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Prone PCNL: Safety and efficacy in obese and morbidly obese patients

Abstract

Introduction: The use of percutaneous nephrolithotomy (PCNL) in obese patients with nephrolithiasis has been a subject of debate. Numerous publications have debated the pros and cons of this procedure. In order to assess the efficacy and feasibility of this technique in patients with a BMI>25 kg/m2, several factors should be studied and compared.

Purpose: The purpose of this study is to prove the efficacy and safety of prone PCNL in obese patients and to compare preoperative, intraoperative and postoperative variables between obese patients and those with normal BMI.

Methods: Data was collected throughout 7 years on all patients presenting for PCNL at our institution. All patients underwent prone PCNL under fluoroscopy by a single urologist and the need for subsequent procedure was studied. A total of 276 patients were grouped, after applying exclusion criteria, into 4 categories according to their BMI: Normal BMI (72), overweight (112), obese (80) and Morbidly Obese (12). Using statistical analysis data was compared among the 4 groups of BMI.

Results: The risk of intraoperative related complications including pneumothorax and bleeding was the same among the 4 study groups (p=0.07). No difference was found in terms of subcostal v/s intercostal access (p=0.068). 8%, 1.79%, 8.54% and 0% of the normal, overweight, obese and morbidly obese respectively required transfusions (p=0.103). No significant difference (p=0.07) was found among the groups in overall complication rates being 12% in the Normal BMI group,16% in the overweight, 10% in the obese, and 21% in the morbidly obese. Mean operative time was 84.39, 85.45, 97.31 and 122.5 min in the normal, overweight, obese and morbidly obese respectively (p=0.01). Stone free rate was 52% in the normal BMI group, 62% in the overweight, 66% in the obese and 50% in the morbidly obese (p=0.268).

Conclusion: PCNL in obese patients, BMI>25 kg/m2, was associated with a longer operative time, but with similar rate of complications, transfusion requirements and the need for subsequent procedures when compared to patients with normal BMI. This pioneer study in the Middle East establishes PCNL as safe and feasible procedure in obese patients.

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Introduction

Obesity is known to be a leading cause of morbidity and mortality worldwide. According to WHO fact sheet, obesity has doubled since 1980. In fact, in 2014 more than 1.9 billion adults, 18 years and older were overweight; of these 600 million were obese.[1]

This rise in obesity prevalence and incidence has led to an associated increase in several comorbid conditions. Besides heart disease, cardiovascular accidents and diabetes mellitus, obesity may result in an increased incidence of stone disease. One of the most pivotal characteristics of obesity, insulin resistance, constitutes one of the most important biochemical risk factor for stone formation.[2]

Obesity in the Middle East and Arab region is also on the rise where in 2014 a study revealed that more than 50% of women are overweight. 24% out of those females were obese compared to 19% obese males. According to the WHO, in Lebanon, the prevalence of overweight and obesity in 2014 is 67.4% and 26.3% respectively.[3]

PCNL was first described in the late 1970 early 1980s and has been established according to the AUA as the modality of choice for stones > 20mm.[4] PCNL may be needed in obese patients in whom ESWL is contraindicated due to table limitations, and increase in skin to stone distance.[5] However, general anesthesia and prone position may entail a higher complication risk in obese patients.

Numerous studies have been conducted in order to assess the outcome of PCNL in the obese population and morbidly obese. In 2012, the CROES PCNL global study discussed the influence of BMI on the outcome of PCNL and showed that PCNL may be done safely in obese patients but with a longer operation time, lower stone free rates and higher reintervention rates,[6] but did not include the Middle East region in its data collection.

Being a referral tertiary care center with a significant number of patients that have undergone PCNL, we have collected the data of these patients in order to provide the first documented PCNL outcome study for patients stratified by BMI in the region. This study will assess differences in preoperative, intraoperative and postoperative factors among patients stratified according to BMI. Another importance of this study is the unified prone technique used, hence helping to evaluate this technique in the obese population.

Methods and Patients

Study Design

After obtaining approval from the local ethics committee, medical records of 330 patients whom underwent PCNL by a single endourologist at Saint George Hospital University Medical Center, between November 2010 and July 2017, were reviewed retrospectively. Exclusion criteria for this study included: Patients with preoperative imaging done at other centers, patient age less than 18 years old, solitary kidney, congenital kidney anomalies, chronic renal failure, and incomplete data collection and/or retrieval. Of the 330 patients initially studied, 276 patients were enrolled in this study.

Patients were then divided into 4 groups according to their respective BMI. Group 1 (Normal BMI) included patients with BMI between 18 and 24.9 kg/m^2; Group 2 (Overweight) consisted of patients with BMI between 25 and 29.9 kg/m^2; Group 3 (Obese) comprised patients with BMI between 30 and 34.9 kg/m^2; Group 4 (Morbidly Obese) included patients with BMI more than 35 kg/m^2. These study groups' data was divided into Preoperative, Intraoperative and Postoperative categories each with its own data elements.

Data Components

Pre-operative data included: patient's demographic including age and gender, BMI, Left or right kidney involvement, stone size according to pre-operative CT, stone characteristics, previous stone history, and previous treatment for stones, anticoagulation, pre-operative Hg.

Intra-operative data included: duration of procedure, transfusion requirements, and puncture sites; Post-operative data included: Hg levels post-operatively, analgesia requirements, post-operative KUB for residual stones, discharge dates, and post-operative complications. Residual stones evaluated by post-operative KUB were subcategorized into 3 main categories: Stone free, Residual stone size less than 4mm and Residual stone size more than 4mm.

Procedure

Bull's eye technique is used to access the preferred calyx. Under general anesthesia, the patient is placed in lithotomy position, and a 6 Fr open-end ureteral catheter is advanced into the renal pelvis. Contrast is injected in order to opacify the collecting system. Patient is turned into the prone position. Under C-arm fluoroscopy, the preferred calyx is determined along with the site of incision and angle of puncture. The C-arm fluoroscopy is rotated 30 degrees laterally and 18G diamond-tip needle is held over the targeted calyx and the direction of the needle is confirmed. In case of intercostal approach, respiration is suspended at full expiration while the needle is advanced until it reaches the pelvi-calyceal system. The C-arm fluoroscopy is then medially rotated 90 degrees and the needle is advanced until it reaches the designated calyx. Needle position in the pelvi-calyceal system is confirmed by urine aspiration or by injecting methylene blue through the open-end catheter and detecting the efflux of material from the needle. A sensor™ guide wire (0.35 Fr) is then advanced into the pelvi-calyceal system. Afterwards, a 10F fascial dilator is placed over the guide wire to dilate the tract. High-pressure balloon Nephromax® (Boston Scientific) is then used for a one-step dilatation to 30Fr. Amplatz sheath (30 Fr) is pushed forward over the inflated balloon into the determined calyx. A rigid nephroscope (24 Fr) is introduced into the collecting system; the open-end catheter is identified and then pulled through the Amplatz sheath. A through-and-through safety guide wire is inserted in an antegrade fashion through the open-end catheter. Afterwards, the calculus is identified and fragmented using a lithotripter. The fragments are then retrieved using suction or stone grasper. Stone debris are removed using irrigation with isotonic solution. Successively, visual and fluoroscopic inspection is performed to ensure a stone free status. Under fluoroscopic guidance, a double lumen catheter is then placed over the safety guide wire and another guide wire is then introduced and advanced until it reaches the bladder. A 6 Fr 26 cm or 6 Fr 28 cm double J ureteral stent is then placed. Finally, nephrostomy tube (22 Fr) is placed draining the kidney into a collecting bag.

In case of intercostal approach a Chest X-ray is performed directly in the recovery room and routinely on the first postoperative day. A plain X-ray KUB is also performed to document stone clearance. Patients with no calcifications or with residual stones < 4 mm are considered stone-free. The nephrostomy is finally clamped and removed if the postoperative film was satisfactory.

Results

Patient characteristics

After applying exclusion criteria, data on 276 patients were analyzed, of whom 72(26%) had normal BMI, 112 (40%) were overweight, 80(29%) were obese, and 12(5%) were morbidly obese. No statistical significance was found among the study groups in terms of left or right kidney involvement (p=0.45), stone characteristics, history of stones (p=0.11), previous stone treatment, and preoperative anticoagulant use (p=0.089). No statistical significance was found in terms of staghorn stone occurrence among the different study groups (p=0.326).

Intraoperative

Access to the renal collecting system was achieved by an urologist in most cases. In terms of access tract location whether subcostal or intercostal, no significant difference was observed among the study population (p=0.068). Mean operative time was 84.39mins in normal BMI group, 85.44mins in overweight patients, 97.31mins in obese group and 122.5mins in the morbidly obese population (p=0.01). The mean hemoglobin change was 1.79, 1.52, 1.6 and 1.49mg/dl, respectively (p=0.788). No significant difference was observed between the groups in intraoperative related complications. No single case of pneumothorax was observed (Table 1).

Postoperative

Postoperative factors that were studied included stone free rates, transfusion requirements, post op pain requirements and postoperative complications in addition to need for subsequent procedures for residual stones. Stone free rates were assessed according to postop KUB done systematically on patients who have undergone PCNL. Complications were divided according to the Clavien-Dindo Classification and results of overall complications post op were studied. Subsequent procedures were defined as procedures that were required for residual stones post PCNL. No statistical significance was found with respect to transfusion requirements among the study groups with a total of 15 patients requiring transfusions (p=0.103). As for analgesia requirements post op a total of 93 patients required

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Pethidine administration with p=0.523 across the 4 population groups. Results of postop KUB used to show stone-free rates demonstrated no significant difference among the different BMIs (p=0.268). As for the need of subsequent procedures for residual stone, it was shown that increasing BMI was not associated with an increase need for subsequent procedures (p=0.353). In terms of hospital stay requirements, no significant difference was found for D/C day of the 4 different study groups by BMI with p=0.87 with most patients being discharged at day 2 post op. No significant difference (p=0.07) was found among normal, overweight, obese and morbidly obese groups in overall complication rates (Table 2).

Table 1 Observations.

Intraop Duration	N	Mean	Std. deviation	Minimum	Maximum	P-value
Normal	72	84.39	32.34	30	200	0.011
Overweight	112	85.45	29.91	25	180	
Obese	80	97.31	49.21	30	300	
Morbidly Obese	12	122.5	115.55	45	460	
Total	276	90.22	44.04	25	460	

Table 2 Observations

	%Normal Wt	%Overweight	%Obese	%Morbidly obese	P Value
Gender					
Male	49.3	81.25	60.98	42.86	
Female	50.6	18.75	39.02	57.14	
Anticoagulant use	4	16.07	12.2	14.29	0.0895
Stone Side					0.454
Left	50.67	55.36	60.98	41.67	
Right	49.33	44.64	39.02	58.33	
Staghorn	24	16.96	19.51	35.7	0.326
Access tract	-	-	-	-	0.068
Intercostal	62.32	46.67	57.33	76.92	
Subcostal	37.68	53.33	42.67	23.08	
Stone Free	52.05	62.16	66.25	50	0.268
Subsequent procedure	16	16.07	8.54	7.14	0.353
Transfusion	8	1.79	8.54	0	0.103
Dolosal Analgesia	37.3	28.57	32.93	42.86	0.523
Clavien-Dindo					0.07
I	5.33	0.89	3.66	0	
II	5.33	12.5	2.44	7.14	
III	1.33	1.79	3.66	14.29	
IV	0	0.89	0	0	

Discussion

Our study investigated the preoperative and intraoperative factors in addition to postoperative outcomes of patients, stratified according to BMI, who underwent prone PCNL by a single endourologist using a standardized technique. This study showed no significant difference in terms of postoperative outcomes of PCNL between patients with increasing BMI and patients of normal BMI.

This highlights the fact that prone positioning in PCNL is in fact safe and feasible with patients that are overweight or obese. In an article serving as a comprehensive review for the debate over PCNL positioning, Duty B et al.[7] discussed that both positions are reasonable each with its own advantages and disadvantages. Prone position was recommended in patients with BMI>35, this is due to better access to the collecting system, decreased risk of visceral organ injury, shorter access tract and decreased risk of blood loss.

The CROES Percutaneous Nephrolithotomy Global Study tackled the issue of the influence of BMI on the outcome of PCNL and showed that an increased BMI was associated with more comorbidity that in turn increases stone prevalence. The CROES study demonstrated a

decrease in the use of supracostal access for obese patients.[6] This was not the case in our study population were no statistical significance was found between the access tract among the different study groups (p=0.068). This may be explained by the unified prone positioning technique used by a single urologist with the aid of anesthesiologists in maintaining full expiration while the needle is advanced into the pelvicaliceal system.

In this study, the duration of PCNL appears to increase with an increase in BMI (p=0.01). This is in line with the results of other studies including the CROES study showing that intraoperative time is increased with increasing BMI. Ortiz et al.[8] discussed that the total operative time and radiation time increases along with BMI. This may be explained by the higher stone burden in obese patients who are at a higher risk of developing metabolic syndrome giving them a higher propensity for bigger stones as previously explained, in addition to a more difficult body habitus for percutaneous access. Preoperative considerations and instrument modifications were suggested for overcoming certain challenges; those included using the shortest possible access tract, extra long access sheaths, wide incision of the skin and subcutaneous tissue in addition to postoperative drainage with nephroureteric tubes rather than with nephrostomy tubes.[9]

In terms of blood transfusion rates, obesity was not associated with an increase need of blood transfusions. This study showed that transfusion requirements among the 4 groups was not statistically significant (p=0.103). In their article, blood transfusion, embolization and nephrectomy after PCNL, Keoghane SR et al.[10] concluded that the risk of transfusion is associated with increasing patient age (>60), operative duration, and a positive preoperative urine culture.

Our results showed no significant difference regarding the tendency of staghorn calculus formation among the studied population. This was not the case with Fuller et al, who stated that there is a higher rate of partial and complete staghorn calculi in the obese and morbidly obese.[6]

One of the most debated topics in PCNL is the use of subcostal v/s intercostal access and its safety issues especially for patients with increasing BMI. Our study showed that no significant difference in the use of subcostal or intercostal access among the study groups. The debate over access is due to a more postulated risk of pneumothorax and hemothorax with intercostal access. This risk is extrapolated for patients with increasing BMI. In our study, the risk of pneumothorax and hemothorax was 0% across all the study groups. This is in accordance with a recently published article studying non-angled intercostal access under full expiration. In their article, Ajib , Matta, Zougheib, &Jabbour (2017)demonstrated that intercostal approach under full expiration is in fact safe and allows better access to the intrarenal collecting system with minimal complications.[11]

Although no significant difference was observed in terms of overall complications, morbidly obese patients had the highest percentage of > Class II complications (14.29%). This was also shown in the CROES study of the influence of BMI on outcome where there was a higher rate of major complications in super obese, but overall there was no difference. In fact in our study, stone free rate was comparable across the different BMIs with p=0.268. One way to assess intraoperative bleeding in PCNL is the use of pre and post PCNL Hemoglobin levels.[12] The delta hemoglobin computed showed no difference in assessing intraoperative bleeding with p=0.78. In the literature there exists evidence that prone positioning leads to hemodynamic changes and respiratory dysfunction,[13] however our data suggests no increased risk with obese patients.

Hospital stay in light of all that has been stated seemed to be uniform across the different BMI groups with most patients being discharged day 2 post the procedure. Fuller et al.[6] stated that obesity had no influence on the duration of hospital stay. One would expect that an increase in BMI is associated with a higher rate of re-intervention for residual stone,[14] but this study demonstrated no statistical difference in the need for a subsequent procedure. (p=0.353)

Limitations of our study include its retrospective study design, medium population size and being a study limited to a single institution. Another drawback not using CT scan for a better postoperative stone-free rate assessment and this is due to financial and practical reasons.

Conclusion

PCNL has been established to be the mainstay treatment for large and complex renal stones. Our study categorized patients who have undergone PCNL in our institution into 4 categories according to BMI. To our best knowledge, this is the 1st study done in the Middle East comparing preoperative, intraoperative and postoperative elements of patients who have undergone PCNL categorized according to BMI. Our study has shown that PCNL is in fact safe and feasible in patients with BMI>25 but with longer operative time. No increase in the rate of complications, transfusion requirements or the need for subsequent procedures for patients with a high BMI. This iterates the fact that PCNL done in prone positioning with our specific technique is in fact safe and efficacious in patients with a high BMI.

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Conflict of interest

Authors declare there is no conflict of interest in publishing the article.

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