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RESEARCH ARTICLE

Evaluation of the Impact of Body Mass Index on the Outcomes of Supine Percutaneous Nephrolithotomy

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Abstract

Objective: This study aimed to evaluate the impact of obesity on the outcomes of supine percutaneous nephrolithotomy (PCNL) at a tertiary university hospital. Understanding surgical outcomes in obese patients, given their rising prevalence and urolithiasis risk, is crucial for optimizing treatment strategies.

Material and Methods: This retrospective study included data from 256 patients aged 18 and older who underwent PCNL in the Galdakao-Valdivia position between July 2021 and July 2024 at a tertiary care hospital. Patients were divided into three groups according to their body mass index (BMI): normal weight (BMI: 18-24.9 kg/m^2), overweight (BMI: 25-29.9 kg/m^2), and obese (BMI: 30-34.9 kg/m^2). Demographic data, stone characteristics, operative time, fluoroscopy time, hospital stay, nephrostomy duration, stone free rates (SFR), and complications were analyzed and compared among the groups.

Results: No significant difference was found among the groups regarding age, sex, stone laterality, location, or size (p>0.05). Median BMI values were 23 (19-24), 27 (25-29.8) and 31.2 (30-34.7) for normal weight, overweight and obese groups, respectively. SFR were 79.2% (61), 77% (124), and 75% (18) for the normal, overweight, and obese groups, respectively (p>0.05). No significant differences were observed in operative time, fluoroscopy time, length of hospital stay, or nephrostomy duration between the groups (p>0.05). The rates of minor and major complications were similar among all groups (p>0.05).

Conclusion: Obesity does not appear to significantly impact the outcomes of supine PCNL, including operative time, SFR, or complication rates. These findings suggest that with experienced surgeons, supine PCNL is a reliable and efficient treatment option for obese patients, though further prospective studies are needed to confirm these results.

Keywords: supine percutaneous nephrolithotomy; kidney stone; obesity; body mass index

INTRODUCTION

Kidney stones are a common urological condition that significantly affect patients' health and quality of life. Kidney stones can cause severe patient morbidity by leading to symptoms such as abdominal pain, infections, hydronephrosis, and decreased kidney function (1).

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Percutaneous nephrolithotomy (PCNL) is a well-established, secure, and it is an efficient treatment method for kidney stones. It is now considered that preferred treatment for large kidney stones, widely recommended by American, European, and various national guidelines. (2-4). Kidney stone formation is influenced by both genetic and environmental risk factors. Gender, age, race, cardiovascular disease, diabetes, chronic kidney disease, hypertension, and obesity are all factors that increase the risk of kidney stone disease (5-7).

The prevalence of obesity has increased from 1% to 8% from 1975 to 2016 and is now described as an epidemic (8). The increasing prevalence of obesity, known as an independent risk factor for urinary stone formation, has resulted in a higher number of obese stone patients undergoing surgery (9). PCNL performed on obese patients presents challenges such as difficulty in precisely locating the stone with X-ray and ultrasound (US) due to increased skin-to-stone distance (SSD), loss of anatomical landmarks, and inadequate access sheath length. Additionally, PCNL in obese patients may result in longer operation times and higher retreatment rates (10-12). Moreover, surgical planning for these patients is often more challenging due to high morbidity from comorbidities such as diabetes, hypertension, coronary artery disease, atrial fibrillation, and heart failure (13).

This study aims to assess the effects of obesity on the outcomes of supine percutaneous nephrolithotomy (PCNL) at a tertiary university hospital.

MATERIAL AND METHODS

Data from 271 patients aged 18 and older who underwent PCNL in the Galdakao-Valdivia position at a tertiary care hospital between July 2021 and July 2024 were retrospectively analyzed. Patients under 18 years of age, those with abnormal bleeding parameters, active urinary tract infections, congenital kidney anomalies, incomplete data, or those lost to follow-up were excluded. The study included a total of 256 patients.

Three patient groups were formed according to the World Health Organization (WHO) Body Mass Index (BMI) classification: Group 1 included patients with normal BMI (BMI: 18-24.9 kg/m^2); Group 2 consisted of overweight patients (BMI: 25-29.9 kg/m^2); and Group 3 comprised obese patients (BMI: 30-34.9 kg/m^2).

The age, gender, BMI, stone laterality, location and size, complications (according to the Clavien-Dindo classification), hospital stay duration, operative time, fluoroscopy time, nephrostomy time, and stone-free status were recorded. Stone size was recorded as the largest diameter observed in preoperative computed tomography (CT) scans. The total size of all stones was recorded for patients with multiple stones. Stone-free status was determined by the absence of residual fragments exceeding 4 mm in size. Patients who underwent endoscopic combined intrarenal surgery were not included in the study. The surgeries were performed after obtaining a sterile urine culture. Antibiotic treatment was administered for patients with positive preoperative urine cultures for 7-10 days on an outpatient or inpatient basis, according to the antibiogram results. Patients who could not achieve a sterile urine culture were operated on under antibiotic suppression as the Infectious Diseases and Clinical Microbiology department recommended.

After the decision to treat with PCNL based on the stone characteristics, preoperative blood tests, including complete blood count, renal function tests (serum urea, blood urea nitrogen, and creatinine), electrolytes, and coagulation tests were performed. Complete blood count and renal function tests were repeated within the first three hours postoperatively. Kidney-ureter-bladder radiography (KUB) imaging was performed on the patients on the first postoperative day.

Surgical Technique:

Following the acquisition of informed consent, the patient was transferred to the operating room. A 5 Fr ureteral catheter was placed into the ureter on the side of the stone in the Galdakao-modified Valdivia position, and the procedure continued in the same position. The renal collecting system was visualized using retrograde pyelography under fluoroscopic guidance. Calyceal access was obtained under scope guidance using an 18 Gauge and 20 centimeters access needle, through which a 0.035 inch hydrophilic guidewire was advanced. Access to the most appropriate calyx was obtained to ensure adequate lithotripsy and stone removal. Either a 30 Fr Amplatz dilator set (Actomed, Ankara, Turkey) or a Nephromax balloon dilator (Boston Scientific, MA, USA) with a calibration of 30 Fr was employed based on the surgeon's decision. To reduce radiation exposure for the operator and the patient, continuous scopy use was avoided, and pulse fluoroscopy (intermittent use) was applied. Once the collecting system was accessed using a

26 Fr rigid nephroscope (Karl Storz, Tuttlingen, Germany), the stones were fragmented with a pneumatic lithotripter (Vibrolith, Elmed, Turkey) and extracted using forceps. Following the surgery, a 4.7 Fr 28 cm DJ stent was inserted antegradely, and a 14 Fr nephrostomy tube was inserted in some patients depending on the surgeon's preference. On the first postoperative day, if a nephrostomy tube was present, it was clamped and removed after 6 hours if there was no flank pain or leakage around the nephrostomy tube.

The stone-free status of the patients was assessed one month after surgery using KUB, US, or CT. If the patient was evaluated as stone-free postoperatively, further evaluation was conducted using either KUB or US, as preferred by the physician, in order to avoid additional radiation exposure. If there was a suspicion of clinically significant residual fragments or if further treatment was needed, the patient was evaluated with a CT scan.

This study received approval from the Ethics Committee of Gazi University on 30 July 2024, with an approval number of 1268.

Statistical Analysis:

The statistical analysis was conducted using SPSS software (Statistical Package for the Social Sciences, version 23, Armonk, NY, USA). The Chi-square test was employed to compare categorical data among groups., and the Kruskal-Wallis test was employed for continuous variables. A p-value below 0.05 was considered indicative of statistical significance. The normality of the data distribution was assessed using the Kolmogorov-Smirnov test.

RESULTS

No statistically significant differences were observed between Groups 1, 2, and 3 regarding age, gender, stone laterality, location, or size (p=0.903, p=0.366, p=0.974, p=0.504, and p=0.191, respectively). The median BMI values for Groups 1, 2, and 3 were 23 (19-24), 27 (25-29.8), and 31.2 (30-34.7), respectively (Table 1).

The stone-free rates (SFR) for Groups 1, 2, and 3 were 61 (79.2%), 124 (77%), and 18 (75%), respectively. There were no statistically significant differences between the groups regarding SFR and median values for operative time, fluoroscopy time, hospital stay, and nephrostomy time (p=0.888, p=0.274, p=0.830, p=0.892, and p=0.772, respectively) (Table 2).

The number and rates of minor complications (Clavien 1-2) for Groups 1, 2, and 3 were 7 (9.1%), 13 (8.1%), and 3 (12.5%), respectively. The number and rates of major complications (Clavien 3-4) for Groups 1, 2, and 3 were 1 (1.3%), 2 (1.2%), and 1 (4.2%), respectively. There were no statistically significant differences in the complication rates between the groups (p=0.770) (Table 2).

Table 1. Demographic and Clinical Characteristics

Characteristics	**Group 1 Normal Weight (BMI: 18-24.9 kg/m²) (n:77)**	**Group 2 Over Weight (BMI: 25-29,9 kg/m²) (n:161)**	**Group 3 Obese (BMI: 30-34,9 kg/m²) (n:24)**	**p**
Age (year) (median (min-max)	57 (18-82)	53 (19-79)	56.5 (33-86)	0.903
Gender				0.366
Male n(%)	44 (57.1%)	91 (56.5%)	10 (41.7%)	
Female n(%)	33 (42.9%)	70 (43.5%)	14 (58.3%)	
Side				0.974
Right n(%)	38 (49.4%)	82 (50.9%)	12 (50%)	
Left n(%)	39 (50.6%)	79 (49.1%)	12 (50%)	

Stone Location				0.504
Pelvis n(%)	46 (59.7%)	106 (65.8%)	12 (50%)	
Lower calyx n(%)	17 (22.1%)	18 (11.2%)	4 (16.7%)	
Middle calyx n(%)	3 (3.9%)	10 (6.2%)	3 (12.5%)	
Upper calyx n(%)	1 (1.3%)	5 (3.1%)	1 (4.2%)	
UP junction n(%)	5 (6.5%)	10 (6.2%)	2 (8.3%)	
Staghorn n(%)	4 (5.2%)	12 (7.5%)	2 (8.3%)	
Stone Size (mm) (median (min-max))	23 (8-46)	24 (9-62)	21.5 (10-38)	0.191
BMI (kg/m^2) (median (min-max))	23 (19-24)	27 (25-29.8)	31.2 (30-34.7)	<0.001

UP: Ureteropelvic, BMI: Body-Mass Index, min-max: minimum-maximum

Table 2. Comparison of the Groups According to Operation Outcomes

	Group 1 Normal Weight (BMI: 18-24.9 kg/m^2) (n:77)	**Group 2 Over Weight (BMI: 25-29.9 kg/m^2) (n:161)**	**Group 3 Obese (BMI: 30-34.9 kg/m^2) (n:24)**	**p**
Stone Free Rate n(%) (median (min-max))	61 (79.2%)	124 (77%)	18 (75%)	0.888
Fluoroscopy Time (second) (median (min-max))	24 (6-89)	26 (5-89)	28 (9-44)	0.830
Operative Time (minute) (median (min-max))	110 (70-190)	105 (70-180)	110 (90-160)	0.274
Hospital Stay (day) (median (min-max))	2 (1-6)	2 (1-14)	2 (1-7)	0.892
Nephrostomy Time (median (min-max))	2 (0-4)	1 (0-7)	2 (0-4)	0.772
Complication (Clavien-Dindo)				0.770
Minor Complication (Clavien 1-2)	7 (9.1%)	13 (8.1%)	3 (12.5%)	
Major Complication (Clavien 3-4)	1 (1.3%)	2 (1.2%)	1 (4.2%)	

min-max: minimum-maximum

DISCUSSION

Overweight, obese, and morbidly obese patients present significant challenges for both physicians and surgeons. This patient group frequently presents with multiple medical comorbidities, including cardiovascular, metabolic, and respiratory conditions, complicating the surgical management of any underlying pathologies (14, 15). Consequently, surgical procedures in these patients can be more complex, with a reduced likelihood of surgical success and higher complication rates (16, 17). This complexity extends to the treatment of urinary stone disease in these patients. Due to the increased SSD in obese patients, ureteroscopy (URS) and PCNL are preferred over Extracorporeal Shock Wave Lithotripsy (ESWL) for treating kidney stones. Therefore, PCNL is the standard procedure for stones larger than 2 cm in obese patients (18).

In a study of 5,803 patients, Fuller et al. compared the PCNL outcomes between obese and non-obese groups and reported that the operative time was longer for obese

patients (11). Contrary to these findings, two separate studies by El-Assmy et al. and Carson et al. concluded that obesity did not affect operative time (19, 20). Similarly, in another study involving 1,152 patients, Dauw et al. reported that BMI did not influence operative time, even in patients with a BMI over 50 kg/m²(21). Slade et al., in their study examining the outcomes of mini-PCNL in obese patients, also reported that obesity did not prolong the operative time (22). Additionally, in different groups based on SSD, it was observed that long SSD did not extend operative time either (23). In our study, no significant differences were found between the groups regarding operative time or fluoroscopy time, particularly during critical stages of the procedure, such as access, stone control, and ureteral stent placement. These findings suggest that BMI may be a manageable factor for PCNL when performed by experienced surgeons.

In the study by Sergeyev et al., which evaluated normal, overweight, and obese patient groups, the length of hospital stay was higher in the normal-weight group. They attributed this difference to the prolonged hospital stay of two patients who had experienced pulmonary embolism and postoperative sepsis (24). However, studies evaluating the impact of obesity on PCNL outcomes have generally reported that body mass does not affect the length of hospital stay (10, 23, 25, 26). Our study's absence of differences in hospital stay duration among the weight groups further supports the idea that body mass may not influence outcomes in supine PCNL.

In the study by Burns et al., the SFR in the severely obese patient group (BMI: 35-39.9) was lower than in the normal, overweight, and obese groups. However, the authors suggested that this difference was due to the higher stone burden in severely obese patients (10). In obese patients, comorbid conditions such as diabetes and metabolic syndrome can lead to a decrease in urine pH and an increase in solute load, which in turn can result in a higher stone burden and a higher incidence of staghorn stones (11, 27). Therefore, inadequate surgical success in these patients may be attributed more to the stone burden rather than obesity itself. However, the high SFR achieved with the PCNL technique may limit the evaluation of obesity's impact on stone-free outcomes. In studies conducted by Iqbal et al. and Ferreira et al., no difference in SFRs was found between BMI groups, supported by other studies (24-26, 28). In the study by Slade et al., although there was a significant difference between groups (%84 vs. %67), the small number of patients in each group (33 vs. 34) rendered the difference statistically insignificant. In this study, the sum of all stone diameters was higher in the obese group (22). In a meta-analysis of 18 studies by Xu et al., no difference in SFRs was observed between obese and normal BMI patient groups in all but one study. However, when the study with a large number of participants by Fuller et al. was included in the analysis, a difference emerged between the two groups (9). In Fuller et al.'s study, the incidence of staghorn stones in the morbidly obese group was 1.5 times higher than in the normal BMI group (40.2% vs 26%) (11). In our study, no difference in SFRs was found. Although a higher incidence of staghorn stones may be expected in obese patients, the absence of this finding in our study may have contributed to similar SFRs.

Since PCNL is performed under general anesthesia, obese patients may be at increased risk for intraoperative respiratory complications, which may require higher ventilation pressures. Additionally, they may encounter an increased risk of general postoperative complications such as wound infections, atelectasis, and thromboembolism (29). In the literature, the incidence of minor complications following PCNL ranges from 23% to 80%, while major complications occur at a rate of 1.1% to 7% (30). In a study by Burns et al., although they reported significantly fewer complications in the normal-weight patient group, they found no statistically significant difference, which they attributed to the small sample size in the study (10). Similarly, Ferreira et al. found a higher rate of significant complications (Clavien ≥3) in obese patients, but again, no statistically significant difference was observed (26). Larger studies conducted by Fuller et al. and Dauw et al. reported no difference in overall complication rates (11, 21). However, Fuller et al. noted that while the rate of minor complications (Clavien 1-2) was lower in the morbidly obese group, the rate of significant complications (Clavien 3-5) was higher (11). El-Assmy et al. also found no difference in postoperative complication rates among obese patients (19). Iqbal et al. evaluated the Clavien grades individually across normal, overweight, and obese patient groups and found no differences in any of the grades from 1 to 5(25). Similarly, Slade et al. conducted the same comparison for mini-PCNL and found no significant differences (22). Although the rate of major complications was higher in the obese patient group, the difference was not statistically significant. The limited number of patients might have hindered an optimal evaluation of this finding.

The study has important limitations. The retrospective nature of our study represents one of the primary sources

of bias. The retrospective nature of the study may lead to incomplete or inaccurate data recording, as well as information gaps due to the lack of a standardized protocol. Additionally, there is a risk of selection bias, as the decision to not perform PCNL on certain patients was largely at the discretion of the researchers. Since the data was collected retrospectively, variations in pre-intervention characteristics among the patient groups may have been overlooked. Additionally, the small sample size might have prevented us from obtaining strong and reliable results from our analyses. Moreover, using non-standard equipment for dilation may have influenced the fluoroscopy time. Assessing stone size in just one dimension may not accurately reflect the total burden and represents a significant bias in this study. Using different imaging modalities to assess SFRs also reduces the reliability of these results. The power of KUB, USG, and CT in evaluating stone-free status may not be the same.

RESULTS

Our findings suggest that supine PCNL performed by experienced surgeons is a safe and effective treatment option for obese patients. However, given the retrospective design of our study and the limited sample size, these results should be validated through prospective studies with larger patient populations.

Conflict of Interest: The authors declare that they have no conflicts of interest.

Ethical Approvement: This study received approval from the Ethics Committee of Gazi University on 30 July 2024, with an approval number of 1268.

Authors' Contribution: All authors reviewed and approved the final version of the manuscript.
Ender Cem Bulut, Bora Küpeli: Study Design. Ender Cem Bulut, Burak Elmas: Analysis. Ender Cem Bulut, Burak Elmas: Data Curation. Ender Cem Bulut, Burak Elmas, Bora Küpeli: Writing Manuscript (Original draft preparation) Ender Cem Bulut, Burak Elmas, Bora Küpeli: Literature Investigation.

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