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Comparative Analysis of Stone Prevalence in Right vs Left Kidney During Percutaneous Nephrolithotomy (PCNL) In A Tertiary Care Centre Cross-Sectional Study

Dr. Satyendra Singh *[1], Dr Soumya Shree Singhal [2]

[1]Urology Division, Shri PD Siddhi Vinayak Hospital, Indore, MP, India.
[2]Urology Resident, Rajarajeshwari Medical College and Hospital, Bengaluru, India.

*Corresponding author: Dr. Satyendra Singh; *drsatyendra19@gmail.com, S.Singh-43@sms.ed.ac.uk*

Abstract

Introduction: Renal calculi present a substantial healthcare burden globally, necessitating effective management strategies. Percutaneous Nephrolithotomy (PCNL) stands as a cornerstone for addressing kidney stones, offering high efficacy but accompanied by potential complications. This study aimed to comprehensively investigate stone prevalence in Right vs Left Kidney. ***Methods:*** A cross-sectional study was conducted between January 1st, 2022, and March 31st, 2024, involving 205 patients. 200 PCNL cases were analyzed which included patients > 18 years of age,all genders and patients underwent PCNL. 5 Patients were excluded with incomplete records, psychiatric problems, sepsis, and distal ureteric obstruction. Data encompassed demographic profiles and comparative analysis of stone prevalence. Statistical analysis utilized chi-square tests and Fisher's exact tests. ***Results:*** The study comprised 135 males (67.5%) and 65 females (32.5%), with a mean age of 40.99 years. 55% of patients have kidney stones on the right side. The primary outcome measure, Stone-Free Rate (SFR), was assessed through postoperative imaging (ultrasound and X-ray). The SFR for the entire cohort was high, indicating the efficacy of the PCNL procedure in achieving stone clearance. ***Conclusion:*** The study demonstrates a higher prevalence of kidney stones in the right kidney (55%) compared to the left kidney (45%) among patients undergoing PCNL. These findings highlight that Kidney stones are more common on the right side then the Left side.

***Keywords*: Kidney stones, Renal stones, PCNL, Left Kidney, Right kidney, stone prevalence.**

Introduction

Renal calculi present a significant burden on healthcare systems globally, affecting 12% of the population, and have been associated with an increased risk of chronic kidney disease [1], end-stage renal failure [2,3], diabetes, and hypertension [4]. Approximately 30% of the workload in urology departments is dedicated to their management [5]. Among various treatment modalities, Percutaneous Nephrolithotomy (PCNL) stands as a cornerstone for addressing kidney stones >2 cm, partial and complete staghorn stones, stones refractory to Extracorporeal Shock Wave Lithotripsy (ESWL), lower calyceal, diverticular and horseshoe kidney stones [6]. AUA [American Urological Association] and EAU [European Urological Association] also mentioned PCNL as a gold standard procedure for stones > 2cm. However, PCNL is linked with potential intraoperative and postoperative complications. Intraoperative risks include bleeding, renal collecting system injury, visceral injury, pleural injury, Deep vein thrombosis (DVT), extrarenal migration of stone, and exposure to radiation while postoperative complications include fever, sepsis, UTI, pyelonephritis, nephrostomy urinary leakage, and infundibular stenosis. Prompt diagnosis and management are essential for addressing these potential issues.

First described by Fernstrom and Johanson in 1976 [7], PCNL has evolved substantially over the years, witnessing advancements in techniques like instrument miniaturization for smaller tracts, fluoroscopy to ultrasound guidance for puncture, and single-step dilatation techniques. Lithotripsy techniques have evolved from EHL to laser-based methods and technologies have shifted from X-ray-KUB to Computed Tomography scan (CT KUB), facilitating improved diagnosis and procedural planning. This progress has led to the development of scoring systems like STONE nephrolithometry and Guy's stone score for better prognostic evaluation [8,9] aimed at enhancing efficacy while minimizing associated complications. Staghorn morphometry is also used as a prognostic tool for PCNL outcomes [10].

The efficacy and safety of PCNL are often measured as Stone-Free Rates (SFRs) and are influenced by a myriad of factors, encompassing demographic profiles, stone characteristics, dilatation techniques, and the number of tracts established during the procedure. Understanding these factors is paramount in optimizing

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clinical outcomes and patient care. However, despite the extensive literature on PCNL, studies examining these factors within the context of a specific tertiary care setting in central India are lacking.

Aim and Objectives

Aim: To study Stone Prevalence in Right vs. Left Kidney During Percutaneous Nephrolithotomy (PCNL) in a Tertiary care centre.

Objectives

1. Characterizing the Demographic Profile: To characterize the demographic profile of individuals who underwent PCNL in the specified tertiary care centre between January 1st, 2022, and March 31st, 2024.
2. Comparison and Evaluation of Stone Prevalence: To comprehensively evaluate the prevalence of kidney stones.

By achieving these objectives, our study seeks to compare Stone Prevalence in the Right vs. Left Kidney During Percutaneous Nephrolithotomy (PCNL) in a Tertiary care centre.

Methods

This cross-sectional study was designed and conducted to identify and compare the stone prevalence in the Right vs. left kidney in patients undergoing percutaneous nephrolithotomy [PCNL] at Shri P.D Siddhivinayak Hospital between January 1st, 2022, and March 31st, 2024. The hospital, as a tertiary care centre, attracts patients from diverse backgrounds and regions, providing a representative sample for this study. Three sampling methods are commonly used for retrospective study; convenience, quota, and systematic sampling. By employing the most common convenience sampling method to select participants in a specific time frame sampling of 205 pts was done out of which 3 patients' records were incomplete and 2 patients did not give consent. Data was collected from the medical records of 200 patients who underwent PCNL during the specified timeframe. This cross-sectional study included all patients above 18 years of age, both genders with patients posted for PCNL and diagnosed after ultrasound KUB (Kidney, Ureter, and Bladder) and CT – KUB, both newly diagnosed and known cases of renal stone, and excluded all those patients whose medical records pertaining to the present study are incomplete. Patients having psychiatric problems, sepsis, and distal urinary tract obstruction, B/L renal stones, pediatric stone disease were excluded.

The data analysis was done between March to April 2024 and report writing was done between April to June and focused on independent variables such as demographic profile, stone prevalence, and hemorrhagic complications, which were hypothesized to influence the outcome of dependent variables, namely Stone-Free Rate (SFR) and post-PCNL complications.

Before PCNL, patients underwent a thorough evaluation, including a detailed history, examination, and pre-operative profile assessment encompassing complete blood counts, renal function tests, random blood sugar, coagulation profile, and urine examination. Additionally, all patients underwent preoperative imaging, including USG, X-rays, and in some cases, CT KUB. Only patients deemed fit for surgery proceeded to the intervention. For patients with urinary tract infections, a sterile urine culture was obtained prior to the procedure. The primary outcome measure, SFR, was assessed through postoperative imaging which includes USG [ultrasound] and X-Ray.

Operational Definitions

Independent Variables: Variables that stand alone and are not affected by the measured factors.

Dependent Variables: Variables that rely on and can be influenced by other measured factors.

SFR (Stone Free Rate): Defined as the absence of residual stones or stones with a maximum diameter of 4 mm or less on imaging, or clinically insignificant residual fragments (CIRF) [11].

Sample size calculation: The sample size was calculated by using a single population proportion formula by taking the prevalence of Renal stones in India which was 12.0% [1] and margin of error = 5%, confidence level = 95%, and standard normal distribution value = 1.9A total sample size was determined as follows: (Cochran's formula)

$$n=((Z_{(\alpha/2)})^2 p(1-p))/d^2$$

Where n is the desired sample size, d is the desired precision 5% = (0.05), z is the standard normal distribution value at confidence level 95% = 1.96, p is the prevalence rate of Renal stone = 12.0%, $〖(Z_{(\alpha/2)})^2 = (1.96)〗^2 = 3.8416$, P = 12.0% = 0.12, and $d=(0.05)^2=0.0025$.

So, $n = (3.8416*0.12*0.88)/0.0025=162.20$

By taking a nonresponse rate, 10% of 162.20 = 16.22. The total sample size was 178.42 ~ 200.

Statistical Analysis

Data was entered into a Microsoft Excel spreadsheet and analyzed using Open Epi Software. Continuous data will be expressed in terms of mean and SD. Categorical data will be expressed in the form of proportions and percentages. Appropriate tests of significance chi-square test and Fischer's exact test were applied wherever necessary. The p-value of less than 0.05 was considered statistically significant.

Results

The present study involved 205 patients who underwent percutaneous nephrolithotomy (PCNL) for renal stones. However, records for 3 patients were incomplete, and 2 patients did not give consent for participation in the study. The predominant symptoms observed among the participants were flank pain and vomiting followed by microscopic haematuria.

Table 1: A total of 200 participants were included, with 135 (67.5%) being male and 65 (32.5%) females. The age range was wide, from 18 to 79 years, with a mean age of 40.99 years and a standard deviation of 14.65. Most participants were aged between 18-40 years, with those aged 18-30 and 31-40 constituting 28.5% and 28.0% of the sample, respectively. Male to female ratio was 2.08 :1.

Table 1: The socio-demographic distribution of the study population.

Socio-demographic	Frequency (n=200)	Percentage (%)
Gender		
Male	135	67.5
Female	65	32.5
Age		
18-30	57	28.5
31-40	56	28.0
41-50	31	15.5
51-60	31	15.5

≥61	25	12.5
18-30	57	28.5
Mean ± SD	40.99 ± 14.65	
Min-Max	18-79	

Table 2: It indicates that the distribution of age varies significantly between males and females ($\chi^2 = 11.719$, $p = 0.025$). For instance, in the 18-30 age group, there were 30 males (22.2%) and 27 females (41.5%). This suggests that kidney stones are more common between 18-30 years of age and a gender disparity in certain age categories, which could be important for understanding the demographics of the study population.

Table 2: The distribution of participants by age and gender

Age	Gender		Total
	Male	Female	
18-30	30 (22.2%)	27 (41.5%)	57 (28.5%)
31-40	39 (28.9%)	17 (26.2%)	56 (28.0%)
41-50	26 (19.3%)	5 (7.7%)	31 (15.5%)
51-60	24 (17.8%)	7 (10.8%)	31 (15.5%)
≥61	16 (11.9%)	9 (13.8%)	25 (12.5%)
Total	135 (100.0%)	65 (100.0%)	200 (100.0%)

Chi-square test- 11.719, p-value-0.025

3. Stone prevalence: The analysis revealed a significant difference in the prevalence of kidney stones between the right and left kidneys. Specifically, 55% of the patients had kidney stones in the right kidney, while 45% had stones in the left kidney.

Discussion

Over the last two decades, the landscape of surgical management for renal stone disease has undergone a remarkable transformation with the advent of minimally invasive procedures such as Extracorporeal Shock Wave Lithotripsy (ESWL) and Percutaneous Nephrolithotomy (PCNL). PCNL has emerged as the preferred treatment for large stones (>2 cm) and complex cases involving anatomical abnormalities or stone types like struvite or cystine [12,13].

In the contemporary era, patients grappling with complicated and sizable kidney stones are increasingly offered PCNL or Retrograde Intrarenal Surgery (RIRS) as viable therapeutic options. The shift toward PCNL over traditional open stone surgery is attributed to its cost-effectiveness, reduced morbidity, and faster recovery periods [14,15].

Many factors come into play when determining the most suitable treatment modality and ultimately influencing the Stone Free Rate (SFR). Patient preferences, the surgeon's expertise, the preferred surgical position, as well as the anticipated treatment duration predicated on the size, number, and location of the stones all wield significant influence in this regard.

The present study offers valuable insights into the factors influencing the clinical outcomes of percutaneous nephrolithotomy (PCNL) in a tertiary care setting in central India. By comprehensively investigating demographic profiles, stone characteristics, dilatation techniques, and the number of tracts established during the procedure, the study sheds light on important considerations for optimizing patient care and treatment efficacy.

In our study, 200 participants were included, with 135 (67.5%) being male and 65 (32.5%) females. Ahmad I et al. found a mean age of 42.46 years with a standard deviation of 11.29, similar to our findings [16]. The age range was wide, in our study which varied from 18 to 79 years, with a mean age of 40.99 years and a standard deviation of 14.65. Most participants were aged between 18-40 years, with those aged 18-30 and 31-40 constituting 28.5% and 28.0% of the sample, respectively. The male-to-female ratio of 2.08:1 aligns with the findings reported by Edvardsson VO et al. [17].

The higher prevalence of stones in the right kidney (55%) compared to the left (45%) was consistent with studies conducted by Karkee et al. and Kulkarni PM [18,19].

The Stone Free Rate (SFR) of 89% in our study exceeded that of Rizvi et al. (83.2%), but was lower than Raya et al. (94%) [20,21]. Complete stone clearance was more likely in smaller stones (20-25 mm and 25-30 mm), with a 100% stone-free rate observed in these categories. As stone size increases, the likelihood of incomplete clearance also rises, particularly evident in stones sized 35-40 mm, where only 25% achieved complete clearance. The challenges of incomplete clearance for larger stones, particularly staghorn calculi, were similarly observed by Turna et al. [22].

This underscores the importance of procedural flexibility and adaptability to optimize outcomes based on stone characteristics and patient factors. Furthermore, patient comorbidities, anatomical variations, and surgical expertise also influence treatment outcomes and postoperative recovery. Multidisciplinary collaboration involving urologists, radiologists, and anaesthesiologists is essential for comprehensive preoperative assessment, procedural planning, and perioperative care coordination.

One notable strength is the comprehensive approach adopted in investigating various factors influencing PCNL outcomes, including demographic profiles, stone characteristics, and procedural variables. The utilization of a relatively large sample size and rigorous statistical analyses enhance the robustness and generalizability of the findings, providing valuable insights applicable to clinical practice.

Advancements in PCNL methodologies, including improvements in patient positioning and safer tract construction, the utilization of cutting-edge imaging technologies, the introduction of advanced intracorporeal lithotripters, and the integration of flexible equipment for streamlined collection system screening have been highlighted in recent updates [23]. Modern PCNL procedures are intricate, requiring precision and technical expertise at every stage. From gaining access to the kidneys and safely dilating the ureter to conducting intracorporeal lithotripsy and fragment removal, each phase demands meticulous execution. Following completion, proper patient positioning and upper system drainage are essential for optimal outcomes. The integration of advanced imaging technologies, intracorporeal lithotripters, and flexible equipment has streamlined the PCNL procedure [24]. However, despite its efficacy, the widespread adoption of PCNL is hindered by its technical complexity and comparatively higher morbidity rates when

compared to shock wave lithotripsy (SWL). The technical complexity and steep learning curve of renal access have been noted as key challenges, though tubeless PCNL offers promising alternatives with reduced morbidity and shorter postoperative stays [25,26]. The adoption of three-dimensional reconstruction and intraoperative imaging techniques has been shown to improve puncture accuracy, stone localization, and overall procedural outcomes [27,28].

Limitations

The study's reliance on convenience sampling may have introduced selection bias by excluding patients with incomplete medical records or those who did not provide consent. This limitation reduced the representativeness of the sample, potentially skewing findings toward individuals with better outcomes or healthcare access. Alternative methods like stratified random sampling or systematic sampling could have minimized bias and improved generalizability. Data collection from medical records presented risks of information bias due to incomplete or inaccurate documentation. Standardized data protocols and audits could have enhanced data reliability. Additionally, the study's reliance on preoperative imaging for stone characterization may have underestimated postoperative outcomes. Incorporating postoperative imaging, such as CT scans, could have provided more accurate assessments of residual stones and treatment success. Conducting the study at a single tertiary care center limited the external validity of findings, as patient demographics and clinical practices might differ across regions. Multi-center collaborations could have improved generalizability by capturing diverse patient populations. The primary outcome measure, Stone-Free Rate (SFR), may not have fully captured treatment success, overlooking factors like symptom resolution or quality of life. Including patient-reported outcome measures (PROMs) would have provided a more comprehensive assessment.

Conclusion

This research offers valuable insights into the prevalence of kidney stones in the Right vs Left kidney in central India, highlighting the significa/nce of customized strategies based on the specific features of kidney stones and the intricacies of the procedure. A deeper understanding of these elements aids in enhancing clinical results and improving patient management during PCNL interventions.

Abbreviations

PCNL: Percutaneous Nephrolithotomy.

SFR: Stone Free Rate

ESWL: Extracorporeal shock Wave Lithotripsy

AUA: American Urological Association

EAU: European Association of Urology

KUB: Kidney, Ureter, Bladder

S.T.O.N.E Nephrolithometery: S- stone size, Tract length, Obstruction involved, Essence [HU].

Declarations

Ethical approval and consent to participate

Research protocols have been approved by the Institutional Review Board of MGM Medical College and M.Y hospital, Indore [MP] with no- 19164. 2.

Informed Consent

Shri P.D Siddhivinayak Hospital director consent was taken for this retrospective study. 3. Registry and the registration number of the study from Ethics Committee M.G.M Medical College & M.Y Hospital, Indore is - EC/MGM/OCT-23/172.

Data Availability

Available upon responsible request to the corresponding author.

Consent for publication

Yes

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None

Author' contributions

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