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One-Year Single Center Initial Experience of Supine PCNL

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ORIGINAL STUDY

One-year single center initial experience of supine percutaneous nephrolithotomy

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Abstract

Objectives: **To study the safety and efficacy of supine position in percutaneous nephrolithotomy (PCNL) in treatment of large renal stones.**

Methods: **A retrospective study included 51 patients with large renal stones (more than 2 cm) planned for PCNL operation underwent PCNL in a modified flank supine position from October 2022 to August 2023. We excluded from this study as uncorrectable coagulopathy, active urinary tract infection, and pediatric patients, younger than 18 years. The study protocol was approved by Damanhur National Medical Institute (HD000188/22/11/2023).**

Results: **The most common site of stone was the renal pelvis in 17 (33.3%) cases then stag horn 11 (21.6%) followed by the pelvis and middle calyx 10 (19.6%). Residual stones, drop of hemoglobin, and need for blood transfusion were found in 13.7, 13.7, and 2.0%, respectively. Shockwave lithotripsy and second look PCNL as auxiliary procedures were done in 15.7%, and 5.9% of patients, respectively. The most common postoperative complication was fever found in three (5.9%) of patients then hemorrhage two (3.9%) followed by urine leakage one (2.0%). Hounsfield unit, operative time, and hospital stays were the most common factors predisposing to postoperative complications ($P < 0.05$).**

Conclusion: **In conclusion, patients with renal calculi larger than 2 cm may be candidates for PCNL in the supine position; this is particularly true for obese patients, patients undergoing concurrent lower ureteric procedures, and patients experiencing cardiac issues.**

Keywords: Large renal stones, Obese patients, Percutaneous nephrolithotomy, Postoperative complication, Supine position

1. Introduction

One of the most prevalent urological conditions in the world is nephrolithiasis. According to Birowo *et al.* [1], it is characterized as a syndrome in which mineral deposits are discovered in the kidney, either attached to the renal papillae or free in the renal calyces and pelvis. According to Sorokin *et al.* [2], the prevalence varied by area, falling between 7 and 13% in North America, five (9%) and in Europe, and 1% and 5% in Asia. About 80% of cases of urolithiasis are composed of calcium, which is the most frequent component of stones [3].

One of the most difficult urological illnesses to treat is large and complex renal calculi [4]. In these situations, percutaneous nephrolithotomy (PCNL) is the recommended course of action. An increasingly popular minimally invasive surgical technique for the treatment of large-volume upper urinary tract (UT) calculi is PCNL [5]. For big stones, PCNL is the recommended course of action. Because interposition of the abdominal organs has been a problem, PCNL has traditionally been done in the prone position. However, Valdivia and colleagues demonstrated in 1987 that supine PCNL was feasible [6,7].

Furthermore, PCNL works well for treating uncommon stone instances such as calyceal diverticula stones. Despite its effectiveness, this treatment requires several preparations, such as the patient's posture, anesthetic, and guidance system [8]. The standard PCNL position is prone, which minimizes the risk of bowel puncture and provides direct

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access to the posterior calyx. Nevertheless, the ability to transition from regional to general anesthesia is restricted by this positioning technique. The supine posture is an alternate position that permits the combination of antegrade and retrograde techniques and general anesthesia switching. Furthermore, in patients with cardiovascular problems, this position is particularly preferable. However, there are restrictions on working space and the number of channels that can be used [9,10].

Over the past 30 years, changes have been made to the supine approach, and strong data has been released regarding its viability, consistency, safety, and efficacy. In addition, supine PCNL is more ergonomic, reduces operating time, helps with anesthesia, and promotes the transition to endoscopic combined intrarenal surgery (ECIRS) more easily than prone positioning [11,12].

As most current literature has shown, there are many more options for the prone position for PCNL outside the supine positions. These include flank, lateral, split leg modified lateral, flank prone, prone flexed, semi-supine, and many others. The important thing to remember is that each of these authors offered suggestions to enhance their surgical percutaneous practice [13]. Of course, urological outcomes (in terms of stone-free rates, operative time, hospital stay, and complication rates) have been compared between the feasibility, efficacy, and safety of PCNL performed in any alternative position and those of PCNL performed prone, with essentially similar results [14,15].

Anesthesiologic, management, and urological benefits of PCNL in the Galdakao-modified supine Valdivia (GMSV) position are among the many documented benefits [16]. With improved access to the airways and circulatory system, the supine position solves the cardiovascular, ventilatory, neuroendocrine, and pharmacokinetic issues associated with the prone position. This is especially true for special individuals, which include patients who are kyphotic or scoliotic, aged, fat, or in a debilitated state [17].

Advantages of this management approach include simple and comfortable patient positioning, the ability for the surgeon to work sitting down and with his hands outside of the fluoroscopic field, less occupational risk from lifting heavy loads, less risk of pressure injuries from incorrect repositioning that causes ligament lesions, visual issues, and neurological deficits, and the elimination of the need for intraoperative repositioning of the anesthetized patient [18,19].

The advantages of urology include easier kidney puncture because the kidney is closer to the skin, increased versatility in combined stone manipulation, a demonstrated lower risk of colon injury, better-descending drainage, and retrieval of stone fragments from lithotripsy due to the downward position of the Amplatz sheath, low intrarenal pressures implying less pyelovenous backflow, and a lower risk of infection following surgery [20,21]. The purpose of this work was to study the safety and efficacy of the supine position in PCNL in the treatment of large renal stones.

2. Patients and methods

A prospective study included 51 patients with large renal stones (more than 2 cm) planned for PCNL operation and underwent PCNL in the modified flank supine position from October 2022 to August 2023. We excluded from this study as uncorrectable coagulopathy, active UTI, and Pediatric patients, younger than 18 years.

2.1. Ethical consideration

The individual was informed of the study's objectives in detail and was then asked to sign an informed consent form. The consent form was prepared by the guidelines provided by the Egyptian Ministry of Health's Quality and Improvement System and the Helsinki Declaration. The study protocol was approved by Damanhur National Medical Institute (HD000188/22/11/2023).

All included patients were assessed preoperatively by:

2.2. Preoperative preparation

Careful history taking includes name, age, sex, residence, employment, marital status, and any unique behaviors; also, note the onset, course, length, place, number, recurrence, and past treatment history, as well as any surgical treatments previously performed. Any medical condition, such as diabetes, hypertension, or chronic renal disease, and its course; also, any medication used and the length of time it should be taken. Include a thorough surgical history of earlier surgical procedures.

2.2.1. General examination

Every patient had a physical examination to determine their body mass index, any spinal deformities, and any scars from prior surgeries.

Evaluation and inspection of the chest in individuals with long-term conditions of the chest. cardiac assessment as well for individuals with long-term heart conditions. After that, additional

anesthetic consultations were conducted, particularly for cardiac and chest abnormalities.

Examine the abdomen for organomegaly, ascites, abdominal or flank edema, and incisional hernias.

2.2.2. Routine laboratory investigation

Comprised serum creatinine, blood urea nitrogen and blood urea, liver enzymes, serum albumin, and a full blood picture. If a urine analysis and culture were conducted and the results were positive, antibiotics were given as needed.

2.2.3. Radiological investigations

In every instance, plain UT film, noncontrast computed tomography (CT), and abdominal and pelvic ultrasounds were performed. Investigations such as radioisotope scanning, and contrast studies were optional.

2.3. Intraoperative details

The length of the fluoroscopy, the kind of dilation employed, the time of the procedure, any difficulties during the procedure, the necessity for a blood transfusion, the exit plan, and the stone-free rate [by computed tomography and fluoroscopy in radiolucent stones] were all included.

2.4. Post-operative assessment

Stone-free status [second postoperative day and CT scan if necessary] and a report of any issues were evaluated. Using a 3 l saline bag under the ipsilateral rib cage and a gel pad under the ipsilateral pelvis, we place the patient in the modified flank free supine position, tilting their ipsilateral flank by 15°. With the contralateral side abducted and the ipsilateral side moderately extended, the legs are put in lithotomy. Compared with the full supine position, where the flank is relatively unexposed, the Valdivia and modified Valdivia positions, where there is a support under the flank, and the relatively easy use of image-guided access, there is no support under the loin. The supine position facilitates easier and more conventional fluoroscopy. Antero-posterior views are ensured by minimal rotation of the C arm, and the surgeon's hands are further away from the operative and radiological fields, reducing the risk of radiation exposure, (Fig. 1).

The posterior axillary line was used as the PCNL puncture site, with access determined by the desired calyx. Using Alken dilators, a guide wire was inserted via the access needle and subsequently dilated. Stone shards were either washed with a plastic Nelaton catheter or extruded using stone forceps. To rule out extravasation, contrast dye was injected once the treatment was complete. Postoperatively, the nephrostomy tube was clamped for 6 h, removed in the morning, and after 48 h, the urethral catheter was removed.

2.5. Postoperative evaluation

Hemoglobin drop indicating significant blood loss necessitating blood transfusion, particularly in cases of severe bleeding during surgery, urine leaks requiring DJ fixation as a preventive measure, fever, stone-free status (no residual stone or residual stone less than 4 mm in diameter) was determined by pelvic-abdominal CT if the stone was radiolucent and by plain radiography if the stone was known to be radiopaque, as well as the average length of hospital stay.

2.5.1. Sample size calculation

The sample size was calculated using Epi Info V.7. A previous study by Ref. [5] reported that the supine lithotomy position has an important advantage in reducing the operative time. When doing mini percutaneous nephrolithotomy (MPCNL), the supine lithotomy posture may be a suitable option. At a significance level of 5%, a minimum sample size of 51 (80%) cases will have power to detect an expected difference of 2.64% in the prevalence of confidence distribution (CD) in a sample of cases with SLE.

2.6. Statistical analysis

Using Microsoft Excel 2019 and SPSS v. 25 (SPSS Inc., Chicago, IL, USA) on a personal computer, the findings were tabulated and statistically evaluated. The distribution of the variables was shown to be normal using the Kolmogorov–Smirnov test. The χ^2, Mann–Whitney U test (U), Kruskal–Wallis test, and Binary Logistic Regression analysis were among the analytical statistics, whilst the mean (x), median, and SD were among the descriptive statistics. P values less than 0.05 were regarded as statistically significant, [22].

3. Results

A flowchart of the study population shown in Fig. 2. Of the 63 patients diagnosed between October 2022 and August 2023 with big kidney stones. Out of the 51 patients who underwent surgery, 12 individuals were eliminated from the study (seven patients rejected consent and five patients did not match the inclusion criteria).

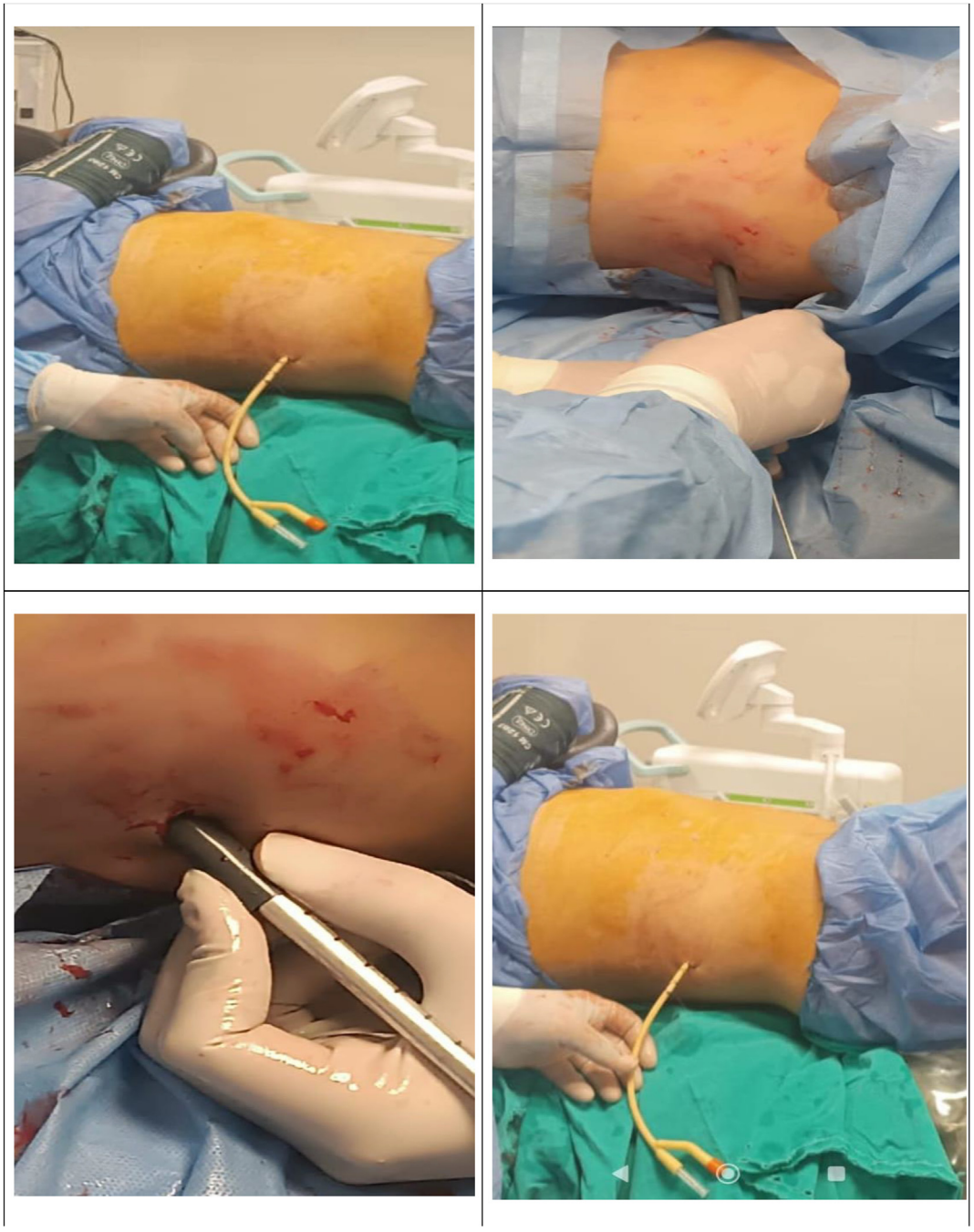

Fig. 1. Patients underwent percutaneous nephrolithotomy operation placed in the modified flank supine position.

Among 51 cases, the mean age was (48.20 ± 13.16), BMI was (38.20 ± 9.50), weight was (157.86 ± 57.01) and height was (160.43 ± 1.63). Most of our patients were males 28 (54.9%) and 23 (45.1%) were females. Most of our patients were obese 40 (78.4%), six (11.8%) patients had normal BMI, and five (9.8%) patients were overweight, (Table 1).

Among 51 cases, the mean size stone was (5.13 ± 1.92), the Hounsfield unit was (838.67 ± 227.92), the residual stone was (1.13 ± 0.38), the fluoroscopy time was (9.62 ± 2.89), the operative time was (88.04 ± 29.26), and hospital stays was (108.57 ± 23.76). The most site of stone was pelvis found in 17 (33.3%) of patients then stag horn 11 (21.6%) followed by pelvis and middle calyx 10 (19.6%), pelvis and lower calyx 8 (15.7%) and pelvis and upper calyx three (5.9%). Residual stone, drop of hemoglobin, the need of blood transfusion were

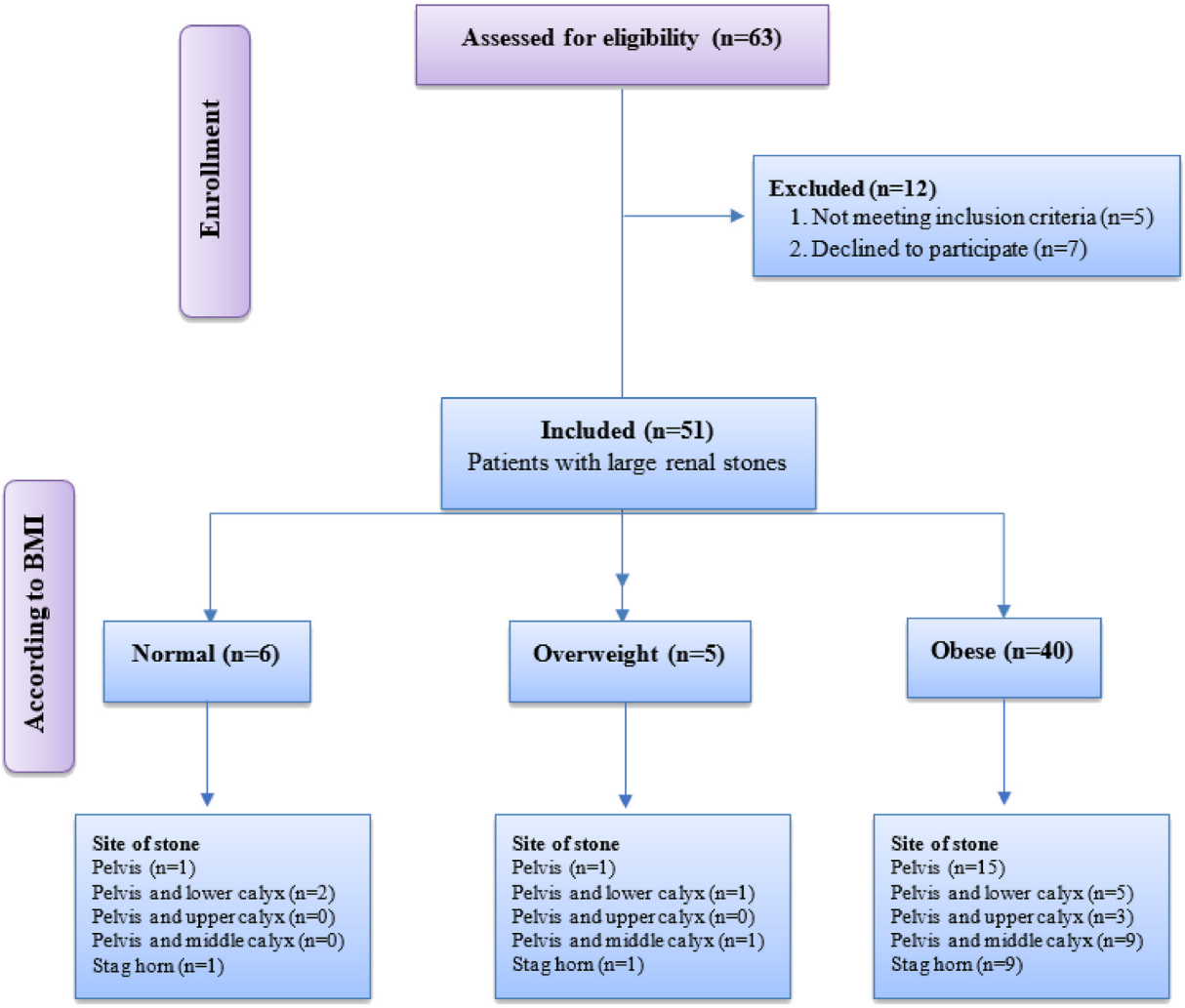

Fig. 2. Flowchart of patients with large renal stones.

found in (13.7, 13.7, and 2.0%) need for auxiliary procedures in the form of Shockwave lithotripsy (SWL) and PCNL was needed in 15.7%, 5.9%, respectively. The most common postoperative complication was fever which was found in three (5.9%) patients, then hemorrhage in two (3.9%) patients followed by urine leakage in one (2.0%) patient (Table 2).

Additionally, there was no relation among gender groups regarding size stone ($P = 0.366$), Hounsfield unit ($P = 0.704$), site of stone ($P = 0.164$) and postoperative complications ($P = 0.549$), (Table 3).

There was no significant relation among sex groups regarding residual stone, fluoroscopy time, operative time, drop of hemoglobin, need of blood transfusion, residual stones, second look PCNL, hospital stays, and postoperative complications ($P > 0.05$). While, SWL was found in seven (25.0) of males and in one (4.3%) of females with significant relation among the two sex groups ($P = 0.044$), (Table 4).

Also, data in Table 5 revealed no significant relation among body mass index groups regarding the size stone, site of the stone, and postoperative complications ($P > 0.05$). While, Hounsfield unit was significantly higher among obese patients (885.90 ± 227.54) than overweight (693.20 ± 146.46) and normal patients (645.00 ± 120.25), ($P = 0.014$), (Table 5).

There was no significant relation among body mass index groups regarding residual stones, fluoroscopy time, operative time, drop of hemoglobin, need of blood transfusion, residual stones, auxiliary procedures, and hospital stays ($P > 0.05$), (Table 6).

Regression analysis indicated that size stone, Hounsfield unit, operative time, and hospital stays were the most common factors predisposing to postoperative complications ($P < 0.05$). While,

Table 1. Demographic data among the studied cases (n = 51).

Variable	The studied cases (N = 51) [n (%)]
Age (years)	
Mean ± SD	48.20 ± 13.16
Range	30.00–70.00
Sex	
Male	28 (54.9)
Female	23 (45.1)
BMI (Kg/m^2)	
Mean ± SD	38.20 ± 9.50
Range	60.00–240.00
BMI categories	
Normal	6 (11.8)
Overweight	5 (9.8)
Obese	40 (78.4)
Weight (kg)	
Mean ± SD	157.86 ± 57.01
Range	60.00–240.00
Height (cm)	
Mean ± SD	160.43 ± 1.63
Range	158.00–163.00
Previous surgery	
No	40 (78.4)
JJ	5 (9.8)
SWL	2 (3.9)
PNL	3 (5.9)
URS	1 (2.0)

Body mass index (BMI); double pigtail ureteric stent (JJ); percutaneous nephrolithotomy (PCNL); percutaneous nephrolithotomy (PNL); shockwave lithotripsy (SWL); Ureteroscopic (URS).

Table 2. Operative data among the studied cases (n = 51).

Variable	The studied cases (N = 51) [n (%)]
Preoperative evaluation	
Size stone (cm)	
Mean ± SD	5.13 ± 1.92
Median (Range)	2.48–7.90
Hounsfield unit	
Mean ± SD	838.67 ± 227.92
Median (Range)	560.00–1200.00
Site of stone	
Pelvis	17 (33.3)
Pelvis and lower calyx	8 (15.7)
Pelvis and upper calyx	3 (5.9)
Pelvis and middle calyx	10 (19.6)
Stag horn	11 (21.6)
Operative evaluation	
Residual stone (cm)	
Mean ± SD	1.13 ± 0.38
Range	0.40–1.80
Fluoroscopy time (min)	
Mean ± SD	9.62 ± 2.89
Range	5.00–13.20
Operative time (min)	
Mean ± SD	88.04 ± 29.26
Range	55.00–175.00
Residual stone	7 (13.7)
Drop of Hemoglobin	7 (13.7)
Need of blood transfusion	1 (2.0)
Auxiliary procedures	
SWL	8 (15.7)
PCNL	3 (5.9)
Hospital stays (hours)	
Mean ± SD	108.57 ± 23.76
Range	30.00–145.00
Postoperative complications	
No	45 (88.2)
Hemorrhage	2 (3.9)
Fever (≥38 °C)	3 (5.9)
Urine Leakage	1 (2.0)

Double pigtail ureteric stent (JJ); percutaneous nephrolithotomy (PCNL); percutaneous nephrolithotomy (PNL); shockwave lithotripsy (SWL); ureteroscopy (URS).

other parameters did not show any significant affection on postoperative complications ($P > 0.05$), (Table 7).

4. Discussion

PCNL is the preferred treatment option for large (>2 cm) renal stones, however, over the last ten years, a few variations regarding patient positioning for PCNL have been proposed [23]. The supine position was developed for PCNL and offered many advantages; the first described position was that of Valdivia in 1998, with a 3-L saline bag below the flank [24]. This position was further modified in 2006 with the Galdakao modified Valdivia position consisting of some rotation to the supine positioning of the contralateral leg in flexion and the ipsilateral leg in extension [23,25].

In our study, the mean stone size of our cases was 5.13 ± 1.92 cm, the most common site of stone was the renal pelvis found in 33.3% of patients then stag horn (21.6%) followed by pelvis and middle calyx (19.6%), pelvis and lower calyx (15.7%) and pelvis and upper calyx (5.9%). Abd Elgawad *et al.* [26] found that the size of the stones in supine position patients ranges from 2.2 cm to 4.5 cm, four multiple renal stones, distributed in renal pelvis and middle calyx, renal pelvis and lower calyx, twice in the lower calyx, and twice in the renal pelvis, were among the single renal stones. Jones *et al.* [27] conducted research on 236 patients, like these statistics. 160 patients made up the supine group. There were three different types of stones: staghorn stones (17 patients), numerous stones (49 patients), and stones larger than 2 cm (94 patients). Eliwa *et al.* [28], on the other hand, discovered two patients with staghorn stones and 28 patients with stones larger than 2 cm in the supine group. While, Sohail *et al.* [29], demonstrated that the range of the stone size in the supine group (96 patients) was 29 mm–29.7 mm. It is better to approach the kidney through the posterior calyx in this position. Furthermore, because it is easier to access the upper calyx and is thought to be safer in terms of thoracic problems, Abdel-Mohsen *et al.*

Table 3. Pre and postoperative data in relation to sex among the studied patients (n = 51).

Variable	Sex		χ^2	*P* value
	Male (*N* = 28) [*n* (%)]	Female (*N* = 23) [*n* (%)]		
Preoperative evaluation				
Size stone (cm)				
Mean ± SD	4.92 ± 2.02	5.38 ± 1.81	U = 274.500	0.366
Hounsfield unit				
Mean ± SD	849.43 ± 234.59	825.57 ± 224.03	U = 302.000	0.704
Site of stone				
Pelvis	7 (25.0)	10 (43.5)	1.940	0.164
Pelvis and lower calyx	3 (10.7)	5 (21.7)		
Pelvis and upper calyx	2 (7.1)	1 (4.3)		
Pelvis and middle calyx	5 (17.9)	5 (21.7)		
Stag horn	6 (21.4)	5 (21.7)		
Postoperative complications				
Hemorrhage	2 (7.1)	0	1.200	0.549
Fever	2 (7.1)	1 (4.3)		
Urine Leakage	1 (3.6)	0		

Chi-square (χ^2); Mann–Whitney *U* test (*U*).

Table 4. Operative data and auxiliary procedures about sex among the studied patients (n = 51).

Variable	Sex				χ^2	*P* value
	Male (*N* = 28)		Female (*N* = 23)			
Operative evaluation	Mean ± SD		Mean ± SD			
Residual stone (cm)	1.18 ± 0.38		1.07 ± 0.39		U = 279.50	0.415
Fluoroscopy time (min)	9.66 ± 2.91		9.57 ± 2.93		U = 316.50	0.917
Operative time (min)	91.25 ± 32.71		84.13 ± 24.56		U = 303.50	0.725
Drop of Hemoglobin	3	10.7	4	17.4	0.475	0.491
Need of blood transfusion	1	3.6	0	0.0	0.838	0.360
Residual stones	6	21.4	1	4.3	3.111	0.078
Auxiliary procedures						
SWL	7	25.0	1	4.3	4.072	**0.044**[a]
PCNL	2	7.1	1	4.3	0.178	0.673
Hospital stays (h)	109.07 ± 23.75		107.96 ± 24.29		U = 314.0	0.879
Postoperative Complications						
Hemorrhage	2	7.1	0	0.0	1.200	0.549
Fever	2	7.1	1	4.3		
Urine Leakage	1	3.6	0	0.0		

Chi square (χ^2); Mann–Whitney *U* test (*U*); percutaneous nephrolithotomy (PCNL); shockwave lithotripsy (SWL).
[a] Significant.

Table 5. Pre and postoperative data in relation to BMI among the studied patients (n = 51).

Variable	BMI categories			χ^2	*P* value
	Normal (*N* = 6) [*n* (%)]	Overweight (*N* = 5) [*n* (%)]	Obese (*N* = 40) [*n* (%)]		
Preoperative Evaluation					
Size stone (cm)					
Mean ± SD.	4.53 ± 1.41	4.54 ± 2.03	5.29 ± 1.99	H = 1.788	0.409
Median (Range)	5 (2.5–6.0)	4.4 (2.5–7.7)	5.6 (2.5–7.9)		
Hounsfield unit					
Mean ± SD.	645.00 ± 120.25	693.20 ± 146.46	885.90 ± 227.54	H = 8.483	**0.014**[a]
Median (Range)	575 (560–800)	658 (600–950)	900 (560–1200)		
Site of stone					
Pelvis	1 (16.7)	1 (20.0)	15 (37.5)	1.463	0.481
Pelvis and lower calyx	2 (33.3)	1 (20.0)	5 (12.5)		
Pelvis and upper calyx	0	0	3 (7.5)		
Pelvis and middle calyx	0	1 (20.0)	9 (22.5)		
Stag horn	1 (16.7)	1 (20.0)	9 (22.5)		
Postoperative complications					
Hemorrhage	– (–)	– (–)	2 (5)	–	–
Fever			3 (7.5)		
Urine Leakage			1 (2.5)		

Body mass index (BMI); Chi square (χ^2); Kruskal–Wallis H test (H); percutaneous nephrolithotomy (PCNL); Shockwave lithotripsy (SWL).
[a] Significant.

Table 6. Operative data and Auxiliary procedures in relation to BMI among the studied patients (n = 51).

Variable	BMI categories			χ^2	*P* value
	Normal (*N* = 6) [*n* (%)]	Overweight (*N* = 5) [*n* (%)]	Obese (*N* = 40) [*n* (%)]		
Operative evaluation					
Residual stone (cm)					
Mean ± SD.	1.13 ± 0.42	1.08 ± 0.44	1.14 ± 0.38	H = 0.052	0.974
Median (Range)	1.3 (0.4–1.5)	1.3 (0.4–1.5)	1.3 (0.4–1.8)		
Fluoroscopy time (min)					
Mean ± SD.	8.65 ± 3.62	9.10 ± 2.52	9.83 ± 2.86	H = 0.918	0.632
Median (Range)	7.6 (5–13.2)	8.6 (6.3–13.1)	10 (5–13.2)		
Operative time (min)					
Mean ± SD.	81.00 ± 15.32	73.40 ± 15.66	90.93 ± 31.60	H = 2.525	0.283
Median (Range)	88 (55–95)	75 (55–90)	89 (55–175)		
Drop of Hemoglobin	0	1 (20.0)	6 (15)	1.176	0.556
Need of blood transfusion	0	0	1 (2.5)	0.280	0.869
Residual stones	0	0	7 (17.5)	2.231	0.328
Auxiliary procedures					
SWL	1 (16.7)	0	7 (17.5)	1.034	0.596
PCNL	1 (16.7)	0	2 (5)	1.629	0.443
Hospital stays (h)					
Mean ± SD.	100.33 ± 39.48	109.60 ± 34.40	109.68 ± 19.76	H = 314.00	0.879
Median (Range)	106 (30–145)	120 (50–135)	114 (70–145)		

Body mass index (BMI); Chi square (χ^2); Kruskal–Wallis H test (H).

Table 7. Regression analysis for the for the parameters affecting postoperative complications.

	Unstandardized coefficients		Standardized coefficients	t	*P* value	95%CI
	B	Std. Error	Beta			Lower – upper
Age (year)	0.001	0.007	0.030	0.201	0.842	0.21–0.35
Weight (kg)	0.002	0.002	0.165	1.121	0.269	0.042–192
Height (cm)	0.028	0.059	0.068	0.467	0.643	0004–0.61
BMI1 (kg/m^2)	−0.004	0.011	−0.059	0.370	0.713	0.290–0.82
Size stone (cm)	0.156	0.052	0.468	2.998	**0.005**[a]	0.36–1.12
Hounsfield unit	0.001	0.000	0.257	1.742	**0.043**[a]	0.85–1.63
Residual stone (cm)	−0.239	0.252	−0.141	0.949	0.348	0.22–0.75
Fluoroscopy time (min)	−0.062	0.034	−0.278	1.815	0.077	0.06–0.20
Operative time (min)	0.007	0.003	0.322	2.045	**0.048**[a]	0.93–1.19
Hospital stays hours	−0.008	0.004	−0.300	2.055	**0.047**[a]	0.71–0.98

Body mass index (BMI); confidence intervals (CI); independent *t*-test (t).
[a] Significant.

[30], opted to approach the kidney through the lower calyx in modified supine positions.

In the present study the mean residual stone was 1.13 ± 0.38 cm, Abd Elgawad *et al.* [26] found that two (13/3%) patients had residual stone in the supine position. Furthermore, Jones *et al.* [27] reported that the supine position had a high prevalence of stone-free rate (70% supine). However, in the supine group, Sohail *et al.* [29] showed an 85% stone-free rate. According to Yuan *et al.* [31], 74.3% of the supine group had no stone.

The biggest prospectively recorded database of PCNL patients (5775 patients) between 2007 and 2009 revealed in another study by Valdivia *et al.* (2011) that the mean supine operation periods were 90.1 min, which falls within the same range as our study (88.04 ± 29.26 min). Our results also agree with the findings of other urologists such as Giusti *et al.* [32] who found the same results. We primarily attributed this to a variety of factors, including variations in the definition of operative time among included studies and variations in the properties of stones, tools, or processes. In a different investigation, Erbin *et al.* [33] discovered that the fluoroscopy duration in supine m-PNL was considerably less (3.0 ± 1.7 min) than what our study (9.62 ± 2.89 min) revealed. Notably, it would probably overlook the variations in the duration of some precise procedures, which were closely associated with surgical difficulties, such setting up the access and performing lithotripsy.

Regarding blood transfusion, Eliwa *et al.* [28] found that 5% of the group receiving transfusions was in the supine position. In the supine group, the mean hemoglobin level before surgery was 12.10 gm/ml ±0.74, and it decreased to 10.75 gm/ml

±1.07 after surgery. In this group, just one (3.3%) patient needed a blood transfusion. This was consistent with our research, which showed that 13.7% of people needed blood transfusions and that hemoglobin levels had dropped. Additionally, Wang *et al.* [34] showed a 2.4% decrease in hemoglobin in the supine group. This supports what our investigation found. According to Jones *et al.* [27], postoperative anemia did not necessitate transfusion in one (0.6%) patient of the patients under study, while three (2%) patients in the supine group required blood transfusions. Nevertheless, a different randomized investigation discovered that 27.5% of the supine patients had a transfusion rate (Falahatkar *et al.* 2008). Variations among studies could be attributed to varying transfusion thresholds among various centers. Furthermore, two other trials [35,36] showed that the supine posture required far fewer blood transfusions than the other position. Maybe as a result of the supine position's increased retroperitoneal mobility and more medial kidneys, which may lessen the requirement for blood transfusions. This might be the outcome of the Supine PCNL's reduced operating duration.

Auxiliary procedures, namely SWL and second look PCNL, were performed in 15.7% and 5.9% of the cases in our study, respectively. Only two patients in the supine group in the Abd Elgawad *et al.* [26] trial needed ESWL (13.3%); one of them had an intraoperative stent (6.7%), while the other did not have a stent for ESWL. The average hospital stay in our study was 108.57 ± 23 h which was in line with the findings of Valdivia *et al.* (2011) and Al-Dessoukey *et al.* [37], who found no discernible difference between the two positions' hospitalization times. Our findings also support the findings of Zhang *et al.* [38] and Karami *et al.* [39], who found no statistically significant difference in hospital stay between the supine and prone groups.

Following PCNL, there may be postoperative complications such as bleeding, fever, infection, pleural effusion, urine leakage, and visceral organ damage. The most common postoperative complications in the current study were fever, which affected three (5.9%) patients, hemorrhage, which affected two (3.9%) patients, and urine leakage, which affected one (2.0%) patient. Wang *et al.* [34] examined each of the problems separately in a different study. The two groups' rates of complications for pleural effusion and urinary leakage were comparable, while the supine group's risk of fever was noticeably lower. This could be because lying supine reduces respiratory stress [35]. Urinary leakage and pleural effusion exhibited comparable overall complication rates in both supine and prone groups [40], although fever rates were considerably lower in the supine position.

However, rates of significant complications, such as septicemia, colonic or pleural damage, and substantial hemorrhage, have been reported to range from 0 to 4.7% in another research by Wang *et al.* [41]. Similar to earlier findings, De Sio *et al.* [40] demonstrate that supine surgeries are safe and effective. However, Shea *et al.* [42] noted that information about problems was included in every study. In the supine group, the overall rate of problems was 16.1% (118/735). Further, Li *et al.* [43] compared each complication, which showed a markedly decreased risk of fever in the supine group and negligible variations in the rates of pleural effusion, blood transfusion, and urine leakage between the two groups. According to Shoma *et al.* [44], there is a tendency for acute bleeding to occur when a patient is in the supine position; however, this could be attributed to the early learning curve, which caused some challenges with puncture dilation and lateral displacement. Furthermore, according to a different study by Hopper *et al.* [45], 1.9% of supine patients had a retro renal colon discovered by CT, which lowers other positions. These investigations suggested that supine PCNL posed a reduced risk of colon damage. None of the supine individuals in our study had any reports of colonic injury.

In our study, obese patients had greater rates of residual stone, operation time, fluoroscopy time, and postoperative problems. Furthermore, the most frequent factors influencing post-surgical problems were hospital admissions, stone size, Hounsfield unit, and operating time. For patients with reduced cardiorespiratory function and for patients who are morbidly obese, supine PCNL gives the best alternative, because there are different postural modifications available [5,40,46,47]. Nevertheless, in the pure prone posture, PCNL and retrograde URS cannot be carried out concurrently. On the other hand, we can perform this in conjunction with endoscopic retrograde intrarenal surgery (ECIRS) when we are in the supine position.

Finally, multiple benefits were found by using MPCNL in the supine lithotomy position as (1) patients with morbid obesity and impaired cardiopulmonary status may benefit most from its ability to lessen ventilatory or cardiocirculatory dysfunction. Therefore, it helps with the anesthesiologist's management during the procedure. (2) Particularly

for obese people, it is more pleasant than the prone position. (3) Because patients do not need to be turned once the ureteral catheter is positioned, it can shorten the duration of the procedure.

4.1. Conclusion

It is noteworthy that in the PCNL method, both the supine and prone positions have advantages and disadvantages of their own. It is proved that there is no completely superior. Therefore, the clinical status of the patient and the surgeon's experience should be taken into consideration while selecting the position for PCNL. The supine approach has considerably lower operating times and is safe and practicable for novice surgeons. Patients with renal calculi larger than 2 cm can benefit from PCNL in the supine position, particularly those who are obese, have concurrent lower ureteric operations or have cardiac issues.

Conflicts of interest

There are no conflicts of interest.

Institutional review board (IRB) approval number

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