Safety and efficacy of ultramini percutaneous nephrolithotomy in comparison with standard percutaneous nephrolithotomy for management of renal calyceal calculi 1–2 cm in size: a comparative randomized prospective study

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Background
The management of renal stones, one of the most prevalent urological issues, can be accomplished using a variety of techniques, including flexible ureteroscopy, laser lithotripsy, extracorporeal shockwave lithotripsy, standard percutaneous nephrolithotomy (S-PCNL), and mini and ultramini percutaneous nephrolithotomy (UM-PCNL), Despite the rising stone clearance rates, S-PCNL remains the therapy of choice for managing renal calculi in spite of its higher complication rate.

Aim
The purpose of this study was to compare the differences between the two procedures in terms of stone-free rate, the length of the procedure, the length of the hospital stay, the cost of the procedure, and any operative complications such as blood loss, the requirement for blood transfusions, and extravasation or urine leakage.

Patients and methods
This comparative study was conducted in Ain Shams University Hospitals from January 2020 till January 2022 and included 60 patients with renal calyceal stones. Their age ranged from 18 to 60 years. They were divided into two groups, with 30 patients in each group: one of them underwent S-PCNL and the other one underwent UM-PCNL.

Results
When compared with PCNL, UM-PCNL is a viable alternative for the management of renal stones. In group A (PCNL), the stone-free rate was 96.7%, whereas in group B, the rate was 90%. Only 3.3% of patients in group B experienced postoperative fever, compared with 10% of patients in group A. In group A, the mean operating time was 71.40±24.02 min, but in group B, it was 108.73 ±41.61 min. In group A, the mean hospital stay was 64.80±20.14 h, but in group B, it was 42.53±13.23 h. The mean cost in group A was 11091±644.64 pounds, whereas it was 14 890±1098.26 pounds in group B.

Conclusion
The gold standard method for treating renal stones with a high stone-free rate is still S-PCNL. Although S-PCNL can cause serious consequences including bleeding and visceral damage, their frequency is relatively low.
An appropriate substitute for S-PCNL in the treatment of renal stones is UM-PCNL. Very low complication rates and a shorter hospital stay make it safer.
Surgeons must put into consideration many factors before selection of the procedure (PCNL vs. UM-PCNL), such as stone size, distribution, presence of comorbidity, patient preference, hospital equipment, surgeon experience, and operation cost.

Keywords:
complications, percutaneous nephrolithotomy, renal stones, ultramini percutaneous nephrolithotomy

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Introduction

Nephrolithiasis is a widespread condition that causes significant morbidity across the world. Overall, 10–15% of the world's population has urological ailments [1]. A number of alternatives for the

treatment of renal calculi are now available to surgeons and patients, including extracorporeal shockwave lithotripsy, percutaneous nephrolithotomy (PCNL), retrograde intrarenal surgery, and traditional open surgery [2].

In comparison with other minimally invasive lithotripsy treatments, PCNL, which removes kidney stones that are bigger than 2 cm or lower calyces larger than 1 cm, is widely regarded as the gold standard [3].

The first time kidney stone removal using a tiny skin incision was documented in the literature was in 1976 by Fernström and Johansson under the name PCNL [4].

In the past, it was believed that the prone position was the only way to get renal access for PCNL. Valdivia Uría proposed the supine PCNL in 1987 [5].

PCNL is also advised for smaller stones in patients with shockwave lithotripsy contraindications, such as shockwave resistant stones and anatomical deformities, or when a patient chooses PCNL as a more effective technique [6].

However, although they are uncommon, serious complications after this percutaneous procedure should be anticipated. These include perioperative bleeding, urine leakage from the nephrocutaneous tract, pelvicalyceal system injury, pain [7], colon injury, hydrothorax, pneumothorax, prolonged leak, sepsis, ureteral stone, vascular injury, and acute kidney loss [8].

Numerous changes have been introduced to PCNL since it was first introduced to increase success rates [9].

Standard percutaneous nephrolithotomy (S-PCNL), mini-PCNL, ultramini percutaneous nephrolithotomy (UM-PCNL), and the recently released micro-PCNL are all current PCNL approaches. The size of the renal access is one of the key variations between the different PCNL procedures, and it affects a wide range of results and problems [10].

Aim

This study compared the differences between the two procedures in terms of the percentage of patients who had no stones, the length of the procedure, the length of the hospital stay, the cost of the procedure, and any operative complications like bleeding, the need for blood transfusions, and extravasation or urine leakage.

Patients and methods

This comparative study was conducted in Ain Shams University Hospitals from January 2020 to January 2022 on 60 patients with renal calculi, with ages ranging from 18 to 60 years, who were divided into two groups, with 30 patients each. One group had S-PCNL, whereas the other underwent UM-PCNL. Approval was obtained from the Research Ethics Commity of the Faculty of Medicine of Ain Shams University with approval No (FMASU MD 06/2020). Written consent was obtained from all patients before participation.

Inclusion criteria

The following were the inclusion criteria:

(1) Single or more unilateral renal stones, having a cumulative stone load of 1–2 cm.
(2) Patients with age 18–60 years old.

Exclusion criteria

The following were the exclusion criteria:

(1) Solitary kidney.
(2) Renal stones that are either above 2 cm or under 1 cm.
(3) Comorbidities that are not under control in patients (hypertension, diabetes mellitus, cardiac disease, and chest disease).
(4) Those having a urinary tract infection that is active.
(5) Individuals with additional anatomic renal anomalies (congenital renal malformations such as horseshoe kidney, polycystic kidney disease, etc.). Likewise those who have significant skeletal deformities.
(6) Pregnant women.
(7) Any prior ureteric stricture history.
(8) An untreatable bleeding condition.
(9) Patients who had urinary diversion or renal transplants.

All patients included in this study were subjected to the following:

(1) Clinical assessment:
    (a) History taking included the following:
        (1) Medical, surgical, and drug history.
        (2) Urological history, including voiding and storage symptoms.
    (b) Physical examination:

(1) Abdominal examination for masses, hernia, or distended bladder.
(c) Pelvic examination.

(2) Investigations:
(a) Laboratory
(1) Urine analysis, culture, and sensitivity if needed.
(2) Routine laboratory investigations (serum creatinine level, serum sodium level, serum potassium level, random blood glucose level, urine analysis, liver function test, and coagulation profile).
(b) Radiological studies:
(1) All patients were evaluated using noncontrast computed tomography (NCCT); plain radiography of the kidney, ureter, and bladder (KUB); and pelvic-abdominal ultrasonography. Preoperatively, the largest axis of each stone's CT scans was added together to determine the size of the stones.

(2) Procedure:
Every operation was done under general anesthesia, and every patient was given a third-generation cephalosporin or according to culture/sensitivity results at the time of anesthesia induction.

In group A (standard percutaneous nephrolithotomy)

Patients were put in the lithotomy position, a 6-F ureteral catheter was inserted retrogradely through cystoscopy, and a 16-F urethral Foley catheter was used to empty the bladder. Patients were positioned prone, and under fluoroscopic supervision, percutaneous access to the target calyx was made using a 18-G puncture needle and 0.035-inch curved guide wire channel. Amplatz dilators up to 30 F were used to dilate the tract. A 30-Fr Amplatz sheath was then inserted into the collection system. Through a rigid 26-F nephroscope (KarlStorz medical instruments, Tuttlingen, Germany), a pneumatic lithotripter was used to fracture the stone, and retrieval graspers were employed to remove it. At the conclusion of the procedure, a ureteric catheter or double J (DJ) (if there was significant bleeding or extravasation) and an 18–24 F closed nephrostomy tube for tamponading were left.

In group B (ultramini percutaneous nephrolithotomy)

Patients were put in the lithotomy position. A 6-F ureteral catheter was inserted retrogradely through cystoscopy, and a 16-F urethral Foley catheter was used to empty the bladder. Patients were positioned prone, and under fluoroscopic supervision, a 18-G needle and 0.035-inch curved guide wire route were used to provide percutaneous access to the targeted calyx. The nephrostomy tract was dilated using Amplatz dilators up to 12–14 F, and a fascial dilator was used to help it pass the 12-F semi-stiff plastic sheath. The sheath was then exposed to a 9.5-F rigid ureteroscope (Karl Storz Medical Instruments). When the silica quartz laser fiber 365 m came into contact with the renal stones, they were broken into pieces using holmium laser lithotripsy (Quanta system laser machine). Depending on the characteristics of the stones, different laser techniques (dusting, fragmentation, and popcorning) were used; the frequency ranged from 5 to 10 Hz/s, and the laser energy was adjusted at 0.8–1.5 J/pulse (according to manufacturer company recommendation for stone treatment). The tract site was then packed for 2–3 min after the ureteroscope and sheath were removed. After that, a DJ stent and nephrostomy tube were implanted for 3–4 weeks, depending on the choice of the operating surgeon.

The following data were recorded: age, sex, comorbidities, and prior kidney stone surgery for the patients. Stone features included stone size (calculated by measuring the largest possible dimension of the stone during preoperative radiologic examinations; in situations of numerous calculi, it was calculated by summing the largest diameter of each stone), laboratory profile, and stone composition.

Operative data

They included the following:

(1) Operative time (operative time measured in minutes after the induction of anesthesia and we would consider a mean difference of 0.5 h as clinically important).
(2) Procedure-related blood transfusion.
(3) Ureteral stenting.

Postoperative data

It included the following:

(a) Decline in hemoglobin (Hb).
(b) Postoperative stone-free rates assessed by KUB or NCCT if needed [the patients were followed in the first week postoperative by radiological assessment with plain KUB and NCCT (if needed)]. After just one session of the process, the stone-free rate was assessed, and the efficacy of the treatment was determined by the presence of negligible residual stone pieces 3 mm or less.
(c) Hospital stay.

(d) Complications such as urine extravasation or leakage and mortality.
(e) Total cost of procedures.

Ethical considerations

The approval of the ethical committee at the medical school of Ain Shams University was obtained.

(1) Before enrolling participants in the study, written informed permission was obtained once the study's objectives and methods were described to them.
(2) Throughout all stages of the study, participants' anonymity and privacy was upheld.
(3) Any participant who did not want to take part in this research had the right to stop participation at any time during the study.

Randomization

Random number tables were used to randomly place the study's participants into one of two equal groups (1 : 1).

Sample size was calculated using PASS 11.0. The calculated sample size achieved 90% power to detect a difference of −1.3 between the null hypothesis that both group means are 2.3 and the alternative hypothesis that the mean of group B is 3.6 with estimated group SDs of 0.8 and 0.8 and with a significance level (alpha) of 0.01000 using a two-sided two-sample *t* test.

Statistical analysis

Statistical analysis was done using IBM SPSS statistics for windows, Version 23.0. Armonk, NY: IBM Corp. When the distribution of the quantitative data was determined to be parametric, the mean, SDs, and ranges were reported. Qualitative factors were also shown as percentages and numbers.

The paired *t* test was used to compare two groups having quantitative data and parametric distribution.

The allowable margin of error was set at 5%, whereas the confidence interval was set at 95%. The *P* value was therefore deemed significant as follows:

P value more than 0.05: not significant.
P value less than 0.05: significant.
P value less than 0.01: highly significant.

Results

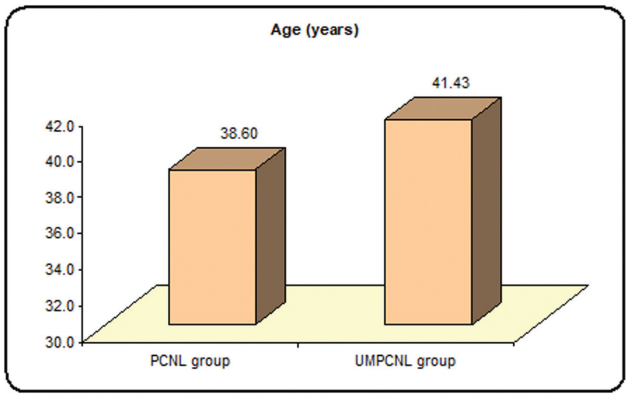
According to the previously mentioned inclusion and exclusion criteria, 60 patients with renal stones were included in this study. They were divided into two

Table 1 Comparison between the two studied groups according to demographic data

	PCNL group (*N*=30)	UM-PCNL group (*N*=30)	Test value	*P* value	Significance
Age (years)					
Mean±SD	38.60±10.79	41.43±10.13	−1.049•	0.299	NS
Range	21–58	24–57			
Sex [*n* (%)]					
Female	12 (40.0)	8 (26.7)	1.200*	0.273	NS
Male	18 (60.0)	22 (73.3)			

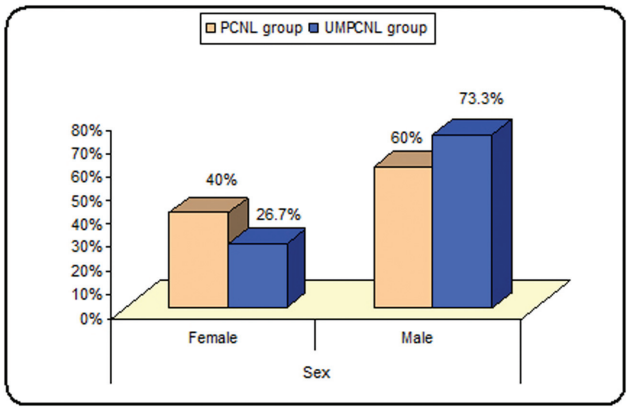
PCNL, percutaneous nephrolithotomy; UM-PCNL, ultramini percutaneous nephrolithotomy. *χ^2 test. •Independent *t* test. *P* value more than 0.05: nonsignificant; *P* value less than 0.05: significant; *P* value less than 0.01: highly significant.

Figure 1



Comparison between the two studied groups according to age.

Figure 2



Comparison between the two studied groups according to sex.

Table 2 Comparison between the two studied groups according to stone characteristics

Variables	UM-PCNL [*n* (%)]	S-PCNL [*n* (%)]	*P* value	Significance
Site				
Lower calyx	20 (66.67)	22(73.34)	>0.05	NS
Middle calyx	8 (26.66)	7 (23.33)		
Upper calyx	2 (6.66)	1 (3.33)		
Size (mm)				
Mean±SD	13.09±2.81	12.58±3.32	>0.05	NS
Median (minimum–maximum)	12.6 (1–18)	12.8 (1–20)		
Density (HU)				
Mean±SD	991.71±293.12	941.38±191.03	>0.05	NS
Median (minimum–maximum)	1002 (524–1750)	1003.5 (605–1210)		
Laterality				
Left	13 (43.33)	16 (53.34)	>0.05	NS
Right	17 (56.66)	14 (46.66)		
Number				
Single	23 (76.67)	25 (83.33)	>0.05	NS
Multiple	7 (23.33)	5 (16.67)		

S-PCNL, standard percutaneous nephrolithotomy; UM-PCNL, ultramini percutaneous nephrolithotomy.

Table 3 Comparison between stone-free rate in the two studied groups

Stone-free rate after 1 week	PCNL group (*N*=30) [*n* (%)]	UM-PCNL group (*N*=30) [*n* (%)]	Test value	*P* value	Significance
No	29 (96.7)	27 (90.0)	1.071*	0.301	NS
Residual	1 (3.3)	3 (10.0)			

PCNL, percutaneous nephrolithotomy; UM-PCNL, ultramini percutaneous nephrolithotomy. *χ^2 test. *P* value more than 0.05: nonsignificant; *P* value less than 0.05: significant; *P* value less than 0.01: highly significant.

groups: in group A, 30 patients had S-PCNL, and in group B, 30 patients underwent UM-PCNL.

The age of males ranged from 55 to 67 years, with mean±SD of 59.4±3.31 for men, and ranged from 56 to 68 years, with mean±SD of 61.07±3.94 for women. There was no statistically significant difference between the mean ages of men and women ($P>0.05$).

Demographic data

Age

Age varied from 21 to 58 years in group A, with a mean age of 38.60±10.79 years, and from 24 to 57 years in group B, with a mean age of 41.43±10.13 (Table 1 and Fig. 1).

Sex

In group A, 18 (60%) patients were male and 12 (40%) patients were female, whereas in group B, 22 (73.3%) patients were males and eight (26.7%) patients were females (Table 1 and Fig. 2).

Stone characteristics

Regarding side and laterality (Table 2), in the UM-PCNL group, 17 (56.66%) patients were right and 13 (43.33%) patients were left, whereas in the S-PCNL group, 14 (46.66%) patients were right and 16 (53.34%) patients were left.

Data regarding stone location, size, density, and number are shown in Table 2.

Regarding stone location, in the UM-PCNL group, 20 (66.67%) cases had lower calyceal stone, eight (26.66%) cases had middle calyceal stone, and two (6.66%) cases had upper calyceal, whereas in the S-PCNL group, 22 (73.34%) cases had lower calyceal stone, seven (23.33%) cases had middle calyceal stone, and one (3.33%) case had upper calyceal.

Regarding stone size, in the UM-PCNL group, the stone size ranged from 1 to 18 mm with a mean size of 13.09±2.81 and a median size of 12.6 mm, whereas in the S-PCNL group, the stone size ranged from 1 to 20 mm with a mean size of 12.58±3.32 and a median size of 12.8 mm.

Regarding stone number, in the UM-PCNL group, 23 (76.67%) patients had a single stone and seven (23.33%) patients had multiple stones, whereas in the S-PCNL group, 25 (83.33%) patients had a single stone and five (16.67%) patients had multiple stones. Taking into our consideration that, patients with multiple stones had multiple stones in the same calyx not in different calyces.

Regarding stone density, in the UM-PCNL group, stone density ranged from 524 to 1750 HU with a mean density of 991.71±293.12 and a median density of 1002 HU, whereas in the S-PCNL group, the stone density ranged from 605 to 1210 HU, with a mean density of 941.38±191.03 and a median density of 1003.5 HU.

There was no statistically significant difference regarding any of the aforementioned variables between both groups.

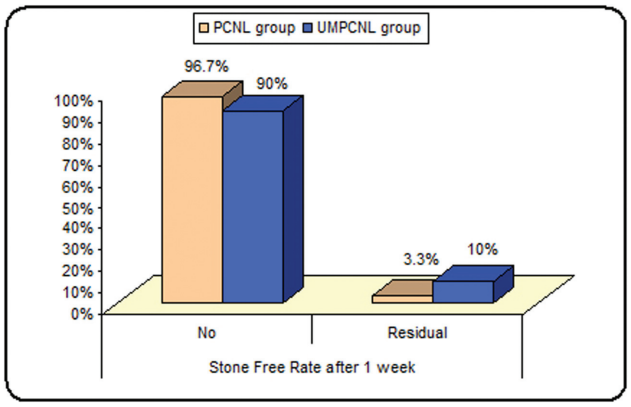
Stone-free rate

A total of 29 patients, with a stone burden of 1–2 cm, were free of stones after a single session of PCNL in group A, with stone-free rate of 96.7%.

A total of 27 patients were free of stones after a single session of UM-PCNL in group B, with stone-free rate of 90%.

There was no statistically significant difference in stone-free rate between the two groups (P=0.301) (Table 3, Fig. 3).

Figure 3



Comparison between stone-free rate in the two studied groups.

Serious bleeding and blood transfusion

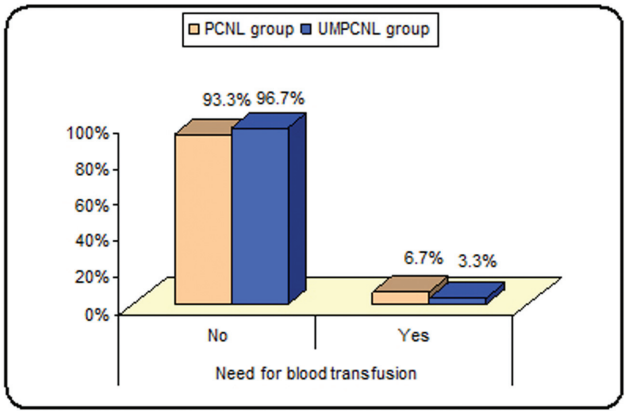
Only two patients in group A had serious bleeding that required blood transfusion, representing 6.67% of patients, whereas one patient in group B had bleeding that required blood transfusion, representing 3.33% of patients.

Table 4 The need for blood transfusion in the two studied groups

Need for blood transfusion	PCNL group (N=30) [n (%)]	UM-PCNL group (N=30) [n (%)]	Test value	P value	Significance
No	28 (93.3)	29 (96.7)	0.351*	0.554	NS
Yes	2 (6.7)	1 (3.3)			

PCNL, percutaneous nephrolithotomy; UM-PCNL, ultramini percutaneous nephrolithotomy. *χ^2 test. P value more than 0.05: nonsignificant; P value less than 0.05: significant; P value less than 0.01: highly significant.

Figure 4



Need for blood transfusion in the two studied groups.

Table 5 Comparison between the two studied groups according to preoperative and postoperative hemoglobin level

	PCNL group (N=30)	UM-PCNL group (N=30)	Test value	P value	Significance
Preoperative Hb level					
Mean±SD	13.11±0.71	12.51±0.85	2.967•	0.004	HS
Range	11.7–14.7	10.9–14			
Postoperative Hb level					
Mean±SD	10.67±0.81	11.28±0.83	–2.851•	0.006	HS
Range	7.9–12	8.8–12.7			
Paired t test					
t	19.623	14.04			
P value	<0.001	<0.001			
Postoperative Hb drop					
Mean±SD	2.42±0.63	1.24±0.48	8.196•	<0.001	HS
Range	1.2–4.1	0.5–3.3			

Hb, hemoglobin; PCNL, percutaneous nephrolithotomy; UM-PCNL, ultramini percutaneous nephrolithotomy. •Independent t test. P value more than 0.05: nonsignificant; P value less than 0.05: significant; P value less than 0.01: highly significant.

There was no statistically significant difference between the two groups (P=0.554) (Table 4 and Fig. 4).

In group A, the mean preoperative Hb. level was 13.11 ±0.71 g/dl, whereas the mean postoperative Hb level was 10.67±0.81 g/dl, with mean Hb decrease of 2.42 ±0.63.

In group B, the mean preoperative Hb level was 12.51 ±0.85 g/dl, whereas the mean postoperative Hb level was 11.28± 0.83 g/dl, with mean Hb decrease of 1.24 ±0.48.

There was a highly statistically significant difference between the two groups regarding preoperative and postoperative Hb levels, as well as the mean decrease (Table 5, Figs 5 and 6).

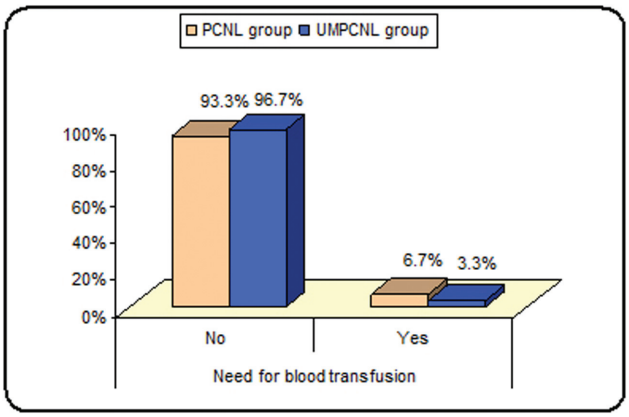
Postoperative fever

A total of three (10%) patients had high-grade fever (>38.5°C) in group A, whereas one (3.3%) patient had high-grade fever (>38.5°C) in group B.

There was no statistically significant difference between the two groups' postoperative fever levels (P=0.301) (Table 6, Fig. 7).

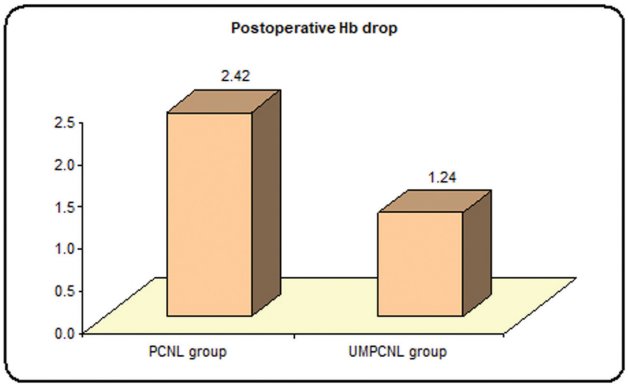
Comparison between PCNL group and UM-PCNL group regarding operative time and hospital stay of the studied patients revealed the following:

Figure 5



Comparison between the two studied groups according to preoperative and postoperative Hb level. Hb, hemoglobin.

Figure 6



Comparison between the two studied groups according to postoperative Hb drop. Hb, hemoglobin.

Table 6 Comparison between postoperative fever in the two studied groups

	PCNL group (N=30) [n (%)]	UM-PCNL group (N=30) [n (%)]	Test value	P value	Significance
Fever					
No	27 (90.0)	29 (96.7)	1.071*	0.301	NS
Yes	3 (10.0)	1 (3.3)			

PCNL, percutaneous nephrolithotomy; UM-PCNL, ultramini percutaneous nephrolithotomy. *χ^2 test. P value more than 0.05: nonsignificant; P value less than 0.05: significant; P value less than 0.01: highly significant.

Table 7 Comparison between standard percutaneous nephrolithotomy group and ultramini percutaneous nephrolithotomy group regarding operative time and hospital stay of the studied patients

	PCNL group (N=30)	UM-PCNL group (N=30)	Test value	P value	Significance
Operative time (min)					
Mean±SD	71.40±24.02	108.73±41.61	–4.256•	0.000	HS
Range	42–150	52–210			
Hospital stay (h)					
Mean±SD	64.80±20.14	42.53±13.23	5.060•	0.000	HS
Range	36–144	30–96			

S-PCNL, standard percutaneous nephrolithotomy; UM-PCNL, ultramini percutaneous nephrolithotomy. •Independent t test. P value more than 0.05: nonsignificant; P value less than 0.05: significant; P value less than 0.01: highly significant.

Regarding operative time

Mean duration of the procedure was 71.40±24.02 min in group A and ranged from 42 to 150 min, whereas it was 108.73±41.61 min in group B and ranged from 52 to 210 min. There was a highly statistically significant difference between the two groups regarding duration of the procedure, which was more prolonged in group B (P=0.000).

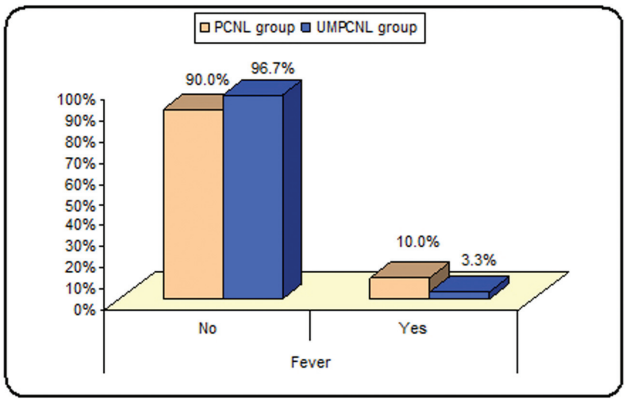
Regarding hospital stay

Mean hospital stay was 64.80±20.14 h in group A, whereas it was 42.53±13.23 h in group B. There was a highly statistically difference between the two groups regarding hospital stay, which was more prolonged in group A (P=0.000; Table 7 and Fig. 8).

Comparison between standard percutaneous nephrolithotomy group and ultramini percutaneous nephrolithotomy group regarding need for double J stenting at the end of the operation

Regarding need for DJ, only two (6.67%) patients in group A needed DJ application, whereas 30 (100%) patients in group B needed DJ application.

Figure 7



Comparison between postoperative fever in the two studied groups.

There was a highly statistically significant difference between the two groups regarding the need for DJ application, which was higher in group B than group A (P=0.000) (Table 8 and Fig. 9).

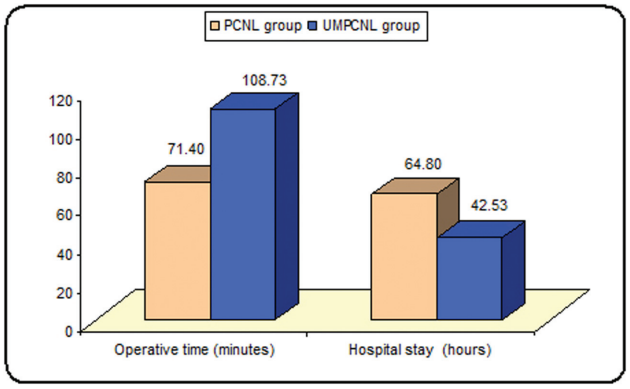
Comparison between standard percutaneous nephrolithotomy group and ultramini percutaneous nephrolithotomy group regarding need for nephrostomy at the end of the operation

Regarding need for nephrostomy, 30 (100%) patients in group A needed nephrostomy application, whereas one (3.33%) patient in group B needed nephrostomy application. There was a highly statistically significant difference between the two groups regarding the need for nephrostomy application, which was higher in group A than group B (P<0.001) (Table 9, Fig. 10).

Cost-effectiveness

The costs of PCNL (A) and UM-PCNL (B) were estimated based on hospital stay, medications, and the

Figure 8



Comparison between S-PCNL group and UM-PCNL group regarding operative time and hospital stay of the studied patients. S-PCNL, standard percutaneous nephrolithotomy; UM-PCNL, ultramini percutaneous nephrolithotomy.

Table 8 Comparison between standard percutaneous nephrolithotomy group and ultramini percutaneous nephrolithotomy group regarding need for DJ stenting at the end of the operation

	PCNL group (N=30) [n (%)]	UM-PCNL group (N=30) [n (%)]	Test value	P value	Significance
Need for DJ					
No	28 (93.3)	0	52.500*	0.000	HS
Yes	2 (6.7)	30 (100.0)			

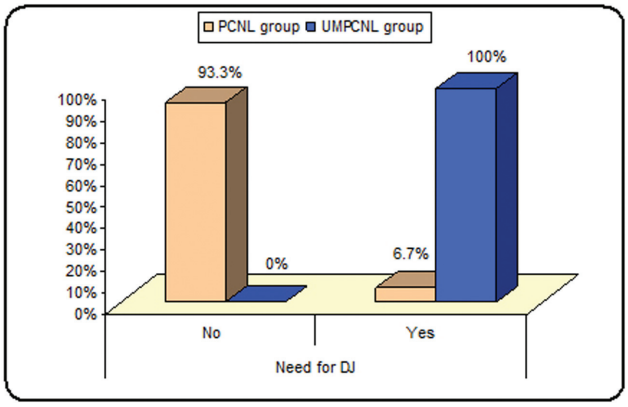
PCNL, percutaneous nephrolithotomy; UM-PCNL, ultramini percutaneous nephrolithotomy. *χ^2 test. P value more than 0.05: nonsignificant; P value less than 0.05: significant; P value less than 0.01: highly significant.

Table 9 Comparison between standard percutaneous nephrolithotomy group and ultramini percutaneous nephrolithotomy group regarding need for nephrostomy at the end of the operation

	PCNL group (N=30) [n (%)]	UM-PCNL group (N=30) [n (%)]	Test value	P value	Significance
Need for nephrostomy					
No	0	29 (96.7)	56.129*	<0.001	HS
Yes	30 (100.0)	1 (3.3)			

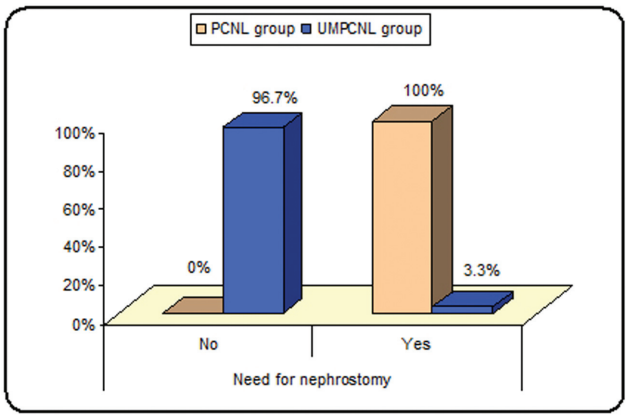
PCNL, percutaneous nephrolithotomy; UM-PCNL, ultramini percutaneous nephrolithotomy. *χ^2 test. P value more than 0.05: nonsignificant; P value less than 0.05: significant; P value less than 0.01: highly significant.

Figure 9



Comparison between S-PCNL group and UM-PCNL group regarding need for DJ stenting at the end of the operation. S-PCNL, standard percutaneous nephrolithotomy; UM-PCNL, ultramini percutaneous nephrolithotomy.

Figure 10



Comparison between S-PCNL group and UM-PCNL group regarding need for nephrostomy at the end of the operation. S-PCNL, standard percutaneous nephrolithotomy; UM-PCNL, ultramini percutaneous nephrolithotomy.

Table 10 Comparison between standard percutaneous nephrolithotomy group and ultramini percutaneous nephrolithotomy group regarding procedure cost

	PCNL group (*N*=30)	UM-PCNL group (*N*=30)	Test value	*P* value	Significance
Procedure cost					
Mean±SD	12 347.67±781.63	14 890.00±1098.26	−10.330•	<0.001	HS
Range	9540–14 000	13 090–17 300			

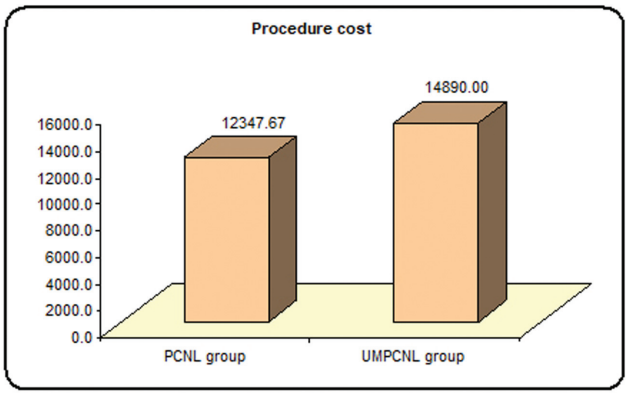
PCNL, percutaneous nephrolithotomy; UM-PCNL, ultramini percutaneous nephrolithotomy. •Independent *t* test. *P* value more than 0.05: nonsignificant; *P* value less than 0.05: significant; *P* value less than 0.01: highly significant.

Table 11 Comparison between standard percutaneous nephrolithotomy group and ultramini percutaneous nephrolithotomy group regarding intraoperative extravasation or urine leakage of the studied patients

	PCNL group (*N*=30) [*n* (%)]	UM-PCNL group (*N*=30) [*n* (%)]	Test value	*P* value	Significance
Extravasion or urine leakage					
No	26 (86.7)	29 (96.7)	1.964*	0.161	NS
Yes	4 (13.3)	1 (3.3)			

S-PCNL, standard percutaneous nephrolithotomy; UM-PCNL, ultramini percutaneous nephrolithotomy. *χ^2 test. *P* value more than 0.05: nonsignificant; *P* value less than 0.05: significant; *P* value less than 0.01: highly significant.

Figure 11



Comparison between S-PCNL group and UM-PCNL group regarding procedure cost. S-PCNL, standard percutaneous nephrolithotomy; UM-PCNL, ultramini percutaneous nephrolithotomy.

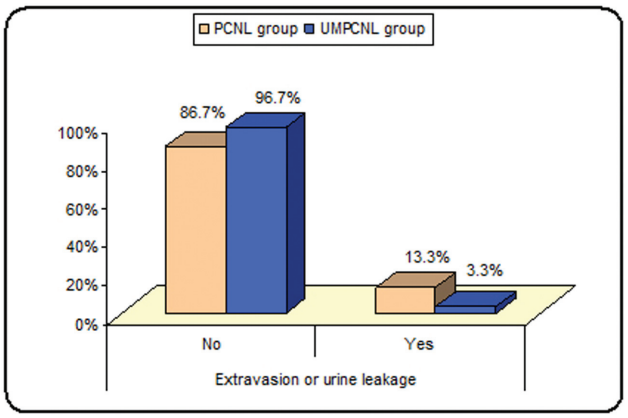
cost of instruments and scopes used in both procedures according to hospital bills in Ain Shams University Hospitals.

The mean cost in group A was 12 347.67±781.63 pounds and ranged from 9540 to 14 000 pounds, whereas the mean cost in group B was 14 890.00 ±1098.26 pounds and ranged from 13 090 to 17 300 pounds. There was a highly statistically significant difference between the two groups regarding the cost, which was higher in group B than group A ($P<0.001$) (Table 10, Fig. 11).

Comparison between standard percutaneous nephrolithotomy group and ultramini percutaneous nephrolithotomy group regarding intraoperative extravasation of the studied patients

Regarding intraoperative extravasation, only four (13.3%) patients in group A showed intraoperative

Figure 12



Comparison between S-PCNL group and UM-PCNL group regarding intraoperative extravasation or urine leakage of the studied patients. S-PCNL, standard percutaneous nephrolithotomy; UM-PCNL, ultra-mini percutaneous nephrolithotomy.

extravasation, whereas one (3.33%) patient in group B showed intraoperative extravasation.

There was no statistically significant difference between the two groups regarding intraoperative extravasation (P=0.161) (Table 11, Fig. 12).

Discussion

The most often used method for treating bigger, more complicated kidney stones is PCNL [11].

Particularly for big renal stones, PCNL has a very high stone-free rate. It is intrusive and frequently results in serious consequences from puncture or dilatation. Significant bleeding, renal pelvis perforation, visceral damage, hydrothorax, and high fever are some of these consequences. However, serious consequences are extremely rare [12].

According to reports, one of the key factors influencing complication rates is tract size. The tract size has significantly shrunk in more recent minimally invasive PCNL techniques like UM-PCNL [11].

A 9.8-F ureteroscope and a 7.5-F nephroscope are used in the minimally invasive PCNL procedure known as the UM-PCNL [13]. In contrast to standard-PCNL, a 6-Fr mininephroscope [14] plays a significant role in the treatment of symptomatic renal and upper ureteric stones that are smaller than 20 mm in size by causing reduced blood loss, length of hospital stay, requirement for transfusion, and postoperative discomfort [15].

Our study compares the differences between PCNL and UM-PCNL regarding stone-free rates, operational time, and overall patient satisfaction.

Operational problems include blood loss, the need for blood transfusions, and extravasation or urine leaks, as well as hospital stay, procedure costs, and these issues.

In terms of stone-free rate, our study found that stone-free rate for the UM-PCNL group was 90%, but 96.7% for the PCNL group, which might be attributed to poor sight in the surgical field owing to intraoperative hemorrhage. Indeed, one of the most common reasons of intraoperative impaired vision was the presence of bleeding in the surgical area. Thus, proper access tract utilization and effective irrigation are advantageous in decreasing bleeding and its detrimental effects on the procedure.

Haghighi *et al.* [15] stated that the stone-free rate for their trial was 93.58% for the UM-PCNL group and 94.60% for the PCNL group in 2017, which was comparable to our study.

Guddeti *et al.* [11] showed in a different research that the stone-free rate was likewise comparable between the groups, with group A (PCNL) having an stone-free rate of 97.33% and group B having an stone-free rate of 98.66% (super mini-PCNL).

Desai *et al.* [10] that although the total stone-free rate after 1 month was 97.2%, the immediate stone-free rate for UM-PCNL patients included in the research after 1 day was 88.9%.

However, in 2007, Giusti *et al.* [16] revealed that for the treatment of stones under 20 mm in diameter, the stone-free rate was 94% for their S-PCNL group and 77.8% in their mini-PCNL group.

Regarding operating time, our study indicated that operative time for UM-PCNL group was 108.73 ±41.61 min but 71.40±24.02 for the PCNL group. The explanation for this discrepancy was that more time was necessary for fragmenting/dusting of the stone with the laser in the UM-PCNL group.

Haghighi *et al.* [15] stated that the operational time for their trial was 48 min for the UM-PCNL group and 51 min for the PCNL group, which was comparable to our study.

Guddeti *et al.* [11] showed in a different investigation that group A (S-PCNL) had an operational time that

was much shorter than group B (36.4 vs. 23.12 min) (super mini-PCNL).

Additionally, Desai *et al.* [10] reported that for the UM-PCNL patients included in their research, the operating time was 59.8±15.9 min.

However, Agrawal *et al.* [13] showed that the operating time for the UM-PCNL patients included in their research was 39.7±15.4 min.

Additionally, Giusti *et al.* [16] discovered that the mini-PCNL operating time was greater than that of the normal PCNL, at 155.5 versus 106.6 min.

Regarding hospital stay, our study reported that the hospital stay for the UM-PCNL group was 42.53 ±13.23 h but was 64.80±20.14 h for the PCNL group.

In comparison to our study, Haghighi *et al.* [15] reported that hospital stay for their study was 2.32 day for the UM-PCNL group, whereas 3.60 days for the PCNL group.

In another study, Guddeti *et al.* [11] demonstrated that the hospital stay was 39.84±3.7 h in group A (PCNL), whereas was 28.38±3.6 h for group B (super mini-PCNL).

Moreover, Desai *et al.* [10] reported that the hospital stay was 3.0±0.9 days for UM-PCNL patients included in their study.

However, Agrawal *et al.* [13] demonstrated that the hospital stay was 22.3±2.2 h for UM-PCNL patients included in their study.

Regarding blood loss, Hb decrease, and the need for blood transfusion, our study reported that only one patient developed serious bleeding intraoperatively with decrease of Hb concentration from 12.1 to 8.8 g/dl and received blood transfusion, representing 3.3% of patients, in the UM-PCNL group, but two patients developed serious bleeding intraoperatively with decrease of Hb concentration from 12.3 to 7.9 g/dl in the first patient and from 13.3 to 9.1 g/dl in the second one and received blood transfusion, representing 6.7% of patients, in the S-PCNL group.In comparison with our study, Haghighi *et al.* [15] reported that Hb decrease was 1.65±1.20 and transfusion rate was 5.71% for the UM-PCNL group, whereas Hb decrease was 3.13 ±1.06 and transfusion rate was 11.4% for the PCNL group.

In another study, Guddeti *et al.* [11] demonstrated that the mean Hb decrease was 7.5 g/dl in group A (PCNL), whereas was 3 g/dl/h for group B (super mini-PCNL).

Moreover, Desai *et al.* [10] reported that the Hb decrease was 5.4±7.8 g/dl for UM-PCNL patients included in their study.

However, Agrawal *et al.* [13] demonstrated that the Hb decrease was 0.40±0.14 g/l for UM-PCNL patients included in their study.

Regarding extravasation, urine leakage, or postoperative fever, our study reported that the extravasation or urine leakage for UM-PCNL group was 3.3% but was 13.3% for PCNL group. Postoperative fever for the UM-PCNL group was 3.3% but was 10.0% for the PCNL group. This lower renal pelvic pressure during UM-PCNL seems to be responsible for a lower risk of postoperative fever.

In contrast to our findings, Desai *et al.* [10] reported that for UM-PCNL patients included in their analysis, urine extravasation was 2.8% and postoperative fever was 8.3%.

Additionally, Haghighi and colleagues reported two cases of urinary leakage from the nephrostomy tract in group A (UM-PCNL patients), one of which was managed by JJ insertion and the other by prolonged ureteric catheterization, and one case in group B (PCNL group), which was also treated by prolonged ureteric catheterization.

In a different trial, Guddeti *et al.* [11] found that five of 75 patients in the S-PCNL group experienced postoperative fever, compared with one of 75 patients in the super mini-PCNL group.

However, Agrawal *et al.* [13] showed that 10 of the 120 patients included in the trial experienced mild postoperative fever (>38°C), which was effectively treated with antibiotics for 5–7 days. There were no urosepsis episodes for UM-PCNL patients who were a part of their research.

Regarding procedures cost, in our study, UM-PCNL were not much higher than those of S-PCNL, which must be taken in consideration while choosing the plan of management of renal stones, especially in a developing country like Egypt, where health insurance does not cover all populations, and this new procedure offer the patients more safer

intervention with very low incidence of complications in comparison with S-PCNL.

Conclusion

The gold standard method for treating renal stones with a high stone-free rate is still S-PCNL. Although bleeding and visceral damage are serious consequences of S-PCNL, their frequency is quite low.

An appropriate alternative for S-PCNL in the treatment of renal stones is UM-PCNL. With a very low incidence of problems and a brief hospital stay, it is safer.

Surgeons must keep in mind many factors before selection of the procedure (S-PCNL vs. UM-PCNL), such as stone size, distribution, presence of comorbidity, patient preference, hospital equipment, surgeon experience, and operation cost.

However, a larger population number with further follow-up period is recommended for more accurate results.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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