Complete Ultrasound-guided Percutaneous Nephrolithotomy in Prone and Supine Positions: A Randomized Controlled Study

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OBJECTIVES To evaluate the safety, efficacy, adverse events, and feasibility of ultrasound guided percutaneous nephrolithotomy (US-PCNL) in the management of large renal stones in supine and prone positions and to point out the practical considerations related to these techniques in comparison with standard PCNL.

PATIENTS AND METHODS This study was conducted between August 2013 to September 2018 as a prospective randomized and controlled study. A total of 392 consecutive patients with nephrolithiasis >2 cm were randomly assigned to undergo ultrasound PCNL in prone (P-US-PCNL) (132 patients); supine position (S-US-PCNL) (129 patients) or conventional PCNL (C-PCNL) (131 patients). The preoperative parameters, the intraoperative findings, operative time, hospital stay, perioperative morbidities, stone free rate, and related data were recorded.

RESULTS The demographic and the baseline characteristics were comparable in all study groups. The mean number of trails and time for successful puncture in P-US-PCNL, S-US-PCNL, and C-PCNL were 1.9 ± 1, 2.3 ± 1.2, and 1.7 ± 1, respectively ($P < .001$), and 15.8 ± 5.8, 19.3 ± 9.4, and 16.5 ± 8.1 seconds, respectively ($P < .001$). The operation time was 69 ± 22, 75 ± 23, and 72 ± 27 minutes, respectively, ($P > .05$). The mean nephrostomy time and length of hospital stay were 3 ± 1.3, 3.4 ± 1.5, 3.2 ± 1.2 hours, respectively, and 3.8 ± 1.5, 4.1 ± 1.5, 3.9 ± 1.3 days, respectively ($P > .05$). The mean percentage decrease in hemoglobin concentration was 1.65 ± 0.66, 1.77 ± 0.78, and 2.1 ± 0.9, respectively ($P < .001$), overall stone clearance was 88%, 79%, and 85%, respectively ($P > .05$). Complications were acceptable and similar between groups.

CONCLUSION US-PCNL either in prone or supine position is as effective, feasible, and safe as C-PCNL with zero radiation exposure. UROLOGY 128: 31−37, 2019. © 2019 Elsevier Inc.

Percutaneous nephrolithotomy (PCNL) is one of the most common and effective methods used for removal of large renal calculi.[1] PCNL traditionally utilizes fluoroscopy for visualizing the renal stone, creating renal access, dilating the working tract, and ensuring stone clearance.[2] It was claimed that the ideal puncture should develop a straight tract through a papilla of the targeted calyx into the renal pelvis.[3] Although the fluoroscopic guided access is the gold standard in management of renal stones, it has several disadvantages including the inadequate visualization which can result in potentially serious injury of adjacent structures during the procedure.[4] In addition, this fluoroscopically-guided technique imposes the potential risk of exposure of patient, surgeon, and personnel to high doses of radiation and its adverse effects.[4] In response to substantial increases in radiation doses associated with this procedure, the Food and Drug Administration has listed fluoroscopy as one of the modalities that requires optimization to comply with the recommended ALARA (as low as reasonably achievable) principle.[5] Furthermore, the contrast media (CM) used for identification of pelvicalyceal system (PCS) during C-PCNL may have side effects ranging from itching to a life-threatening emergency, known as contrast-induced nephropathy.[6]

The adverse effects of fluoroscopy-guided techniques prompted urologists and interventional radiologists to use alternative methods to manage kidney stones and to minimize these adverse effects.[7]

In contrast to C-PCNL, US-PCNL provides continuous real time control during puncture with accurate localization of radiolucent stones and it does not require

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administration of CM.[7] In addition, utilization of US-PCNL overcomes the problem of unsuccessful retrograde ureteral catheterization, which is essential for contrast injection during C-PCNL.[8] Another critical advantage of US-PCNL is that US provides 3-dimensional picture during puncture, while fluoroscopy provides only 2-dimensional one, and thus allowing the accurate imaging of all tissues/viscera like intestines and lungs along the intended tract.[8,9]

Also US allows possible imaging in numerous planes simply by shifting, tilting, and rotating the scanning head.[9] In addition, it reduces puncture attempts, shortens the procedure time and evades patients the hazards of CM.[10] Another advantage of US is B-mode scanning, as the kidney has a high intrarenal vascular network, so US can be used as a tool for localization of these vasculature to avoid its inadvertent puncture thus reducing the risk of bleeding.[11]

To this end, published studies comparing US-PCNL in supine and prone positions with the C-PCNL is scarce. Thus, we carried out this prospective, randomized controlled study to compare the feasibility, safety, efficacy, and complications of supine and prone US-PCNL with the gold standard C-PCNL in management of large renal stones in Egyptian patients.

PATIENTS AND METHODS

This prospective randomized controlled study was performed at urology department, Benha University Hospitals, Egypt. Patient's enrolment started from August 2013 to September 2018 after the approval of the study protocol by local Research Ethics Committee (REC-FOMBU), which is an independently organized committee operating according to international guidelines including the Declaration of Helsinki. Sample size was calculated by Epi Info 7 (WHO, Geneva, Switzerland), with CI of 95%, 5% α error and a power of 80% and population proportion of 90%. Calculated total sample size was 324 at minimum (108 per group). Accounting for the possible attrition, and to avoid type I error we raised the allocated patients to 135 patients in each group.

Informed consent was obtained from each subject, and all procedures were performed by 2 experienced surgeons (W.E. and W.K.) in accordance with the Helsinki Declaration. The demographics information of the participants, including; age, sex, body mass index (BMI), laterality, grade of hydronephrosis, Guy's stone score, stone volume, type and density were recorded. Detailed history of patients including; comorbidity, medical, and surgical history was also recorded.

Inclusion criteria: consecutive, adult patients (age 18-70 years) with renal stones diameter of at least 2 cm and American Society of Anesthesiology score $\leq$ 2.

Exclusion criteria: patients with renal anomalies, transplanted kidney, uncorrected coagulopathy, or active infection.

Preoperative evaluation: included history, physical examination, laboratory investigations (urine analysis, culture and sensitivity, coagulation profile, complete blood count, serum urea and creatinine) and imaging studies (included abdominal-pelvic US, kidney, ureters and bladder radiography (KUB), and noncontrast spiral CT).

Patient's randomization: the balanced randomization [1:1:1] method was used to assign the recruited patients into either 1 of the treatment groups.

Surgical technique

A single intravenous dose of ceftriaxone was given preoperatively. The patient was placed in the lithotomy position and a 6 Fr ureteral catheter was passed into PCS by cystoscope under general or spinal anesthesia.

For US-PCNL, Toshiba CoreVision pro machine with 3.5 MHz probe (SSA-350 Toshiba, Tokyo, Japan) was utilized. Initially, renal US scanning was performed to confirm stone size, location, skin to stone distance and for detection of possible intervening organs to avoid its injury. Puncture of the kidney was performed either in prone or complete supine positions. For the prone position, a needle-guide attached to the probe was used and therefore the trajectory of the needle is precisely represented in the screen by dotted line (sonoline) (Fig. 1A & B). While in supine position, a free hand technique was used, and the probe was firmly applied against anterior abdominal wall to minimize medial renal displacement (Fig. 1C). We distend PCS by retrograde instillation of saline for better visualization. The puncture of desired calyx was performed using with 18-gauge diamond tip graduated puncture needle. The efflux of urine after trocar removal confirmed its correct position. The tract length (as the needle used as a ruler) and angle were recorded and engraved in mind, then a 0.038-inch J-tip guidewire was sent into PCS. If multiple tracts were intended, so insertion of multiple guidewires into different calyces and secure them to the skin except the initial one for primary tract formation.

A small incision, alongside the needle was made. The antenna of the metallic dilators was passed into the PCS on the wire in the same angle and for the same length. Then one-step tract dilatation with 30-F Teflon dilator. Lastly an Amplatz sheath was inserted into PCS. All these steps were US-monitored.

Nephroscopy was performed with a 26-F nephroscope (Karl Storz, Tuttlingen, Germany), and the stones was fragmented by pneumatic lithotripter (Lithoclast Richard Wolf GmbH, Knittlingen, Germany). Stones and fragments were removed by forceps or zero-tip baskets.

At the end of the maneuver, US was used to ensure clearance of the stone, and insertion of 18F nephrostomy tube (Fig. 1D).

C-PCNL was performed while the patient in prone position. The steps were the same as aforementioned for US-PCNL except C-Arm (BV Libra Mobile C-Arm, Philips Medical Systems, Best, the Netherlands) was used to guide the procedure.

Patients who required a second look were operated in a similar way as the initial assigned treatment.

Postoperative follow-up

KUB, US and noncontrast spiral CT were performed for each patient at first postoperative day, then 4 weeks and 3-months later; for evaluation of stone free rate (SFR). Tubes and catheters were removed in a stepwise manner.

Intraoperative data including the number of attempts and time to access into PCS, operative time (time elapsed from initial attempt for PCS puncture until nephrostomy tube placement), intraoperative difficulties, and complications were rerecorded.

The decision of performing a second procedure was determined based on the presence of clinically significant residual fragments as well as the number, location, and accessibility of the residual stone(s) as determined by first postoperative evaluation. Adverse

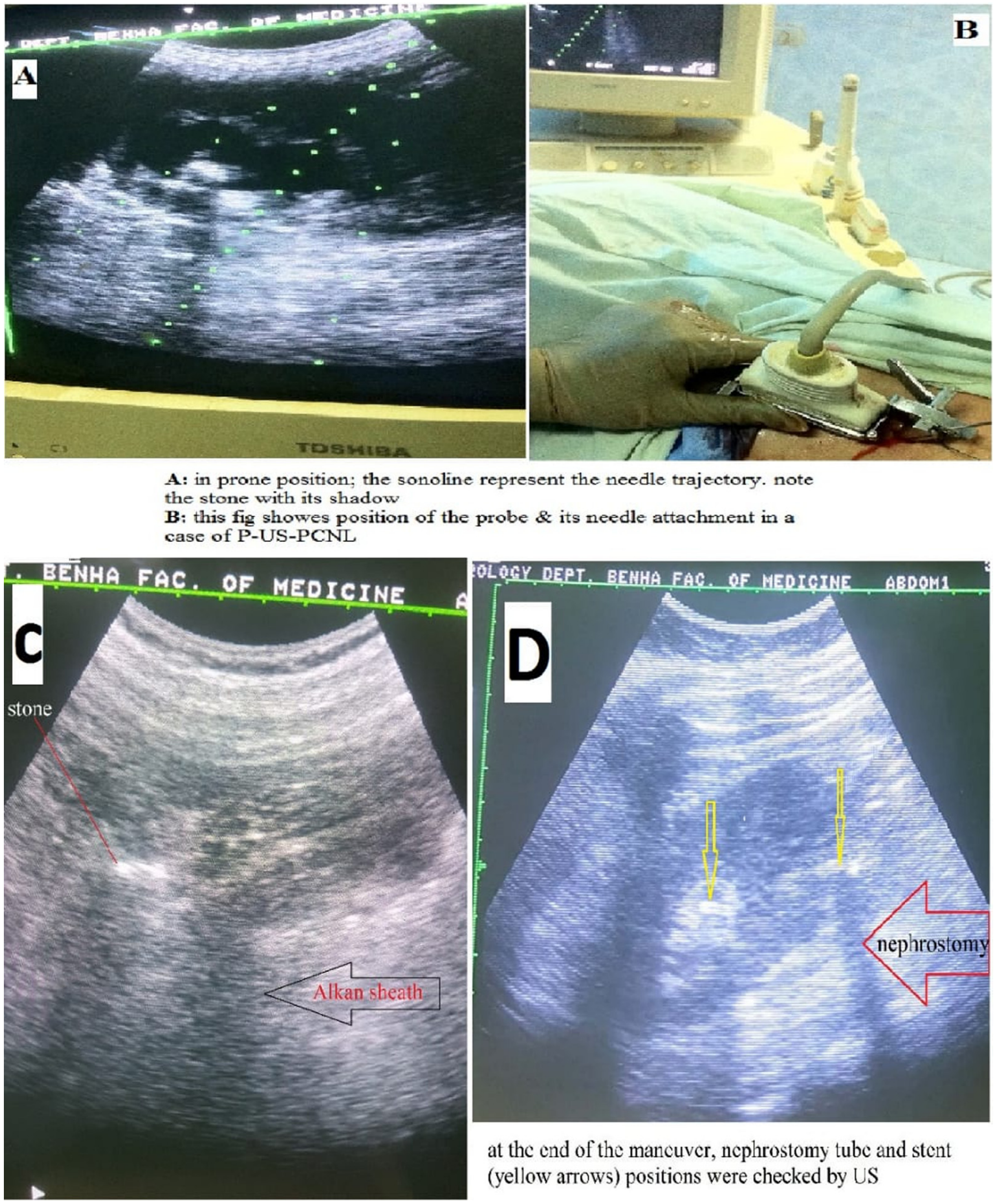

Figure 1. (**A**, **B**) Picture represents a case of US-PCNL in prone position. (**C**) This figure represents a case of US-PCNL in supine position with the Amplatz sheath in the targeted calex habouring stone. (**D**) The picture shows the ureteric catheter and nephrostomy tube at the end of S-US-PCNL. (Color version available online).

events and the need for auxiliary or additional maneuvers were noted and recorded

STATISTICAL ANALYSIS

SPSS 20 (IBM, Armonk, NY, USA) was the platform of statistical analysis. Continuous data were expressed as mean ± SD and analyzed by one-way ANOVA and a Post *Hoc* test. Categorical data shown as number and/or percentage and were analyzed using Fisher's exact or Chi-square tests when appropriate. A 2-sided $P < .05$ was the indicator for statistical significance.

RESULTS

During the study period, 486 consecutive patients were recruited. Out of this number, only 392 patients fulfilled inclusion criteria of the study and agreed to sign the informed consent (Supplementary Fgure). The patients were randomly assigned into 1 of the following treatment groups:

Group I: 132 patients underwent complete P-US-PCNL.

Group II: 129 patients underwent S-US-PCNL in complete supine position.

Group III: 131 patients underwent C-PCNL.

Table 1. Demographic and preoperative clinical characteristics of the patients

Parameters	P-US-PCNL Group ($n = 132$)	S-US-PCNL Group ($n = 129$)	C-PCNL Group ($n = 131$)	P value
Age, (years; mean ± SD)	39.6 ± 9.6	38.8 ± 11	40.6 ± 10.8	.920
Sex (male/female)	89/43	91/38	90/41	.861
Laterality (Rt / Lt)	79/53	70/59	71/60	.571
BMI (kg/m^2, mean ± SD)	27.9 ± 3.2	28.8 ± 3.4	28.3 ± 3.3	.092
Comorbidities, *n* (%)				.702
Hypertension	18 (13.6)	24(19.4)	22(16.8)	
Diabetes mellitus	16 (12.1)	11 (8.5)	13(9.9)	
Previous renal stone surgery, *n* (%)	17 (13%)	13 (10%)	19 (14.5%)	.551
Hydronephrosis Grade, *n* (%)				.879
None	17 (13)	24 (18.6)	19 (14.5)	
Mild	45 (34)	42 (32.6)	45 (34.4)	
Moderate	58 (44)	51 (39.5)	52 (39.7)	
Severe	12 (9)	12 (9.3)	15 (11.5)	
Stone size (mm; mean ± SD)	31.2 ± 8.9	32.2 ± 9	33.6 ± 9.9	.116
Guy's stone score (M ± SD)	1.8 ± 0.96	1.77 ± 0.99	1.82 ± 1	.590
Stone density (HU; mean ± SD)	861 ± 229	915 ± 263	900 ± 253	.201
Stone type, *n* (%)				.679
Single	70 (53)	59 (45.7)	71 (54.2)	
Multiple	46 (35)	52 (40.3)	46 (35.1)	
Staghorn	16 (12)	18 (14)	14 (10.7)	

The detailed demographic characteristics of the participants are indicated in Table 1. There were no statistically significant differences in the age, sex, BMI, comorbidities, Guy's stone score, and stone type among the groups assigned for treatment with P-US-PCNL, S-US-PCNL, or C-PCNL.

Similarly, the 3 groups were similar with regard to stone diameter (31.2 ± 8.9, 32.2 ± 9 and, 33.6 ± 9.9, respectively ($P > .0.5$). Likewise, patients in 3 groups before undergoing the designated procedure had comparable hydronephrosis grade, stone density (861 ± 229, 915 ± 263 and, 900 ± 253, respectively ($P \geq .0.5$).

With regard to the primary endpoint of our study which is SFR, our results demonstrated that there are no statistically differences in SFR among the 3 groups ($P > .05$).

Concerning the secondary endpoints, our data demonstrated that the mean trail times for successful puncture were significantly higher in S-US-PCNL group as compared to P-US-PCNL and C-PCNL groups ($P < .001$) (Table 2). The mean time for successful puncture was significantly longer in S-US-PCNL group (19.3 ± 9.4 seconds) compared to US-PCNL or C-PCNL group (15.8 ± 5.8, 16.5 ± 8.1 seconds, respectively) ($P = .001$) (Table 2).

Of note, in some cases (60 patients) multiple punctures were done followed by insertion of guide wire. Of those patients, only 43 cases required additional tract creation to complete stone clearance.

Tract creation was successfully performed in all patients of all groups except 1 patient in the S-US-PCNL group and 2 patients in the P-US-PCNL group who had the guide wire in PCS and on nephroscopy time the Amplatz sheath was outside the system, so the correct tract was created under direct vision following the guidewire then the Amplatz sheath was slide over the nephroscope and the procedures were continued safely. The length of working tract was significantly longer in S-US_PCNL group as compared with the corresponding value in P-US-PCNL and C-PCNL groups (100 ± 23 mm vs 87.2 ± 15.4 and 89.6 ± 16.3 mm, respectively, $P < .001$) (Table 2).

For the postoperative variables, the mean percent of hemoglobin drop was 1.65 ± 0.66, 1.77 ± 0.78 g/L, and 2.1 ± 0.9 g/L ($P < .001$) in S-US-PCNL; P-US-PCNL and C-PCNL group, respectively (Table 2). This result implies that there was more blood loss in C-PCNL group compared with other groups.

In terms of 30-day postoperative complications, the complications were classified according to modified Clavien grading system.[12] Our results demonstrated that there is no significant difference in the overall complications among the 3 groups (Table 3). Thus, the incidence of postoperative adverse events were observed in 29 (22%), 19 (14.7%), and 23 (17.6%) patients in P-US-PCNL, S-US-PCNL, and C-PCNL, respectively (P > 0.05) (Table 3). These adverse events were managed as follow: 2 patients (0.5%) who had their nephrostomy tubes displaced were observed and required no additional treatment. Thirty-seven (9.4%) cases experienced postoperative fever which was managed with antipyretic drugs only. Fourteen (3.6%) patients had blood transfusions, and 2 (0.5%) of them had repeated attacks of bleeding who were amenable for angioembolization. Twenty-one (5.4%) patients had urinary tract infection (UTI) and treated by antibiotic according to their culture & sensitivity. In 8 (2%) patients, the maneuvers were stopped because of excessive bleeding that rendered the vision blurred and expected increase risk of perforation and transfusion. Thus, the procedures in these patients were postponed for second look several days later. Only 1 patient (0.3%) in C-PCNL group had descending colonic perforation which was discovered in the second look session and managed by Double-J stenting and withdrawal of nephrostomy tube to be as a colostomy. In P-US-PCNL group, 1 patient developed myocardial infarction in postoperative day 1 who admitted to cardiac care unit. Urosepsis has been developed in 3.1% of all cases (3.8% in P-US-PCNL, 0.8% in S-US-PCNL, and 4.6% in C-PCNL group ($P = .172$). Those patients required intensive monitoring and support. Renal loss, conversion to open surgery, or death had never occurred in any of different treatment groups.

COMMENTS

Proper puncture of the desired calyx is the key step of felicitous PCNL. It composes with tract dilatation the

Table 2. Operative data

Parameter	P-US-PCNL Group (*n* = 132)	S-US-PCNL Group (*n* = 129)	C-PCNL Group (*n* =131)	*P* value
Puncture attempts median (range)	2 (1 - 4)	2 (1 - 6)	1 (1 - 4)	*>.001**
Access time (seconds; mean ± SD)	15.8 ±5.8	19.3 ±9.4	16.5±8.1	*.001***
Working tracts *N* (%)				*.701*
• Single	121 (92)	114 (88.4)	114 (87)	
• Multiple	11 (8)	15 (11.6)	17 (13)	
Targeted calyx, *N* (%)[∞]				.073
• Lower	98 (74)	100 (77)	112 (85)	
• Middle	33 (25)	27 (21)	21 (16)	
• Upper	9 (7)	4 (3)	8 (6)	
Tract length (mm; M ± SD)	87.2 ± 15.4	100 ± 22.8	89.6 ± 16.3	*>.001*[¶]
Operative time (minute; mean ± SD)	69 ± 22	75± 23	72 ± 27	*.095*
Hemoglobin drop (g/dL; mean ± SD)	1.65 ± 0.66	1.77 ± 0.78	2.1 ± 0.90	*>.001*[◆]
Nephrostomy time (days; mean ± SD)	3 ± 1.3	3.4 ± 1.5	3.2 ± 1.2	*.087*
Hospital stay (days; mean ± SD)	3.8 ± 1.5	4.1 ± 1.5	3.9 ± 1.34	*.190*
1ry SFR; *N* (%)	86 (65.2)	73 (56.6)	81 (61.8)	*.431*
Ancillary procedure; *N* (%)				*.843*
• Second look PCNL	13 (9.8)	21 (16.3)	19 (14.5)	
• ESWL	6 (4.5)	5 (3.9)	6 (4.6)	
• URS	3 (2.3)	2 (1.6)	3 (2.3)	
Final SFR, *N* (%)	116 (88)	102 (79)	111 (85)	*.146*

* P-US-PCNL vs S-US-PCNL, $P = .003$; P-US-PCNL vs C-PCNL, $P = .365$; S-US-PCNL vs C-PCNL, $P < .001$.
** P-US-PCNL vs S-US-PCNL, $P = .001$; P-US-PCNL vs C-PCNL, $P = .844$; S-US-PCNL vs C-PCNL, $P = 26$.
¶ P-US-PCNL vs S-US-PCNL, $P < .001$; P-US-PCNL vs C-PCNL, $P = .508$; S-US-PCNL vs C-PCNL, $P < .001$.
◆ P-US-PCNL vs S-US-PCNL, $P = .478$; P-US-PCNL vs C-PCNL, $P = .023$; S-US-PCNL vs C-PCNL, $P < .001$.
∞ Some cases have initial punctures into multiple calyces.

most challenging part of the procedure besides its steep learning curve.[13] Recently, percutaneous access to PCS is often guided by fluoroscopy, and/or US. Each of these modalities has its advantages and disadvantages. Fluoroscopic images are biplanar and expose the patient and operative theater staff to radiation. While US images often blurred, but do not impose any risk for the patient or medical personnel.[14]

C-PCNL requires administration of CM which may cause morbidity or may overcast the stone. In addition, CM may cause confusion if there is extravasation due to inability to delineate the PCS.[15] Up till now, the position of choice during PCNL is the prone position as it provides a wider space for puncture and better field and therefore it allows easier manipulation of the nephroscope.[16] However, this position displays several disadvantages including uneven weight distribution that may lead to cardiopulmonary problems, especially in obese and cardiac patients. Indeed, this position is prohibited in patients with pulmonary or circulatory impairment. In addition, the prone position interferes with management of airway during the procedure and repositioning of the patient needs many assistants.[17]

Table 3. Summary of 30-days postoperative adverse events and their incidence in study subjects, *N* (%)

Complication *N* (%) *According to Modified Clavien Classification of Complications*	P-US-PCNL Group (*n* = 132)	S-US-PCNL Group (*n* = 129)	C-PCNL Group (*n* = 131)	*P* value
Overall,* I: IVB	29 (22)	19 (15)	23 (17.5)	.309
I: Deviation from normal course with no need for intervention				
Nephrostomy tube displacement	0 (0)	2 (1.6)	0 (0)	.129
Postoperative Fever	14 (10.6)	10 (7.8)	13 (9.9)	.713
II: *Minor complications requiring treatment*				
Bleeding required transfusion	4 (3)	2(1.6)	8 (6)	.130
Urinary tract infection	7 (5.3)	5 (3.9)	9 (6.9)	.563
IIIA: *Complications requiring intervention without general anesthesia*				
Obstruction required Double-J insertion	2 (1.5)	4 (3.1)	1 (0.8)	.349
Hydrothorax required drainage	3 (2.3)	0 (0)	2 (1.5)	.250
IIIB: *Complications requiring intervention with general anesthesia*				
Bleeding required quitting the operation	1 (0.8)	2 (1.6)	5 (3.8)	.191
Pseudo-aneurism required angio-embolization	0 (0)	0 (0)	2 (1.5)	.135
Colon perforation	0 (0)	0 (0)	1 (0.7)	.368
IVA: *Life-threatening complications requiring intensive care* *(single organ)*				
Myocardial infarction	1 (0.8)	0 (0)	0 (0)	.373
IVB: *Multiorgan dysfunction*				
Urosepsis	5 (3.8)	1 (0.8)	6(4.6)	.172

* **N.B:** *Some patients had simultaneous complications.*

Supine PCNL was firstly described by Valdivia et al in the 80s of last century. This position has several advantages especially for individuals of high risk for anesthesia. By time, the supine position has gained popularity and it is widely used by many urologists to abolish the unfavorable effect of the prone position. Nonetheless, still there is a controversy and ambiguity regarding the comparative efficacy and safety of supine and prone positions during PCNL in patients without comorbidity.[18]

In the current study, our results revealed that operative time was similar in P-US-PCNL, S-US-PCNL, or C-PCNL group. This is in agreement with previous findings by Yan et al.[19] However, a large multicentric study by Valdivia et al reported significantly lower operative time for prone versus supine PCNL.[20]

Our data also revealed that the number of attempts for successful PCS punctures and the access time were significantly higher in S-US-PCNL compared with the corresponding values in either P-US-PCNL or C-PCNL. It is likely that the reasons for this significant difference may be attributed to the fact that in P-US-PCNL procedure the needle trajectory is accurately determined by the sonoline on the screen. This technique is more helpful and accurate for assessing depth and pass of the puncture needle.[3,21] On the other hand, in S-US-PCNL procedure, free hands technique was adopted. In addition, there is excessive medial renal movement in the supine position, therefore we used only diamond tipped needles with some pressure against abdominal wall to partially overcome this problem. This observation was supported by another finding in this study which is the length of working tracts which is significantly longer in supine group than in the 2 prone group. So, S-US-PCNL may convey more challenges than prone US-PCNL.

With regard to transfusion rates, the overall transfusion rate was 3.6 % and there was no statistically significant difference in the transfusion rate between the 3 groups. Meanwhile, in patients managed by C-PCNL the blood loss (reflected by hemoglobin drop) was significantly higher than the other 2 groups. This may be due to doppler utilization in US-PCNL to avoid the injury of main vasculature during puncture. This finding is similar to the result of a recent meta-analysis which concluded that the hemoglobin drop was significantly lower in US-PCNL compared with fluoroscopic PCNL, while transfusion rate was nonsignificantly less in US.[22]

In another meta-analysis by Wang et al, it is concluded that both blood transfusion rate and intraoperative blood loss were significantly lower in US-guided group than fluoroscopic-guided one.[23] Similarly, in a randomized study, Zhu et al demonstrated that PCNL under US, C-Arm or combined guidance were associated with no significant difference in mean blood loss between the 3 modalities. The discrepancy between our results and the findings by Zhu et al could be because their procedures performed using mini-PCNL.[24]

Concerning the length of the hospital stay, our results demonstrated that there were no statistical significant differences in length of hospital stay between the different study groups. This is in agreement with the results of Basiri et al who have reported that the mean hospital stay for their patients was 3.7 ± 1.15 days.[25] Another 2 studies compared US-PCNL and C-PCNL demonstrated that there was no significant difference in hospitalization time between the 2 groups with shorter hospital stay than in our study (their mean hospitalization time ranged between 2.5 and 2.9 days) this may be due to that they operated only on single nonstaghorn stones.[26,27]

Regarding SFR, our study showed that the primary SFR was comparable between the 3 arms of the study. These rates were raised after additional auxiliary procedure. Indeed, some authors claimed that primary SFR range from 55% to 100% which increased after additional procedures with a trivial nonstatistically significant difference between fluoroscopy and US arms.[21,22,24,27] On contrary, a meta-analysis by Wang et al revealed that US-PCNL had better SFR than C-PCNL (P = .03).[23]

Adverse events during PCNL such as, nephrostomy tube slippage, transient fever which is reported as most common one, UTI, pneumonia, sepsis, pleural injury, persistent urinary leakage perirenal hematoma, pseudoaneurysm, conversion to open surgery, colonic perforation, nephrectomy, septic shock, and even deaths have been reported.[19,24,27-29] In our study, the complication rates were similar in P-US-PCNL, S-US-PCNL, and C-PCNL groups. Indeed, these results are comparable to that obtained from a large, global, multicentric prospective study performed on 5803 patients by The Clinical Research Office of the Endourological Society.[30] Similarly, another large Pakistan series had reported complications rate similar to reported rate in our study.[29] Also, Valdivia et al gathered results from 96 centers all over the world, they reported that complication rates in supine and prone PCNL were about 20%.[20]

It is worth noting that colon perforation was occurred in 1 patient from C-PCNL group in our current series which is in accordance with nearly all published data. This type of complication usually does not occur neither in supine PCNL nor with US guided PCNL which is a clear advantage of these techniques.[19,20,22,27,28] In 1 series study, the colonic perforation was reported in a patient who underwent a PCNL guided by combined US and C-Arm during second tract creation, the authors explained what happened by the kidney structure and needle tip were poorly visualized during additional tract formation.[24]

Based on the findings of this randomized controlled study in nearly 400 patients, the current standard practice of using US is a reliable tool of guidance during PCNL.

CONCLUSION

US-PCNL either in prone or supine position is as effective, feasible, and safe as conventional PCNL, it obviates radiation exposure and its hazards, besides less blood loss. It is worth mentioning that this conclusion from our cohort study may not be generalized to other cohorts with different patient characteristics

SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.urology.2019.03.004.

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