain X-ray KUB repeated on 2^{nd} post-operative day showed no radio-opaque shadows in KUB region and when the patient had no hematuria/fever. DJ stent was removed after an interval of 4 weeks in patients with complete stone clearance. 'Primary stone free rate' was defined as the total number of renal units cleared of calculi after initial PCNL. 'Final stone free rate' was defined as the total number of renal units cleared of the calculi following both initial PCNL and auxiliary procedures. Complications encountered during or after the procedure were graded according to Clavien-Dindo classification. Renal units not cleared of calculi were subjected to additional procedure like redo-PCNL and ESWL.

Statistical analysis:

Descriptive statistics were used to analyze the data obtained. Measures of central tendency calculated in terms of mean and measures of variability calculated in terms of standard deviation.

RESULTS

We analyzed 22 patients with HSK calculi treated by prone PCNL from June 2012 to May 2022. Table 1 represents demographic details of study population. Mean age of patients in this study was 44.2 years ranging from 9 to 70 years. Male to female ratio in our study was observed to be 2.67:1. Loin pain was the presenting complaint in all the patients. Recurrent UTIs were seen in 27.3% of study population. Even though macroscopic hematuria was seen in only one patient (4.5%), microscopic hematuria was seen in 17 patients (77.3%) on complete urine analysis.

Table 1: Demographic data

Patient characteristics		Distribution
Mean Age ± SD		44.2 ± 15.63 years
Sex	Male	16 (72.7%)
	Female	6 (27.3%)
Mean BMI		25.81 ± 4.26
Presenting complaint	Loin pain	22 (100%)

	Nausea/Vomiting	8 (36.5%)
	Fever	2 (9.1%)
	Hematuria	1 (4.5%)
	Recurrent UTI	6 (27.3%)
Side	Right	13 (59.1%)
	Left	9 (40.9%)
Hydronephrosis	No hydronephrosis	5 (22.7%)
	Mild	11 (50 %)
	Moderate	4 (18.2%)
	Severe	2 (9.1%)

Table 2 represents stone characteristics on imaging. Mean stone size was 19.4 mm. Stone more than 2cms size was seen in 19 patients (86.5%). In other 3 patients, stone density was more than 1000 HU and was subjected to PCNL instead of ESWL for this reason even though size of calculus was 1.5 to 1.7 cms. Mean stone surface area was 376.54 mm^2. Twelve patients (54.5%) had single calculus corresponding to Guys stone score 2 (Fig 1, 2). Multiple calculi were seen in 9 patients (40.1%) and partial staghorn calculus was seen in only 1 patient (4.5%) corresponding to Guys stone score 3. There were no cases of staghorn calculus.

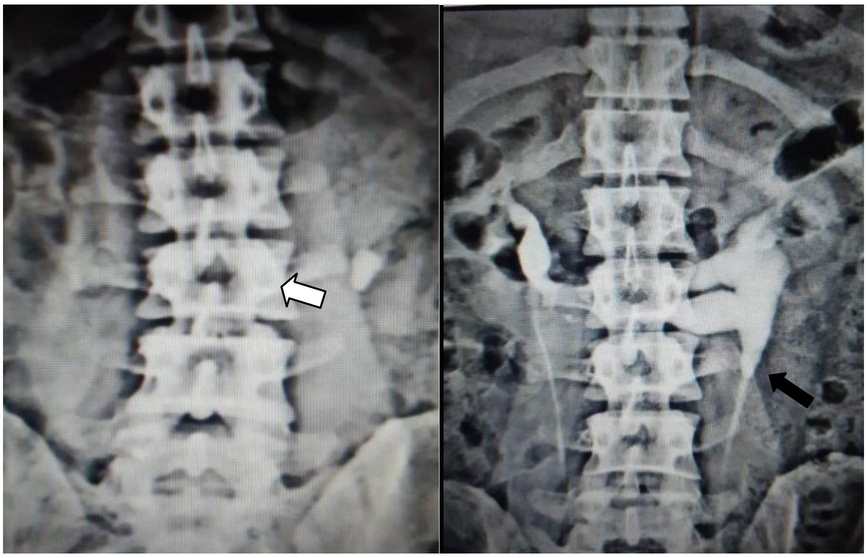

Fig 1: A. Plain radiograph KUB region showing calculus in left renal region (white bold arrow). B. IVU showing calculus impacted at left PUJ (black bold arrow) with moderate hydronephrosis

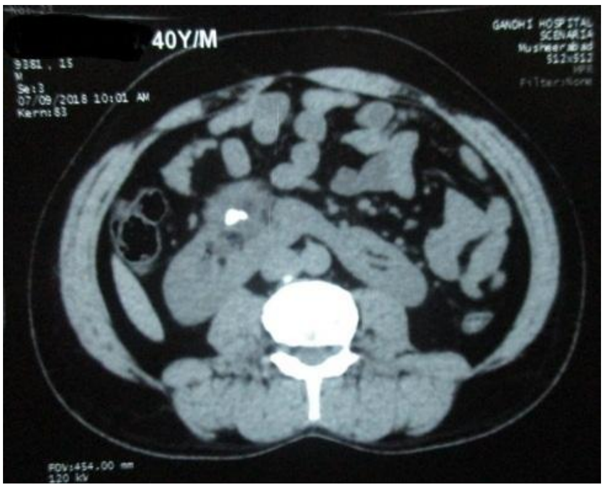

Figure 2: NCCT KUB showing right renal calculus in a 40 year old male with HSK

Table 2: Stone characteristics on imaging

Stone characteristics	Distribution
Mean stone size (mm)	19.4 ± 8.5

Mean stone surface area(mm^{2})		376.54 ± 74.81
Guys stone score	1	0
	2	12 (54.5%)
	3	10 (45.5%)
	4	0

Out of 22 upper pole calyceal punctures, supracostal upper calyceal punctures were done only in 4 patients (18.2%) and the rest of the 18punctures were subcostal punctures. Majority of the procedures required single upper pole calyceal puncture to clear the calculi (63.6%) and additional midpole punctures were done where access into midpole calyx was difficult through upper pole calyceal puncture (Table 3). Fluoroscopic time was lengthened in patients who required multiple tracts for stone clearance. Mean operative time was directly proportional to stone burden and number of tracts established. Eighteen out of 22 patients (82.7%) were cleared of calculus disease in single sitting whereas one patient underwent redo PCNL as there was hard stone not amenable to ESWL and 2 patients underwent ESWL. One patient had a residual calculus of size 5 mm on post-operative NCCT KUB and was kept in follow-up without any further intervention. Post-operatively, significant fall in hemoglobin requiring blood transfusion seen in 2 patients and infectious complications in 2 patients in the form of high grade fever, chills and rigors (Table 3). Out of 6 patients who received prolonged analgesics, 4 patients had supracostal punctures. Two patients with infectious complications were given prolonged IV antibiotics, thereby prolonging their hospital stay. Mean post-operative hospital stay was 2.5 days and was prolonged in patients who received prolonged IV antibiotics, blood transfusion and auxiliary procedures. Primary stone free rate was 82.7%. Final stone free rate was 95.5%. One patient presented with renal calculus in the opposite kidney during follow up, after an interval of 4 years and surgery is awaited for this patient.

Table 3: Peri-operative variables

Variables		Distribution
Puncture location	Upper pole	14 (63.6 %)
	Middle pole	4 (18.2%)
	Lower pole	0
	Upper+Middle	4 (18.2%)
Puncture site	Supracostal	4 (18.2%)
	Subcostal	18 (81.8%)
No. of punctures	Single	18 (81.8%)
	Double	4 (18.2%)
	Multiple	0
Mean fluoroscopic access time		7.2 ± 4.5 mins
Mean intraoperative time		47.2 ± 26.9 mins
Complications – Clavien Dindo	1	2 (9.1 %)
	2	4 (18.2%)
	3	3 (13.5%)
	4	0
	5	0
Stone free rate	Primary	82.7 %
	Final	95.5 %
Auxiliary procedures	Redo - PCNL	1 (4.5%)
	ESWL	2 (9%)
Transfusion rate		2 (9%)
Mean post-operative stay		2.5 ± 1.78 days

DISCUSSION

Majority of studies proposed various risk factors predisposing patients with HSK to lithiasis, which included suboptimal urinary drainage, recurrent urinary tract infections and metabolic abnormalities in up to 35%, 41% and 100% of cases respectively [12, 13]. Renal moieties on each side are positioned caudally when compared to normal anatomy of kidneys, with the renal pelvis rotated toward the anterior and the calyces more posterior than usual. During PCNL, identification of proper posterior calyx intraoperatively may be difficult, thereby making initial needle punctures difficult [8, 14, & 15]. Previous studies concluded that PCNL in HSK is safe and effective for large calculi or calculi that could not be treated by other methods [8]. A high stone free rate (SFR) is crucial for the success of any definitive procedure for stone management either in normal kidney or HSK.

Male to female ratio was found to be 2.67:1 in our study which is similar to the incidence of HSK in other studies [2]. Fourteen patients out of the total study population had a BMI of more than 25 Kg/m^2 and 3 patients had a BMI more than 30 Kg/m^2. None of the patients required long length Amplatz sheath or nephroscope. These patients however had prolonged operative time andmore torque over nephroscope while manipulating the instruments, thereby requiring prolonged analgesics in 2 patients. Single calculus corresponding to Guys score 2 was seen in 54.5% of study population. None of the cases with calculus in HSK is considered as Guys score 1 as per the classification. All the calculi in HSK are considered as Guys score 2 and above [11]. Upper pole calyceal puncture was used in majority of cases as it is in direct axis with pelvis and stone clearance was maximal with minimal nephroscope manipulation thereby minimizing complication rate and a similar explanation was given by Satav et al. in his study [16]. Middle pole calyceal puncture was required in only those cases where midpole calyx was not accessible through upper pole calyceal puncture or a single calculus located in middle calyx. Supracostal access i.e., above the level of 12th rib was required for 4 patients and none of the patients had pulmonary complications in our study except for minimal pleural effusion in 1 case and the patient was treated conservatively.

Operative time depended on the stone location and multiplicity of stones. Higher stone burden, lower pole calculi and presence of middle pole stones requiring additional punctures were associated with increased operative time. Majority of authors suggested flexible nephroscopy for more effective stone clearance in HSK [17, 18 & 19]. In our study, we used only rigid nephroscope and achieved a primary stone free rate of 82.7% and this is comparable with other studies [18-22]. Primary stone clearance was directly proportional to stone size, volume and location. Primary stone clearance was maximal in patients with solitary stones and those in upper or middle pole. A similar finding was seen in majority of studies suggesting large stone volume has lower primary stone free rates and requires auxiliary procedures for achieving complete stone clearance [23]. Prolonged post-operative stay was seen in patients with large stone burden who had high complication rate and those who required auxiliary procedures or additional pharmacologic treatment. No death was encountered in our case series. Major limitation of our study is the retrospective study design. Other limitations include use of rigid nephroscope alone and small study sample.

Few studies proposed that the addition of flexible nephroscopy and laser energy sources to rigid nephroscopy during PCNL could attain maximum stone free rate and prevent multiple punctures, thereby reducing complication rate associated with multiple punctures. Prospective randomized studies are needed to address the role of flexible nephroscopy and laser energy sources in the management of HSK calculus disease.

CONCLUSION

Prone PCNL is an equally safe and efficient management strategy for the treatment of calculi in horse shoe kidneys comparable to PCNL in normal kidneys. Stone volume and its location in the collecting system have a role in predicting the stone free rates.

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CONFLICTS OF INTEREST: None

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