

A prospective, observational study to assess the feasibility and safety of supine percutaneous nephrolithotomy under regional anesthesia for obese patients with a body mass index ≥ 30

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ABSTRACT

Introduction: Besides being a risk factor for urolithiasis, obesity is a challenge in the treatment of urolithiasis from the perspective of both the surgeon and the anesthetist. In this study, we tried to assess the feasibility and safety of supine percutaneous nephrolithotomy (PCNL) under regional anesthesia in obese patients with a body mass index (BMI) ≥ 30 .

Methods: This was a prospective observational study and included 51 obese patients (BMI ≥ 30 kg/m²) with renal stones planned for PCNL. All patients underwent supine PCNL under regional anesthesia with the standard technique. A decision for totally tubeless or a tubeless PCNL was made at the end of the procedure and the intraoperative and postoperative data were recorded. All patients underwent computed tomography (CT) imaging at 1 month after surgery to assess the stone-free status and the need for additional treatment.

Results: The mean age of the patients was 53.2 ± 8.09 years, and the mean BMI was 34.4 ± 2.369 kg/m². The mean operative time was 73.3 ± 26.2 min, the mean hospital stay was 58.3 ± 22.1 h, and the mean postoperative Visual Analog Score (VAS) for pain was 3.8 ± 1.4 . The stone-free rate was 68.6% on the follow-up CT performed after 1 month, and 31.4% of the patients had significant residual fragments which required re-treatment either by retrograde intrarenal surgery (RIRS) in 19.6% (either as primary RIRS for the residual calculi in one patient [1.9%] or as RIRS for post shock wave lithotripsy (SWL) or alkalization failure in 9 patients), SWL in 21.6%, or urine alkalization in 7.8%.

Conclusion: Supine PCNL under regional anesthesia, in this subgroup of obese patients, was found to be feasible and safe with satisfactory stone-free rates and minimal postoperative pain.

INTRODUCTION

Obesity is a serious and an increasing health issue worldwide, with about two-thirds of the obese individuals residing in the developing world.^[1,2] It is well known that obesity increases the risk of metabolic diseases and the incidence of urolithiasis is also higher in these patients.^[3] Insulin resistance in obese patients disrupts ammonia metabolism and

results in a drop in the pH of urine, thus increasing the concentration of lithogenic chemicals in urine,^[4] particularly uric acid, which in turn leads to a higher incidence of urinary calculi.^[5] In addition, obesity also makes the surgical procedure more challenging both for the anesthesiologists and the surgeons. Along with the previously described systemic disorders, positioning a patient with high body

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mass index (BMI) into the prone position for the standard percutaneous nephrolithotomy (PCNL) is challenging. Regional anesthesia is advantageous in these patients as there is minimal manipulation of the airway with avoidance of the use of general anesthetic medications which can cause cardiopulmonary depression. Regional anesthesia may also lower the peri operative and postoperative opioid requirement, which is especially important in obese patients as they are at a higher risk for postoperative pulmonary complications.^[6] Thus, we planned this study with the primary aim to assess the stone-free rates of supine PCNL under regional anesthesia in obese patients with a BMI of ≥ 30 , as determined by computed tomography (CT) performed at 1 month follow-up.

MATERIALS AND METHODS

This was a prospective observational study carried out at the Cairo University Hospitals, Egypt, between December 2017 and January 2022. The study was conducted in accordance with the World Medical Association's Declaration of Helsinki and the study protocol was approved by the ethical committee at the Kasr Al Ainy Hospital in November 2017. Written informed consent was obtained from all the patients.

The study included obese patients above the age of 18 years with renal stones planned for PCNL (BMI ≥ 30 kg/m², class 1 and higher according to the WHO classification). Those with solitary kidneys, renal anomalies, chronic renal failure, isolated upper calyceal stones, previous renal surgeries, and uncontrolled coagulopathies and those planned for synchronous bilateral PCNLs were excluded from the study. All the patients underwent tubeless (without nephrostomy tube but a double-J [DJ] stent was placed) and totally tubeless (without nephrostomy tube and the ureteral catheter was removed at the end of the procedure) supine PCNL under regional anesthesia (spinal anesthesia \pm epidural cannula). Preoperatively, all the patients underwent evaluation with history and physical examination, routine preoperative investigations, and spiral CT scan of the urinary tract. All the patients underwent surgery under spinal anesthesia and an epidural cannula was inserted if a long duration of surgery was anticipated or for better management of postoperative pain. Initially, the patients were placed in a lithotomy position for cystoscopy with ipsilateral retrograde pyelography and a 6 or 7 Fr ureteral catheter was inserted. Then, the patients were repositioned to the Valdivia position, the final position for the surgery, although in some patients the Galdakao position was made if a simultaneous combined retrograde intrarenal surgery (RIRS) was anticipated based on the findings of the retrograde pyelography. Supine PCNL was performed with the standard technique and a calyceal puncture, which provided the shortest access, was chosen and the method of dilatation was customized to the patient's needs. Long Amplatz renal access sheaths and

extra-long nephroscopes (Karl Storz, Tuttlingen, Germany; 25 cm length) were routinely used. If required, multiple punctures were made in patients with large stone burden which were subsequently dilated with a balloon dilator, taking into the consideration the patient's safety and the duration of the surgery. In peripherally located renal stones or inaccessible stones, the renal access was achieved either by ultrasonography (by the radiologist) or in combination with RIRS. Stones were fragmented by pneumatic lithoclast.

The decision for totally tubeless PCNL or tubeless PCNL was taken at the end of the procedure. If the endoscopic vision was clear and there was no evidence of pelvicalyceal system (PCS) injury, the hematuria was mild and there were no residual fragments on the fluoroscopy, a totally tubeless PCNL was performed, whereas those with a larger stone burden (residual fragments) or PCS injury underwent tubeless PCNL. The nephrostomy site was closed at the end of the procedure, and the ureteral catheter was replaced with a DJ stent in the tubeless PCNL, whereas the ureteral catheter was removed at the end of the procedure in the totally tubeless PCNL. The urethral catheter was left in place in both the tubeless and the totally tubeless PCNL to monitor the urine output and for better fluid management during the early postoperative period in the high risk patients. The urethral catheter was then removed after 24 hours.

Intra-operative parameters such as the duration of the surgery, fluoroscopy time, and intraoperative complications, especially the intraoperative bleeding and the need for blood transfusion were recorded. Postoperatively, the change in the hemoglobin levels (Δ Hb, pre- and postoperative), the duration of hospital stay, and the postoperative pain (through Visual Analog Pain Score) were recorded. All the patients were discharged with a dry nephrostomy site and in an afebrile condition. The overall stone-free status, the presence of clinically insignificant residual fragments (CIRF, residual stone ≤ 4 mm), and the need for retreatment were assessed by a CT scan performed for all the patients 1 month after the procedure. All the statistical calculations were performed on SPSS (IBM Corp, Armonk, NY, USA) version 22 for Microsoft Windows.

RESULTS

Fifty-five patients were screened for inclusion, of which 4 refused surgery under regional anesthesia and opted for general anesthesia, thus were excluded. A total of 51 obese patients (25 females and 26 males) underwent supine PCNL under regional anesthesia from December 2017 to January 2022. The patients' demographics and clinical data are illustrated in Table 1. The mean age of the patients was 53.2 ± 8.09 years, the mean BMI was 34.4 ± 2.369 kg/m², and the procedure was right sided in 28 patients and left sided in 23. The mean surface area of the stones, as measured on the CT scan, was 853 ± 324 mm² [Table 2]. Patients with all types of renal stones including

complete staghorn (8 cases), partial staghorn (6 cases), renal pelvic stones (8 cases), multiple calyceal stones (5 cases), and others, except those with isolated upper calyceal stones, were included in this study. Most of the procedures were performed with a single-tract dilatation (45 cases), but multiple tracts were required in 6 cases, which could be performed safely without additional significant complications. The majority of the accesses were subcostal (40 cases) and the rest 11 were supracostal (between the 11th and 12th ribs). Assisted access under intra-operative ultrasound guidance (gained by the radiologist) or with combined RIRS was required in 12 patients, in whom either the stones were located peripherally in the kidney or the access seemed to be difficult as assessed on the retrograde pyelography. In one patient with a renal pelvic stone the puncture could not be made and the tract could not be established and thus RIRS was performed in two sessions, 2 weeks apart.

The mean operative time was 73.3 ± 26.2 min, the mean hospital stay was 58.3 ± 22.1 h, and the mean postoperative Visual Analog Pain Score (VAS) was 3.8 ± 1.4. Blood transfusion was required in four patients (Clavien II), of these one was due to bleeding and in the other three the blood was transfused on the anesthetists' request in view of symptomatic ischemic heart disease and a preoperative Hb level of <10 g/dl. Furthermore, one patient who was a known case of ischemic heart disease had intraoperative chest pain (Clavien IVa) and the procedure was aborted after placing a DJ stent. Another patient with an impacted renal pelvic stone had a minor renal pelvic injury (Clavien IIIa) during stone fragmentation which was managed with a DJ stent. Four patients had postoperative fever, of which 2 had high grade fever (≥38.5 c) and were diagnosed to be in urosepsis (Clavien IVa) and were transferred to the intensive care unit. Another patient had urine leak from the site of the puncture 1 week after the surgery. Evaluation with a spiral CT scan did not reveal any ureteral obstruction and the leak resolved with conservative management without further intervention (Clavien II) [Table 3]. None of the patients developed pulmonary complications, deep venous thrombosis or visceral injuries, and no patients died due to the procedural complications in our study.

35 patients (68.6%) were stone free or had CIRF on the follow-up CT scan performed at 1 month. On the other hand, 16 patients (31.4%) had significant residual fragments that required treatment either by RIRS in 19.6% (either as primary RIRS for residual calculi in one patient (1.9%) or as RIRS for post-shock wave lithotripsy (SWL) or alkalization failure in 9 patients), SWL in 21.6%, or urine alkalization in 7.8% [Table 4].

DISCUSSION

Performing PCNL in obese patients is challenging both for the surgeon and the anesthesiologist. Patients with high BMI

Table 1: Patient demographics

Variables	Value
Age (years)	53.27±8.09
Gender	
Male	26 (51)
Female	25 (49)
BMI (kg/m ²)	34.45±2.369
Laterality	
Right	28 (54.9)
Left	23 (45.1)
Comorbidities	
Chronic renal failure	6 (11.7)
Diabetes	10 (19.6)
Hypertension	17 (33.3)
Hypothyroidism	3 (5.88)
Ischemic heart disease	7 (13.7)
Medications	
Antiplatelets	7 (13.7)
ASA classification (mean)	2.24±0.428
ASA 2	39 (76.5)
ASA 3	12 (23.5)

ASA=American Society of Anesthesia, BMI=Body mass index

Table 2: Intraoperative parameters and duration of hospital stay

Parameters	Value
Stone area (mm ²)	853±324
Stone density (HF units)	1076±345
Mean radiation time (min)	6.3±2.3
Irrigation fluid volume (L)	17±5.4
Operative time (min)	73.3±26.2
Hb change (g/dL)	0.9±0.3
Postoperative VAS	3.8±1.4
Hospital stay (h)	58.3±22.1

VAS=Visual Analog Pain Score, Hb=Hemoglobin

Table 3: Postoperative complications

Complications	Number of cases (%)
Intraoperative complications	
Renal pelvic perforation	1 (0.2)
Others	1 case - Acute chest pain
Postoperative hematuria	
CI	34 (66.7)
Mild to moderate	14 (27.5)
Moderate	3 (5.9)
Postoperative fever	
Low grade	2 cases (3.9)
High grade	2 cases (day 0 1 case-another case day 1)
Postoperative sepsis	2 (3.9)
Urine leak at puncture site	1 case - After 1 week with puncture site urine leak

CI=Clinically insignificant

are not suitable for prone position as they are at a higher risk for respiratory complications apart from the general difficulties faced during endotracheal intubation and in gaining an intra-venous access. In addition, performing PCNL in obese patients is fraught with multiple surgical difficulties such as poor fluoroscopic visualization and long skin-to-stone distance that necessitates the use of special instruments such as long access sheaths and nephroscope. This study was designed to assess the feasibility of PCNL in obese patients in supine position under regional anesthesia,

Table 4: Stone-free percentage and retreatment methods

Parameters	Number of cases (%)
Stone-free percentage	35 (68.6)
Stone residuals	
No residual stones	25 (49.0)
CIRF	10 (19.6)
Significant residuals	16 (31.4)
Retreatment methods	
RIRS	10 (19.6)
SWL	11 (21.6)
Alkalinization therapy	4 (7.8)

RIRS=Retrograde intrarenal surgery, SWL=Shock wave lithotripsy, CI=Clinically insignificant, CIRF=CI residual fragment

which is a novel approach in obese patients, and to assess whether such an approach can overcome the previously described challenges.

Previous studies have reported fewer respiratory complications and a lower risk for visceral injury in supine PCNL as compared to the prone PCNL.^[7] One of the major advantages of supine position under regional anesthesia is the ease of patient positioning, as turning an obese patient prone risks cervical spine injury due to excessive neck movement which can result in musculoskeletal complications. Further, the supine position provides easier access to the airway if a conversion to general anesthesia is required intra operatively.^[8]

The feasibility of supine PCNL under regional anesthesia has been established in a few studies and has shown comparable results to supine PCNL under general anesthesia. In a retrospective review of 17 patients with a BMI >50 kg/m² who underwent prone PCNL, Keheila *et al.* have reported acceptable outcomes.^[9] The mean stone area in their study was 1037 mm² (4 partial staghorn and 6 complete staghorn calculi) and 11 patients were rendered stone free in a single session. There were two Clavien III b or more complications, and the authors concluded that prone PCNL was feasible and safe in morbidly obese patients.

The CROES Global study^[10] analyzed 650 obese and 97 super-obese patients who underwent PCNL. As the overall SFR was low while the complications and need for re-intervention were high, the authors concluded that more research is required to better understand the effects and side effects of PCNL in the obese patients.

Manohar *et al.*^[11] evaluated 62 patients who were deemed at high risk for surgery, of which 11 had a BMI >30 kg/m². All the patients underwent supine PCNL, 57 under general anesthesia and 5 with epidural anesthesia. The authors concluded that supine PCNL is a safe and effective procedure in high-risk and obese patients. As compared to Manohar *et al.*, all the patients in our study had a BMI >30 kg/m² and all underwent supine PCNL under regional anesthesia.

Mazzucchi *et al.*^[12] compared the outcomes of prone and supine PCNL in patients with a BMI >30. In their study, 32 patients underwent supine PCNL with a mean operative time of 120.3 min and the stone-free rate was 78.1%. They concluded that supine PCNL has a significantly shorter operative time and hospital stay as compared to prone PCNL. Our study also has similar findings, and the mean operative time was short (73.3 ± 26.2 min).

Moslemi *et al.*^[13] compared the feasibility of supra-costal access for PCNL under regional anesthesia versus general anesthesia and reported comparable results and negligible anesthesia-related complications in the regional anesthesia arm without the need for conversion to general anesthesia in any of the patients. The authors recommended regional anesthesia for PCNL in high-risk patients, especially in those with pulmonary comorbidities. Patients with isolated upper calyceal stones were not included in our analysis as we prefer other treatment modalities, such as RIRS or SWL, because of the associated pulmonary complications in the obese high-risk individuals.

Gupta *et al.*^[14] evaluated the surgical outcomes and the feasibility of spinal anesthesia for tubeless and totally tubeless supine PCNL in 53 patients, 54.7% of whom underwent surgery under spinal anesthesia and 45.3% under general anesthesia. They concluded that supine PCNL is technically feasible with good surgical outcomes and can be performed under spinal and general anesthesia in carefully selected patients, which is in accordance with the findings of our study.

Singh *et al.*^[15] performed tubeless PCNL in prone position under regional anesthesia in 10 patients in an early series with limited stone burden, where the stones were located either in the middle or the lower calyces, to shorten the operative time. They concluded that tubeless PCNL under regional anesthesia reduces the morbidity without compromising the results or affecting the safety, and thus advocated for its routine use for superior postoperative pain control.

There are some limitations of our study. First, the sample size is small despite the long duration of the study (3 years). Second, since our study is an observational noncontrolled study, large-scale prospective comparative studies evaluating different treatment modalities with a larger number of patients is required to better establish the role of supine PCNL under regional anesthesia in obese patients.

There is a paucity of literature on the feasibility and the surgical and anesthetic outcomes of totally tubeless or tubeless PCNL in obese patients under regional anesthesia. This was a prospective study and included patients with BMI >30 and all the patients underwent supine PCNL under regional anesthesia.

CONCLUSION

Supine PCNL under regional anesthesia, in this subgroup of obese patients, was found to be feasible and safe with satisfactory stone-free rates and minimal postoperative pain.

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