Percutaneous Nephrolithotomy in Anomalous Kidney

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ABSTRACT

Objective: To assess the stone-free rate (SFR) subsequent to percutaneous nephrolithotomy (PCNL) in patients with anatomically anomalous kidneys.

Study Design: Cross-sectional study.

Place and Duration of the Study: Department of Urology, Sindh Institute of Urology and Transplantation Karachi, from 23 July 2020 till 30 October 2021.

Methodology: Sixty-five patients of renal stone disease with abnormal kidneys, aged 18-60 years of both genders were enrolled in this cross-sectional study. Demographic information like age, gender, stone size, duration of disease, and type of abnormality were noted. After PCNL, stone-free status was determined after 2 weeks of the procedure by performing ultrasound KUB.

Results: A total of 65 patients were included in this study with mean age of 36.37 ± 12.86 years [Range: 18-60]. There were 76.9% of males and 23.1% of females. Regarding anatomical malformation, 46.2% were malrotated kidneys, 16.9% were horseshoe kidneys, 16.9% were partial Duplex system, 9.2% had bifid pelvis. Median duration of the disease was 12 (IQR=10). Forty-one patients (63.1%) had single and 24 (36.9%) had multiple number of stones with average size of 3.26 ± 1.14 cm. SFR after PCNL in patients with abnormal kidneys was 70.77% (46/65) while 29.23% (19/65) were observed with residual fragments. Out of 19 cases with residual fragments, 10 (53.2%) had stone size <1 cm and 9 (47.4%) had stone of 1 to 3 cm. Sixteen out of 19 patients with residual stones were treated with ESWL (most required: one session), and re-do PCNL was performed in three cases.

Conclusion: PCNL is an effective and safe operation in anatomically anomalous kidneys. For satisfactory outcomes, it requires extreme care and exceptional surgical skill.

Key Words: *Malrotated kidney, Duplex system, Kidney anomaly, Horseshoe kidney, PCNL, Extracorporeal shockwave lithotripsy (ESWL).*

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INTRODUCTION

With the growth of science, minimally invasive surgical procedures have become possible. On the other hand, surgical techniques for kidney stones with aberrant anatomy are yet unknown.[1] The incidence of various forms of aberrant kidneys had been observed to range from 3 to 11%.[2] One of the most common renal anomalies is the horseshoe kidney followed by crossed fused ectopia. There is no specific advice or therapeutic option for the management of urolithiasis for such anatomical variations in the existing stone guidelines.[3] Extracorporeal shockwave lithotripsy (ESWL) is somewhat effective in treating stones in malformed kidneys, with stone clearance rates ranging from 28 to 78 percent in the horseshoe kidney and 66 to 71 percent in the ectopic kidney.[4,5]

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Its efficiency is further reduced by larger stones and decreased urinary drainage, with a stone clearance rate that is not optimal.[5] Flexible ureteroscopy, PCNL, and laparoscopic pyelolithotomy are some of the other minimally invasive stone removal procedures.

Due to the aberrant orientation of the renal pelvi-calyceal system and the unusual course of renal vasculature, percutaneous nephrolithotomy is a difficult procedure in anatomically deformed kidneys. Since the pelvis rotates anteriorly and the calyces lie posterolaterally in horseshoe and malrotated kidneys, calyceal puncture becomes extremely difficult. Laparoscopic assistance is essential in the case of an ectopic pelvic kidney to avoid iatrogenic insult to the bowel that surrounds the kidney; all of these factors can make PCNL challenging with a low stone clearance rate.[6] Vicentini *et al*. found 72.4 percent success rate in patients with PCNL in anatomically deformed kidneys.[7] Another study by Bas and colleagues found SFR in 71 percent of patients with horseshoe kidneys following PCNL.[8] SFR was reported to be 90% following PCNL in patients with anomalous kidneys in a research by Ergin *et al*.[9]

Since there is a lack of local data in this area, the results of this study will be invaluable to the field of urology and will guide clin-

ical decision-making when treating patients who need PCNL and have anatomically abnormal kidneys. Understanding the likelihood of stone-free results in this particular population can help inform treatment plans, enhance surgical execution, and improve patient care.

METHODOLOGY

After approval from Ethical Review Committee of SIUT, this cross-sectional study was conducted at the Department of Urology, Sindh Institute of Urology and Transplantation Karachi, from 23 July 2020 till 30 October 2021. It comprised of 65 patients; sample size was calculated by using epi-tools online software for sample size calculation of one proportion (available at http://epitools.ausvet.com.au/content.php?page=1Proportion, by taking expected frequency of SFR 71.0% after PCNL[8], desired precision level: 5%). Patients of renal stone disease with atypical renal anatomy diagnosed on CT scan, aged 18-60 years, both genders with disregard of disease duration were included in the study after taking an informed written consent. The patients planned for re-do procedures and chronic kidney disease diagnosed on clinical history and laboratory investigations (having serum creatinine levels >1.5 mg/dl) were excluded.

Data regarding patient's age, gender, size, and location of stone, laterality, and type of abnormality were collected. Urine analysis and culture of all the patients were sent to rule out urinary tract infection. Patients with positive urine culture were treated with broad spectrum antibiotics according to sensitivity. All patients with negative urine cultures were admitted in ward, at least one day prior to the surgery. On the table, single shot of intravenous empirical antibiotic was given to each patient at the time of anaesthesia induction.

All procedures were performed in general anaesthesia. First Retrograde Pyelography (RPG) was performed in lithotomy position followed by conventional PCNL (24-28Fr Amplatz sheath) with rigid nephroscope in prone or supine (modified Valdivia Gladakao) position depending upon the calyceal anatomy and location of stone(s). All PCNLs were performed by a consultant urologist having a minimum of 3 years of post-fellowship experience. Post-PCNL 16 Fr Nelaton catheter was inserted as nephrostomy in each patient. Patient remained admitted for at least 24 hours post procedure for monitoring postoperative course and complications (if any). After removing nephrostomy, every patient was discharged with advice to follow-up in the outpatient department. Stone-free status was confirmed with an ultrasound after 2 weeks of the principle procedure.

The data were entered and analysed through SPSS-23. The categorical data were expressed as frequency and percentage (%), and numerical data were expressed as mean and SD.

RESULTS

A total of 65 patients with kidney stone disease who had abnormal kidneys were included in this study. The mean age of the patients was 36.37 ± 12.86 years. There were 76.9% of men and 23.1% of women. Majority of the patients (52.3%) were urban residents. Regarding anatomical malformations, there were 46.2% of malrotated kidneys, 16.9% of horseshoe kidneys, 16.9% of partial duplex system, 9.2% of bifid pelvis, and others are as shown in Table I. Mean disease duration was 15.40 ± 15 months. Forty-one patients (63.1%) had a single stone and 24 (36.9%) had multiple stones. Prone PCNL was performed in 39 (60%) patients while 26 (40%) underwent PCNL in the supine position. The most used energy source for stone fragmentation was a combination of pneumatic lithoclast and ultrasonic lithoclast in 55 (84.6%) patients, as shown in Table II.

Table I: Demographic characteristics (n=65).

Variables	Statistics
Age (years)	36.37±12.86 (Range 18-60)
Gender	
Male	50 (76.9%)
Female	15 (23.1%)
Place of Residence	
Urban	34 (52.3%)
Rural	31 (47.7%)
Anatomical malformation	
Malrotated kidney	30 (46.2%)
Horseshoe kidney	11 (16.9%)
Partial duplex system	11 (16.9%)
Bifid pelvis	6 (9.2%)
Duplex system	2 (3.1%)
Polycystic kidney	1 (1.5%)
Crossed fused ectopia	1 (1.5%)
Duplex kidney with history of hemi-nephrectomy	1 (1.5%)
Malrotated kidney with bifid pelvis	1 (1.5%)
Malrotated with partial PUJO	1 (1.5%)

*Results are presented as n (%) and *mean ±SD.*

Table II: Diagnosis, size of stone, and surgical parameter (n=65).

Variables	Statistics
Duration of disease (months)*	12 (10)
Diagnosis	
Single moiety stone	4 (6.2%)
Renal pelvic stone	56 (86.2%)
Staghorn stone	5 (7.7%)
Number of stone	
Single	41 (63.1%)
Multiple	24 (36.9%)
Site	
Pelvic	35 (53.8%)
Lower calyx	5 (7.7%)
Middle calyx	1 (1.5%)
Pelvis and upper calyx	6 (9.2%)
Pelvis and lower calyx	15 (23.1%)
Pelvis and middle calyx	1 (1.5%)
Pelvis+ upper calyx+ lower calyx	2 (3.1%)
Size of stone (cm)	3.26 ± 1.14
PCNL surgery	
Right	34 (52.3%)
Left	31 (47.7%)
Approach	
Lower calyx	36 (55.4%)
Upper calyx	29 (44.6%)
Position	
Prone	39 (60%)
Supine	26 (40%)
Energy sources	
Pneumatic lithoclast	3 (4.6%)
Pneumatic lithoclast + ultrasonic lithoclast	55 (84.6%)
Trilogy	3 (4.6%)
Ultrasonic lithtriptor	4 (6.2%)

*Results are presented as n (%) and *median (IQR).*

Table III: Characteristics of patients with residual fragments (n=19).

Variables	Statistics
Site of residue	
Pelvic	4 (21.1%)
Lower calyx	9 (47.4%)
Middle calyx	4 (21.1%)
Upper calyx	2 (10.5%)
Treatment	
ESWL	
One session	15 (78.9%)
Two session	1 (5.3%)
Re-do PCNL	3 (15.8%)
Stone size (cm)	
<1 cm	10 (52.6%)
1-3 cm	9 (47.4%)

SFR was 70.8% (46/65) in patients with anomalous kidneys after PCNL, while 29.2% (19/65) of patients were seen with residual fragments. Mean size of residual stone was 1.14 ± 0.58 cm. Of the 19 cases with a residual fragment, 16 patients were treated with ESWL (mostly one session), and re-do PCNL was performed in three cases. Sites for most residual were the lower calyx and the middle calyx, as shown in Table III.

DISCUSSION

The majority of the literature had identified malrotated, duplex system, and horseshoe kidney as the most common types of kidney configuration or orientation anomalies.[10,11] Because of the shift in kidney configuration, PCNL can become very complicated. Furthermore, the renal-vasculature and its relationship to the neighbouring organs are altered.[12] Procedures where minimal invasive technique can be adopted lower complication risk and reduce the length of hospitalisation. It also has the benefit of making recovery easier and reducing analgaesia requirements.[13] Despite the availability of evidence supporting the use of minimally invasive procedures for treating conditions such as horseshoe kidney or pelvic ectopic kidney, the existing data regarding the efficacy of the PCNL technique in these cases is limited.[14] In circumstances where the stone size is substantially lower, the minimally invasive to non-invasive approaches other than PCNL are recommended.[15] Because the mean stone size in this study's cohort was substantially large, PCNL was the most appropriate option. Researchers and experts around the world also suggested a similar approach for large stone bulk.[10,15] The location of the calculus and pelvicalyceal anatomy can have a significant impact on the rate of stone removal from the kidney. In cases where stone is located in renal pelvis, retrograde intrarenal surgery (RIRS) can be offered. Nephroscope examination will be required when RIRS is unsuccessful in attaining the desired stone clearance. This examination revealed that the kidney harboured either substantially larger stones or multiple calculi.[16] In the current study, PCNL involved puncturing the superior calyx in majority of cases. However, an alternative option could be puncturing the mid-posterior calyx, which may help avoid damage to the pleura, especially considering the relatively lower position of the horseshoe kidney in patients with this anatomical abnormality.[17] According to the findings of this study as well as the supporting material published in previous papers,[10,18] the likelihood of significant problems with PCNL surgery were extremely low. Despite the benefits, the PCNL treatment still carries the risk of intra-operative bleeding in cases of bigger stones. When the stone size is very large, blood transfusion may be required in 14 to 24% of cases.[19]

Aside from that, it seems to be the method of choice with a minimal risk in the majority of patients. The length of hospitalisation following surgery, as well as the length of surgery, revealed in this study were consistent with the previously published data.[10,11,20] The treatment was not performed by a single surgeon, which was one of the study's major drawbacks that can be addressed in the future. Second, there was no consistent cut-off point for stone size in the inclusion criteria because few patients had a large stone load and several stones.

It had been demonstrated that PCNL is an effective and safe surgical treatment for patients with kidney anomalies. However, achieving satisfactory results requires caution and heightened awareness due to the complexities associated with renal anomalies.

While PCNL had demonstrated promising results in the management of stones in anomalous kidneys, it is essential to conduct additional research comparing the efficacy and safety of PCNL to other treatment modalities in this patient population. Such comparative studies would provide valuable insights, enabling healthcare professionals to make well-informed judgement regarding the most appropriate treatment option.

CONCLUSION

In patients with kidney anomalies, PCNL is a reliable and secure surgical procedure. However, achieving satisfactory outcomes compels duteous care and steadfast vigilance throughout the process.

ETHICAL APPROVAL:

An ethical approval for the research project was obtained from the SIUT-Ethical Review Committee [SIUT-ERC-2020/A-224]. This approval ensured that the study adhered to the ethical standards and guidelines, prioritising the well-being and rights of the participants involved in the research process.

PATIENTS' CONSENT:

Informed consents were diligently obtained from each patient participating in the research, ensuring their voluntary and knowledgeable agreement to participate in the study.

COMPETING INTEREST:

None of the authors had any conflict of interest to declare.

AUTHORS' CONTRIBUTION:

NAM: Concept, study design, literature search and review, manuscript drafting.
HHQ: Concept, drafting of manuscript, and critical review of data.
GMA: Study design, data analysis and acquisition, drafting of the manuscript.
MM: Data acquisition, literature search.
SRK: Data acquisition, literature search and review.
GS: Critical analysis and final approval of the manuscript.

All authors approved the final version of the manuscript to be published.

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