Urologia Internationalis

Original Paper

Urol Int 2021;105:77–82
DOI: 10.1159/000511292

Received: June 4, 2020
Accepted: September 1, 2020
Published online: November 20, 2020

Outcomes of Flank-Free Modified Supine Percutaneous Nephrolithotomy Based on BMI

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Keywords
Percutaneous nephrolithotomy · Obesity · Body mass index · Supine position

Abstract
Objective: To evaluate the impact of body mass index (BMI) on the outcomes of percutaneous nephrolithotomy (PCNL) in the flank-free modified supine position. ***Patients and Methods:*** A prospective study was carried out in the urology department during the period from May 2015 to October 2019 on 464 patients admitted for PCNL. The patients were divided into 4 matched groups according to their BMI: group A, normal weight with 18.5 ≤ BMI <25 kg/m^2; group B, overweight with 25 ≤ BMI <30 kg/m^2; group C, obese with 30 ≤ BMI <40 kg/m^2; and group D, morbid obesity with BMI ≥40 kg/m^2. All operative data as well as postoperative outcomes are recorded and compared to each other. ***Results:*** The 4 studied groups were matched regarding age. The comorbidities were slightly higher in groups C and D. The operative time and fluoroscopy time were slightly high in obese and morbid obese groups but with no significant difference. The rate of complications either major or minor was comparable in all groups. No significant difference was seen among all groups regarding hemoglobin loss, stone-free rate, hospital stay, and need for auxiliary procedures. ***Conclusions:*** The outcome of PCNL in flank-free modified supine position is not affected by changes in BMI. The procedure can be performed in obese and morbid obese patients safely with results similar to and comparable to nonobese patients.

Introduction

Obesity is a major worldwide problem representing a risk factor for many cardio vascular diseases and type 2 diabetes mellitus and even may contribute too many premature deaths [1–30]. Obesity is a risk factor in stone formation via several metabolic ways [2] and on the other side represents a challenging factor in stone management.

According to the WHO fact sheet, obesity has doubled since 1980. In fact, in 2014, >1.9 billion adults, 18 years and older, were overweight; of these, 600 million were obese [3]. Egypt has reached the maximum figures in adult weight among 195 countries and territories, with almost 35.3% of Egyptian adults (about 19 million) suffering from obesity [4].

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Body mass index (BMI) is a simple index used to define obesity and defined as the weight in kilograms divided by square of the height in meters (kg/m^2). Persons with 18.5 ≤ BMI <25 kg/m^2 are normal weight, persons with 25 ≤ BMI <30 kg/m^2 are overweight, persons with 30 ≤ BMI <40 kg/m^2 are obese, while those person with BMI >40 are morbid obese [5]. American Society of Anesthesiologist (ASA) had classified obese persons with BMI 30–40 as ASA II and morbid obese with BMI >40 as ASA III even without associated comorbidities [6].

Extracorporeal shock wave lithotripsy (ESWL) is the treatment of choice for patients with renal stone <2 cm, but in obese patients, the results are poor due to inadequate localization of the stone, large skin-to-stone distance, and attenuation of the shock waves by the body fat, so the need for multiple sessions is high [7]. Retrograde intrarenal surgery (RIRS) using flexible ureteroscopy and laser appears to be a safe alternative option for treatment of renal stones in obese patients, but the main problem urologists face is long time of operation especially in large stone size [8].

In spite of many challenges, percutaneous nephrolithotomy (PCNL) is considered the primary line of treatment for obese patients [9]. Many anesthetic hazards arise when performing PCNL in the prone position in obese and morbid obese patients due to limitation of chest wall expansion and inadequate ventilation [10]. In our study, we evaluate the impact of BMI on outcomes of PCNL in the flank-free modified supine position that was described for the first time in our department in 2011 [11].

Materials and Methods

This is a cohort study carried out in our urology department on 464 patients admitted for PCNL; the sample size is calculated using Open Epi Info program with 95% confidence level and 80% power of test. The sample size was completed after 53 months (from May 2015 to October 2019). All patients met inclusion criteria which were renal stones >2 cm and age >18 years; the exclusion criteria were patients <18 years, uncontrolled coagulopathy, renal anomalies, and any other contraindication for PCNL. The patients were divided into 4 matched groups according to their BMI with each group containing 116 patients: group A with 18.5 ≤ BMI <25 kg/m^2, group B with 25 ≤ BMI <30 kg/m^2, group C with 30 ≤ BMI <40 kg/m^2, and group D with BMI >40.

Complete history taking obtained from all patients including age, gender, height, and weight was used to calculate BMI. Preoperative laboratory evaluation was performed including urine analysis and culture, RBS, KFT, LFT, and coagulation profile Table 1 and 2 (Table 1, 2).

Color version available online

Fig. 1. Flank-free modified supine position. The area between the last rib superiorly and Iliac crest inferiorly and PAL anteriorly and PVM posteriorly is the permitted area for puncture according to renal anatomy and desired calyx for puncture, but the puncture is usually on the PAL between the last rib and Iliac crest as shown by the black arrow. PAL, posterior axillary line; PVM, paravertebral muscles.

Imaging protocol such as KUB, pelvi-abdominal ultrasound, and noncontrast spiral CT was performed for all patients to detect stone size, stone location, and stone density. IVU was performed only in certain cases but not a routine. The skin-to-stone distance was measured by taking the average of 3 distances measured on preoperative CT from the center of the stone to skin in 0°, 45°, and 90° [12]. Preoperative antibiotic in the form of 1-g 3rd generation cephalosporin was given for all patients 2 h before the procedure.

Operative Technique

Spinal anesthesia and fluoroscopy were used in all patients. Cystoscopy was performed in the lithotomy position, and a 6-F open-tip ureteric catheter was inserted and fixed to the indwelling Foley catheter. Then, the patient was placed in the flank-free modified supine position. In this position, we elevate the flank by 15–20° by placing a suitable cushion under the ipsilateral shoulder and another suitable cushion under the ipsilateral buttock and nothing under the flank. This modification provides ample space for nephroscope maneuverability. Also, in this position, we crossed the extended ipsilateral leg over the flexed contralateral leg to increase the distance between the last rib and Iliac crest; this gives more space for multiple tracts when needed (Fig. 1).

All cases were handled by the same team, and the operation time was calculated from the beginning of induction of anesthesia till the insertion of the nephrostomy tube. All intraoperative data were reported including tract length, operative time, fluoroscopy time, need for blood transfusion, and any intraoperative complication. The nephrostomy tube was removed after 24 h.

A subjective questionnaire was completed after each procedure, asking for puncture, dilatation, vision, urologist comfort, and anthologist comfort [13]. Postoperative complications, need for any auxiliary maneuver, length of hospital stay, and stone-free rate were reported.

Table 1. Patient demographics and stone characteristics

	Normal weight	Over weight	Obese	Morbid obese	*p* value
Gender					
Male	69	71	64	55	0.15
Female	47	45	52	61	
Age, years	45.9±13.09	46±12.89	46.18±12.65	46.07±12.88	0.99
ASA					
I	79	62	0	0	0.00
II	29	38	99	0	
III	8	15	16	114	
IV	0	1	1	2	
Comorbidities					
HPN	18	21	25	26	0.52
DM	7	9	15	10	0.29
Cardiac troubles	2	3	5	7	0.31
Chest troubles	1	1	1	2	0.89
Multiple	6	8	12	13	0.34
Stone size, cm	3.92±1.01	3.91±1.01	3.88±1.01	3.8±0.93	0.12
Stone shape					
Simple	41	47	44	48	0.78
Partial stag	55	50	49	51	0.87
Complete stag	12	13	13	12	0.99
Multiple	8	6	10	5	0.54
Stone side					
Right	73	68	69	79	0.43
Left	43	48	47	37	
Stone density	715.4±320.7	694.7±284.6	705.8±301.9	690.3±306.4	0.92

ASA, American Society of Anesthesiologist; HPN, hypertension; DM, diabetes mellitus.

Table 2. Outcomes of PCNL in the 4 studied groups

	Normal weight	Over weight	Obese	Morbid obese	*p* value
Operative time, min	87.22±14.52	87.48±14.84	87.91±15.56	88.78±17.19	0.88
Skin-to-stone distance	9.07±1.21	11.87±2.07	14.23±1.67	17.1±1.13	0.001
Track length	10.2±0.75	12.89±1.80	15.52±2.17	18.67±1.93	0.001
Fluoroscopy time, s	102.53±14.16	103.33±14.37	103.46±14.57	105.29±14.91	0.52
Complication					
I	12	15	16	18	0.71
II	6	8	7	10	0.73
III a	5	5	5	5	1.00
III b	7	6	6	7	0.98
IV a	0	0	1	0	0.39
Hemoglobin loss, g/dL	1.4±1.01	1.2±0.59	1.3±1.17	1.4±1.11	0.36
Hospital stay, days	2.63±0.83	2.63±0.82	2.39±1.14	2.45±0.88	0.12
Stone-free rate, %	93.1	91.37	90.52	87.07	0.46
Auxiliary procedures					
2nd-look PCNL	3	5	4	4	0.99
ESWL	4	5	4	5	
URS	3	2	2	3	

PCNL, percutaneous nephrolithotomy; ESWL, extracorporeal shock wave lithotripsy.

All the patients were reassessed by KUB and pelvi-abdominal ultrasound 24 h after the operation and before removal of the nephrostomy tube. Noncontrast spiral CT was performed for all patients after 1 month to assess any residual stones before removal of double J stent. Residuals <4 mL were considered nonsignificant.

Data Management

Sorting, tabulation, and analysis of data were performed by using SPSS (Statistical Package for Social Studies) version 20 [14]. Statistical significance for the differences between proportions was determined using the χ^2 test for qualitative data. Comparison among groups was carried out using one way analysis of variance (ANOVA). $p < 0.05$ was adopted as the level of significance.

Results

Our study included 464 patients who were divided according to their BMI into 4 groups, each containing 116 patients, and this why the study extended along 53 months to get equal number of patients in each group to get accurate results. 259 patients (55.8%) were male, and 205 patients (44.2%) were female. The patients' age ranges from 19 to 71 years, and the mean age was 64.04 ± 12.83 years with no significant difference between all groups.

The mean BMI was 23.05 ± 1.14, 28.31 ± 1.25, 35.51 ± 2.39, and 46.13 ± 3.29 kg m in all groups, respectively. There were some comorbidities in the patients such as hypertension in 90 patients (19.4%), diabetes mellitus in 41 patients (8.8%), chest troubles in 5 patients (1.08%), cardiac troubles in 17 patients (3.7%), and multiple comorbidities in 39 patients (8.4%). The comorbidities were higher in groups 3 and 4 with no significant.

The mean stone size was 3.88 ± 0.99 cm in all groups with no significant difference among them. The stone shape was simple (pelvis only or 1 calyx only) in 180 patients (38.8%), partial stag (pelvis and 1 calyx) in 205 patients (44.2%), complete stag (pelvis and >1 calyx) in 50 patients (10.8%), and multiple in 29 patients (5.2%) with no significant difference between all groups.

The stones were right sided in 289 patients (62.3%) and were left sided in 175 patients (37.7%). The patients underwent PCNL in the flank-free modified supine position with single access in 430 patients (92.7%) and 2 renal accesses in 34 patients (7.3%).

The mean operative time was 87.22 ± 14.52, 87.48 ± 14.84, 87.91 ± 15.56, and 88.78 ± 17.19 min in all groups, respectively, and the overall mean operative time was 87.85 ± 15.52 min which is slightly longer in the morbid obese group but with no significant difference between all groups. The mean fluoroscopy time was 102.53 ± 14.16, 103.33 ± 14.37, 103.46 ± 14.57, and 105.29 ± 14.91 s in all groups, respectively, and the overall mean fluoroscopy time was 103.65 ± 14.49 s which is slightly higher in the morbid obese group but with no significant difference between all groups.

The complications are classified according to the modified Clavien grading system; no complication of grade IV b or V had been occurred. One patient in group C complicated with colonic injury was successfully treated by conservative treatment with triple antibiotic, low-residual diet, insertion of a double J stent, and withdrawal of the nephrostomy tube to serve as a colostomy tube for one week.

The mean hemoglobin loss was 1.4 ± 1.01, 1.2 ± 0.59, 1.3 ± 1.17, and 1.4 ± 1.11 gm/dL, and blood transfusion was needed in 2 patients in group A, 3 patients in group B, 2 patients in group C, and 3 patients in group D. The mean hospital stay was 2.63 ± 0.83, 2.63 ± 0.82, 2.39 ± 1.14, and 2.45 ± 0.88 days in all groups, respectively, with no significant difference among them.

The overall stone-free rate was 90.52% in all the study groups. The stone-free rate was 93.1, 91.37, 90.52, and 87.07% in the 4 groups, respectively, with no significant difference among them.

The subjective questionnaire shows no significant difference between all groups regarding puncture, vision, and comfort for both the surgeon and anesthesiologist. Significant difference was noted in dilatation where it was easier with increase in BMI.

Auxiliary procedures were needed in the form of 2nd-look PCNL in 16 patients after 48 h from the 1st look. ESWL was needed in 18 patients, and ureteroscopy was needed in 10 patients with no significant difference between all groups.

Discussion

Obesity is an increasing problem worldwide especially in high-income countries [8]. Obese patients are considered a real challenge for any surgery with fear of increased incidence of complications regarding the anesthesia and the surgery itself [15, 16].

Obesity is a major risk factor for urolithiasis due to many metabolic disorders as well as sedentary life style [17]. The treatment of renal stones in obese and morbidly obese patients is challenging because ESWL, which has been used for renal stones <2 cm, shows poor results in such patients and shows worse results if the stones are of size >2 cm [18].

Flexible URS and laser fragmentation provide a very great option for management of renal stones in obese patients with very good results regarding stone-free rate and

irrelevant complications [19]. On the other hand, PCNL is considered the treatment of choice for renal stones >2 cm in obese and morbidly obese patients [20].

The impact of BMI on PCNL had been studied in many series [21–23]. In our study, it is the first time to investigate the impact of BMI on results of PCNL in the flank-free modified supine position, which had been reported by our department in 2011 [12]. This modified position represented a very good option for obese patients due to less anesthesia hazards as well as increased space between the last rib and iliac crest with subsequent easy manipulation using a nephroscope and facility of multiple punctures.

Many series studied the impact of BMI on results of PCNL in a retrospective and prospective manner. In a study carried out by Ferber and Goh [24], 2 groups of patients underwent PCNL: the first one was normal weight patients (437) and the second one was morbid obese patients (93). The results were comparable, but the hospital stay was slightly longer in the morbid obese group (3.5 vs. 4.4 days); the complication rate was also higher in the morbid obese group (37 vs. 17%).

Pearle et al. [25] divided their patients into 2 groups: the first one included 57 patients with BMI >30 kg/m^2 and the second one included 179 patients with BMI <30 kg/m^2. They concluded that there was no significant difference between both groups regarding results and complications.

A large retrospective series conducted by El-Assmy et al. [26] in Mansoura Urology and Nephrology center on 1,121 patients including 546 patients with BMI >30 kg/m^2 concluded that the outcome of PCNL is independent on BMI and the results of PCNL in obese and nonobese patients are similar without significant difference regarding stone-free rate, hospital stay, complication rate, and need for auxiliary procedure. Koo et al. [23] conducted their study on 181 patients who were divided into 4 groups according to their BMI and reported no significant difference between all groups regarding the stone-free rate and intraoperative or postoperative complications.

A large prospective study was carried out by CROES and published in 2012 in which the patients were divided into 4 groups according to their BMI. They concluded that PCNL can be performed safely in obese and superobese patients but with longer operative time and lower stone-free rate [22].

Bagrodia et al. [27] conducted their study on 200 patients who underwent PCNL to detect the impact of BMI on the cost as well as the outcomes of the operation and concluded that there was no significant difference between all groups regarding operative time, length of hospital stay, stone-free rate, and complication rate. A retrospective study was carried out by Alyami et al. [28] on 114 patients who underwent PCNL. They found no significant difference between all studied groups regarding the length of hospital stay, complication rate, and stone-free rate.

In our study, 464 patients were divided into 4 matched groups according to their BMI and underwent PCNL in the frank-free modified supine position. The patients' demographics and stone characteristics in all groups were similar and show no significant difference. The operative time was slightly higher in obese and morbid obese groups but with no significant difference, and this agrees with the results of El-Assmy, Pearle, and Koo but disagrees with results of CROES which shows significant longer operative time with increasing BMI.

The change in Hb concentration and need for blood transfusion are nearly similar between all groups, and this agrees with the results of all other studies. The fluoroscopy time was slightly higher in obese and morbid obese groups but with no significant difference between all groups.

The rate of minor complications such as fever, wound infection, urinary tract infection, transient elevation of serum creatinine, and urine leakage <24 h is increasing with increase in BMI but with no significant difference between all groups, and on the contrary, the rate of major complications was similar between all groups. The result of this current study is similar to the study carried out by Jin et al. [29] and meta-analysis performed by Zhou et al. [30] that concluded similar complication rate with PCNL in different BMI groups.

The stone-free rate was 90.52% with no significant difference between all groups. This agrees with the results of El-Assmy et al. [26] which show a stone-free rate of 84.8% in obese patients and 83.7% in normal weight patients, but this does not agree with CROES which concluded that high-volume centers get higher SFR but superobese patients have a worse outcome.

The main limitations in our study were the strict inclusion criteria and the need for obtaining 4 matched groups, so the duration of the study had extended over 4 years. Also, the is a lack of studies performed with PCNL in the flank-free supine position for comparison.

So, we recommend further studies about PCNL in the flank-free supine position and studies to measure the irradiation dose exposure for the surgeons as well as the operation room personnel during this technique in patients with different BMI. Multiple concerns regarding the prone position for PCNL in morbid obese patients, especially considering anesthesia, exist. So, from our study, we can recommend the modified flank-free supine position for all patients regardless of their BMI.

Conclusion

The outcomes of PCNL in the flank-free supine position is not affected by increasing the BMI regarding operative and postoperative complications, as well as operative time, fluoroscopy time, hospital stay, stone-free rate, and need for auxiliary procedures.

Statement of Ethics

An informed consent was obtained from every participant. Official permission was obtained from the Institutional Review Board.

Conflict of Interest Statement

The authors declare no potential conflicts of interest. All participants in this study are humans and provided written informed consent.

Funding Sources

The authors did not receive any funding.

Author Contributions

E. Desoky: manuscript writing/editing, data analysis, and project development. K.M. Abd Elwahab: data analysis and management. I.M. Babouly: data collection and analysis. M.M. Seleem: project development and data analysis.

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