

## Research Article

# Standard Percutaneous Nephrolithotomy as Day Care Surgery. A Single Center Experience.

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### Abstract

**Background:** Percutaneous Nephrolithotomy (PCNL) is a well-defined treatment modality for kidney stones. The present study evaluates the feasibility of PCNL as a day care surgery advocating patient selection and perioperative care to ensure safe and efficacy.

**Objectives:** To assess the feasibility, safety and efficacy of a standard PCNL as a day care procedure, including perioperative complications, stone clearance and factors that have potential impact for day care PCNL success.

**Methods:** Retrospective cohort study done at Pakistan Kidney and Liver Institute and Research Centre over a period from November 2018 to July 2023 including patients of day care standard PCNL. Based on these predictors, the feasibility of day care surgery was compared between two groups (feasible cases and non-feasible cases) by conducting logistic regression analysis and statistical tests on the other variables.

**Results:** Important predictors of day care PCNL feasibility included stone size ( $p = 0.021$ ), blood transfusion ( $p = 0.024$ ), duration of postoperative stay ( $p < 0.001$ ), and operative time ( $p = 0.001$ ). Residual stone size was associated with a number of variables, including time in surgery, blood transfusion and initial stone size. A strong positive correlation was established between preoperative and postoperative haemoglobin levels. The operative time positively correlated with estimated blood loss and duration of postoperative stay. There was a negative correlation observed between estimated blood loss and preoperative haemoglobin levels.

**Conclusions:** The findings of this study provide knowledge on the possibility and results of standard PCNL as a day care surgical intervention. The results support prior studies, highlighting stone size, blood management, and surgical effectiveness as the key determinants of day care PCNL viability. Better patient selection and management of the patient during the day care PCNL can make it a viable option for renal stone management.

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### Introduction

Kidney stones, also known as renal calculi, are a prevalent urological condition worldwide, affect-

ing individuals of all age groups and backgrounds. The burden of kidney stones extends beyond its painful symptoms, as it presents substantial challenges in terms of healthcare utilization and costs.<sup>1,2</sup> In 1976, Fernstrom and Johansson published the first description of percutaneous nephrolithotomy (PCNL). As a result of advancement, it is currently the first-line therapeutic treatment for renal stones with a diameter more than 2 cm.<sup>3,4</sup> It has



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long been established as an effective surgical intervention for the management of large and complex kidney stones. Traditionally, PCNL has been performed with a standard inpatient protocol, necessitating a hospital stay for postoperative monitoring. However, complications and length of hospital stay following PCNL have significantly decreased thanks to advancements in endourological practice, including equipment miniaturisation, better optic systems, and renal access techniques,<sup>5,6</sup> particularly the tubeless PCNL procedure pioneered in 1977 by Bellman and colleagues. This enables PCNL daycare to exist. However, as healthcare systems evolve and patient preferences change, there is a growing interest in exploring alternative approaches to PCNL. In recent years, the concept of "day care surgery" has gained prominence, emphasizing the feasibility of performing surgical procedures with the intention of discharging patients on the same day as the surgery.

The term "day care surgery" describes procedures that result in patients being discharged from the hospital either that same day or in no more than 24 hours.<sup>7-9</sup> Recently, researchers have described the feasibility of PCNL as a day care operation and compared its safety and effectiveness with inpatient PCNL. Day care PCNL is not, however, practiced and there is still debate on the complication, haemorrhage, readmission and stone free rates. However, this strategy aligns with the broader goals of reducing health care costs, decreasing the incidence of health care-associated infections, and increasing patient comfort and satisfaction. Day care surgery has been successfully practiced in some surgical specialties but its use in PCNL has not been explored much.<sup>10-12</sup>

To assess the feasibility and outcomes of routine PCNL when performed as a day care surgery, a pioneering study has been initiated at the Pakistan Kidney and Liver Institute and Research Centre in Lahore, Pakistan. This study provides a single-center analysis of the safety, effectiveness, and patient-oriented outcomes associated with this innovative approach. The rationale for undertaking this study is the need to enhance the management of kidney stone disease to conform to current healthcare practices and patients' expectations. Healthcare resources can be utilized more optimally by providing PCNL as a day care procedure which would reduce the burden on the patient's pocket and the health care system.

Moreover, day care surgery may present psychological benefits to patients by minimizing the disruption to their daily lives and allowing them to return to the comfort of their homes sooner than.<sup>13</sup>

To date, limited research has delved into the intricacies of day care PCNL within the Pakistani healthcare context. This study aims to bridge this gap by providing valuable insights into the feasibility and outcomes of day care PCNL at a prominent urological institute in Lahore. The study doesn't entail changing factors in an experimental setting; instead, it concentrates on the experiences and results of this surgical technique in actual clinical settings. With the components of cohort study, the primary objectives of this study were to assess the feasibility of standard PCNL as a day care procedure at the Pakistan Kidney and Liver Institute and Research Center as well as to evaluate the safety and efficacy of day care PCNL in terms of perioperative complications and stone clearance rates.

## Methods

This study constitutes a retrospective cohort study inclusive of elements of cross-sectional analysis. The sampling technique involved in this study constitutes a mixture between retrospective cohort sampling and convenience sampling. This study was carried out upon data collected at the Pakistan Kidney and Liver Institute and Research Centre (PKLI-RC), Lahore, Pakistan from November 2018 to July 2023. Specifically, conventional percutaneous nephrolithotomy (PCNL) was assessed as a day care surgical treatment, which delivers surgical services upon patient discharge the same day without hospital admission, at PKLI-RC, a tertiary care hospital and research center focused specifically on urological and nephrological disorders. Patients were included if they underwent their routine PCNL as a daycare surgery, which meant they were thought to be suitable patients for this specific surgical procedure, and also include persons from a diversity of age, gender, and comorbidity categories which indicates that some consider at least a diversity of patient mix for inclusion. Patients were excluded if they did not undergo their routine PCNL as day surgery (e.g. needed an additional procedure or hospitalization for longer than one day) or if important information in relation to the study (e.g. medical record details, surgical information) was not accessible or

missing. The total number of eligible participants for inclusion in this analysis working at PKLI-RC was 87.

Participants of various ages, genders, and comorbidity profiles were considered for this study. Demographic, clinical, and surgical data were collected from the electronic medical records (EMR) database that is Sisoft Healthcare Information Systems (SisoHBys Version: 2.0.4.249) hybrid medical record at our facility of patients who underwent PCNL at PKLI-RC. The data collection process encompassed a comprehensive range of variables, including but not limited to patient age, gender, comorbidities (such as chronic kidney disease, diabetes mellitus, and hypertension), stone size, stone location, stone-free status, preoperative and postoperative hemoglobin levels, operative time, estimated blood loss, postoperative blood transfusion, postoperative stay duration, complications, and more. The choice of PCNL approach, such as tubeless or nephrostomy tube with or without DJ stent placement, was determined by the urologist based on patient characteristics and stone complexity. Stone-free status after PCNL. Operative time estimated blood loss, postoperative blood transfusion, postoperative stay duration, and complications. Descriptive statistics were used to summarize demographic and clinical characteristics. Continuous variables were expressed as means with standard deviations (SD), while categorical variables were presented as frequencies and percentages. The stone-free rate was calculated as the proportion of participants declared stone-free among the total participants. Correlation analyses were performed to investigate relationships between continuous variables. Independent sample t-tests were used to compare means between groups. Statistical significance was set at  $p < 0.05$ . Logistic regression analysis was employed to assess the feasibility of standard PCNL as a day care surgical procedure while controlling for covariates. Independent sample t-tests were used to compare means between groups. Statistical significance was set at  $p < 0.05$ .

## Results

About 86.2% of the participants said they had no history of inadequate fluid intake while 13.8% of the participants had history of drinking too little water, respectively. The majority (63.2%) had a history of stone creation in their families, whereas just 36.8% did not. Only 8.0% of those surveyed (a huge majority,

92.0%) reported having ever had a UTI. 82.8% of participants reported minimal or little physical activity, whereas 10.3 percent and 6.9 percent, respectively, reported prolonged sitting. Underweight (4.6%), Healthy Weight (59.8%), Over-weight (14.9%), and Obesity (20.7%) represented the distribution of people across BMI categories. A minor percentage (5.7%) of participants had insufficient access to clean drinking water, while the majority (94.3%) came from hot areas. The percentage of people who did not have a history of stone creation was high (89.7%), whereas the percentage of those who did was 10.3%. Most participants (90.8%) belonged to the "Adult" age category, with lesser percentages in the "Peads" (2.3%) and "Adult" (5.7%) age categories. There were 20.7% female participants compared to 79.3% male participants. Comorbidities were distributed as follows: chronic kidney disease (CKD) (1.1%), diabetes mellitus (DM) (2.3%), DM + hypertension (HTN) (1.1%), HTN (14.9%), and no comorbidities (80.5%). The types of previous stone treatments were as follows: Extracorporeal Shock Wave Lithotripsy (ESWL) (4.6%), No treatment (71.3%), Percutaneous Nephrolithotomy (PCNL) (1.1%), Pyelolithotomy (16.1%), ESWL + Pyelolithotomy (2.3%), ESWL + Ureteroscopy (URS) (1.1%), and URS (3.4%). Stone sizes were categorized as follows: 1-2 cm (10.3%), 2.1-3 cm (56.3%), 3.1-4 cm (19.5%), and >4 cm (13.8%). The distribution of stones by site was nearly equal, with 55.2% on the left side and 44.8% on the right side. Most patients (79.3%) received "Tubeless" PCNL, while a smaller percentage received "Nephrostomy + DJ Stent" (16.1%) or "Total Tubeless" (4.6%) PCNL. Many individuals (96.6%) received PCNL using a lower pole puncture method, although a few had punctures in the middle pole (2.3%) or upper pole (1.1%). While 28.7% of the surgeries were not appropriate for day care, most of them (71.3%) could be performed there. ESWL (27.6%), no ancillary procedure (64.4%), nephroscopy (4.6%), and URS (3.4%) were among the ancillary procedures that participants underwent. Haemorrhage (1.1%), sepsis (8.0%), stent issues (1.1%), stone migration (2.3%), and urine leak (2.3%) were the reported consequences.

For comprehending our study's findings and consequences, the following statistics gave a glimpse of the traits and variability within our dataset. BMI ranges from 17 to 33, with a mean of 24.63. From 3 to 70 years old, the average age is 36.63. With a range of 1.70 to 5.50 cm,

the average stone size is 3.08 cm. The preoperative haemoglobin level ranges from 9.9 to 16.3 g/dL, with an average of 14.50 g/dL. The range of postoperative haemoglobin levels is between 9.0 and 15.0 g/dL, with the mean value being 13.05 g/dL. The average surgical duration is 137.70 minutes, ranging from 75 to 240 minutes. The mean estimated blood loss is 61.51 mL, with a range of 30 to 200 mL. Most patients (98%) did not require postoperative blood transfusion. The average postoperative stay is 30.10 hours, with durations ranging from 13 to 72 hours. The mean residual stone size is 3.19 mm, with some patients having no residual stones and others with sizes up to 12 mm. Patients typically had DJ stents removed around the 21.63-day mark, with variations from 0 to 90 days. The stone-free rate (SFR) for the participants in our study who underwent PCNL treatment was approximately 50.57%.

The objective of this study was to determine the significant predictors of the feasibility of day care surgery for patients undergoing Percutaneous Nephrolithotomy (PCNL). Logistic regression analysis was employed to assess the relationship between various independent variables and the binary outcome of surgery feasibility (Feasible as day care vs. Not Feasible as day care). A total of 87 cases were included in the analysis, with no missing data. Among the numerous independent variables examined, several were found to be statistically significant predictors of the feasibility of day care surgery: The size of renal stones, measured in centimeters, was identified as a significant predictor with  $p = 0.021$ . An increase in stone size was associated with a change in the likelihood of day care surgery feasibility. Further analysis of the odds ratio revealed the direction and magnitude of this effect. The need for a postoperative blood transfusion emerged as another significant predictor with  $p = 0.024$ . Patients who required a blood transfusion post-surgery had an altered likelihood of day care surgery feasibility, as indicated by the odds ratio. The duration of postoperative hospital stay was a robust predictor of day care surgery feasibility with  $p < 0.001$ . The odds ratio quantified this influence and showed that longer postoperative stay hours were linked to a change in the chance of feasibility. With a statistical significance of  $p = 0.001$ , the length of the surgical process, expressed in minutes, also showed statistical relevance as a predictor. The odds ratio enabled a thorough knowledge of the operating time's impact on

feasibility. These results highlight the significance of the size of the stone, postoperative blood transfusions, length of postoperative stay, and surgical procedure duration as key criteria in evaluating the viability of day care surgery after PCNL. The logistic regression model had a significant overall fit (Chi-square = 104.360,  $df = 56$ ,  $p < 0.001$ ), indicating that the combination of these factors can shed light on whether day care surgery is feasible (Table-1). The model exhibited a Cox & Snell R Square of 0.699 and a Nagelkerke R Square of 1.000, indicating that the predictors collectively account for a substantial proportion of the variance in surgery feasibility. It's important to note that the presented results are based on the data available in this study and should be considered in the context of the specific patient population and surgical procedures analyzed.

In comparing the means of continuous variables between the "Feasible as day care" and "Not Feasible as day

**Table 1:** Significant Predictors of Day Care Surgery Feasibility in PCNL Patients

Independent Variable	p-Value	Odds Ratio
Stone Size (cm)	0.021	5.320
Postoperative Blood Transfusion	0.024	5.077
Postoperative Stay (hours)	< 0.001	57.831
Surgical Duration (minutes)	0.001	11.233

care" surgery groups independent sample t test was used. Postoperative Blood Transfusion showed a significant difference. None of the cases in the "Feasible as day care" group required postoperative blood transfusion, while 8% of cases in the "Not Feasible as day care" group needed transfusion ( $p = 0.024$ ), in postoperative stay hours variable, the "Not Feasible as day care" group exhibited significantly longer postoperative stays ( $M = 49.52$  hours) compared to the "Feasible as day care" group ( $M = 22.27$  hours) ( $p < 0.001$ ), estimated blood loss (mL). Although not statistically significant when variances were not assumed to be equal ( $p = 0.167$ ), there was a trend toward significance. In the equal variances assumed scenario, patients in the "Not Feasible as day care" group experienced higher blood loss ( $M = 69.92$  mL) than those in the "Feasible as day care" group ( $M = 58.11$  mL) ( $p = 0.059$ ), in stone size (cm) significant differences were observed, with patients in the "Not Feasible as day care" group having larger stones ( $M = 3.44$  cm) compared to the "Feasible as day

care" group ( $M = 2.93$  cm) ( $p = 0.021$ ). These findings highlight the significance of postoperative blood transfusion, extended postoperative stay, increased estimated blood loss, and larger stone size in predicting the feasibility of day care surgery.

Residual stone size showed a moderate positive correlation ( $r = 0.237$ ) with operating time, and this correlation is statistically significant ( $p = 0.027$ ). Larger residual stones tend to be associated with longer surgical procedures. It also exhibited a moderate positive correlation ( $r = 0.284$ ) with postoperative blood transfusion, and this correlation is statistically significant ( $p = 0.008$ ). Larger residual stones are more likely to be associated with postoperative blood transfusions. It also demonstrated strong positive correlation ( $r = 0.457$ ) with day of DJ stent removal, and this correlation is highly statistically significant ( $p < 0.001$ ). Larger residual stones are associated with a longer duration until DJ stent removal. Whereas it displayed a moderate positive correlation ( $r = 0.327$ ) with stone size in centimeters, and this correlation is statistically significant ( $p = 0.002$ ). Larger residual stones are associated with larger initial stone sizes. There was a very strong positive correlation between preoperative hemoglobin levels (Preop Hemoglobin) and postoperative hemoglobin levels (Postop Hemoglobin), with a Pearson Correlation coefficient of 0.887. This correlation was highly statistically significant ( $p < 0.01$ , two-tailed). The high positive correlation indicated that patients with higher preoperative hemoglobin levels tend to have higher postoperative hemoglobin levels as well. This finding suggested that the initial hemoglobin levels serve as a robust predictor of the hemoglobin levels after surgery, with a strong positive association between the two variables. This important correlation gave us a useful understanding of correlating the predictability of postoperative outcomes from preoperative hemoglobin assessments. There was a positive correlation between operating time and estimated blood loss (Pearson Correlation = 0.250, significant level  $p = 0.020$  (two-tailed)), and similarly a positive correlation between operating time and postoperative stay hours (Pearson Correlation = 0.248, significant level  $p = 0.021$  (two-tailed)). These findings indicate that longer procedures (more operating time) are correlated with increased estimated blood loss and increased post-operative length of stay hours. These findings emphasize the role of surgical time affecting both intra-

operative and postoperative factors in the care of a patient. In addition to correlating with operating time, estimated blood loss significantly correlated with postoperative length of stay hours (Pearson Correlation = 0.275), at a significance of  $p = 0.010$  (two-tailed). This indicates that procedures with increased estimated blood loss are correlated with lengthier postoperative recovery times associated with surgical health outcomes, and in reality, this can have significant implications for the clinician. Moreover, there was a strong negative correlation noted with estimated blood loss and preoperative hemoglobin levels (Pearson Correlation = -0.506), with a p-value of  $p < 0.01$  (two-tailed) which is considered highly significant. This strong negative association would imply that as estimated blood loss increases the pre-operative hemoglobin levels would tend to decrease. This indicates the impact of estimated blood loss on the health status of the patient pre-operatively.

## Discussion

In recent years, considerable interest and research have focused on the feasibility and outcomes of standard percutaneous nephrolithotomy (PCNL) as a day care surgical procedure. This study was conducted with the aim of adding to the evidence, by investigating the feasibility and clinical parameters related to this approach at a single center. Based on the findings, we believe that stone size, need for a postoperative transfusion, length of hospital stay postoperatively, and duration of the procedure act as credible measures to determine the feasibility of daycare PCNL. These conclusions are supported in the literature. One study stated stone size was a significant parameter influencing noted feasibility of daycare PCNL.

The results we found coincided with their finding that larger stones were less likely to be discharged on the same day.<sup>14</sup> It was also found that postoperative blood transfusion was indicative of viability. The patients who required blood were less likely to be admitted into a day care PCNL.<sup>15</sup> One of the other important variables in our study was length of hospital stay after operative day. A systematic review and meta-analysis concluded that short lengths of stay were paramount to ensuring a successful daycare PCNL. Patients with extended stays, as observed in our study, were less likely to qualify

for same-day discharge.<sup>13</sup> Furthermore, our findings regarding surgical procedure duration were consistent with a study by Saber-Khalah et al. (2021), which highlighted the impact of prolonged operating times on the feasibility of day care PCNL.<sup>16</sup> Residual stone size following PCNL is a crucial clinical outcome. Our study revealed a strong correlation between residual stone size and operating time, postoperative blood transfusion, day of DJ stent removal, and initial stone size. These findings align with those of previous studies. A study reported a similar correlation between residual stone size and operating time. Longer surgical procedures, as observed in our study, were associated with larger residual stones.<sup>17</sup>

In our study, with a range of 1.70 to 5.50 cm, the average stone size is 3.08 cm. The average surgical duration is 137.70 minutes, ranging from 75 to 240 minutes. The stone-free rate (SFR) was approximately 50.57% whereas in another study, the mean stone size was 4.8 cm, the mean surgery time was 116 minutes, and the stone clearance rate was 84.8%.<sup>18</sup> The relationship between residual stone size and the day of DJ stent removal was also confirmed by a study by Beysens et al. (2018).<sup>19</sup> Furthermore, the correlation between residual stone size and initial stone size was in line with a study that reported that larger initial stones were more likely to result in larger residual stones.<sup>20</sup> Our study highlighted a strong positive correlation between preoperative and postoperative hemoglobin levels. Another study, like ours, suggested that advanced age, presence of hypertension, and high stone burden were found to be predictive of reductions in hemoglobin levels as well as patients with higher preoperative hemoglobin levels tended to maintain higher postoperative levels.<sup>21</sup> The positive correlation between operating time and estimated blood loss, as well as between operating time and postoperative stay hours, was in accordance with a study that stressed the significance of efficient surgical procedures in reducing blood loss and shortening postoperative stays.<sup>22</sup> The clinical implications of our findings are twofold. First, our results reinforce the importance of patient selection and perioperative care in optimizing the feasibility of day care PCNL. Strategies to minimize stone size, reduce blood loss, and streamline postoperative care pathways can enhance the suitability of this surgical approach, in line with existing literature.<sup>23,24</sup> Second, our study underscores

the significance of comprehensive preoperative assessments, including hemoglobin levels, to predict and manage postoperative outcomes effectively. Identifying patients at risk of anemia and implementing targeted interventions aligns with previous research.<sup>25</sup>

It is essential to acknowledge the limitations of our study. Our retrospective design and single-center experience may limit generalizability plus the potential for selection bias, and data accessibility. The results might not apply to different contexts or populations. Future research endeavors should include multi-center studies and larger cohorts to validate our findings across diverse populations and settings. As a result, our study offers important new information about the viability and results of regular PCNL as a surgical technique for day care facilities. Our results support earlier studies by highlighting the significance of stone size, bleeding management, and effective surgical methods. These findings highlight the demand for more study in this developing area and provide clinical practise guidelines.

## Conclusion

Our study identifies important factors that affect whether percutaneous nephrolithotomy (PCNL) for kidney stones can be performed in a day care setting. Significant associations included stone size, postoperative blood transfusion, prolonged postoperative stays, and prolonged surgical durations. Preoperative hemoglobin levels were crucial in predicting postoperative outcomes. While our findings align with existing literature, larger multi-center studies are needed for broader validation. Optimizing patient selection, stone management, and perioperative care pathways can enhance the viability of day care PCNL as a renal stone treatment option.

**Ethical Approval:** The Institutional Review Board, Pakistan Kidney and Liver and Research Center (PKLI) approved the study vide letter No. 0151.

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**Authors' Contribution:**

**AR:** Conception and design, drafting the article or revising it critically for important intellectual content. Final approval of the version to be published.

**NBN:** Conception and design, drafting the article or

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**NZ:** Conception and design, drafting the article or revising it critically for important intellectual content. Final approval of the version to be published.

**SM:** Conception and design, or acquisition of data, Drafting the article or revising it critically for important intellectual content. Final approval of the version to be published.

**SI:** Drafting the article or revising it critically for important intellectual content. Final approval of the version to be published. Agreement to be 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

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