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Comparative Study between Minipercutenous Nephrolithotomy versus Standard Percutenous Nephrolithotomy: Safety and Efficacy (RCTS)

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Abstract: Nephrolithiasis is a recurrent disease which has an influence on the quality of life. Technological advancement improved the kidney stone treatment. Percutaneous nephrolithotomy (PCNL) is recommended by the European Association of Urology (EAU) guidelines to be the therapy of choice for large renal calculi (>20 mm) and also for smaller stones (10–20 mm). However, PCNL has several associated complications which may influence its efficacy. Standard PCNL have been modified and developed to decrease the adverse outcomes such as blood loss, renal damage and post operative pain, this new strategy called minimally invasive PCNL or mini-PCNL or mini Perc. **Objectives:** to assess the effect of using small instruments via a small sized tracts less than 20 French in reducing complications related to standard PCNL as bleeding, postoperative pain & hospital stay…..etc. and also to assess the stone free rates between the standard& mini-PCNL techniques. **Patient & methods:** from march 2016 till December 2018 This prospective study was conducted on 64 patients who were divided into 2 groups; patients who performed standard PCNL and those who performed mini-PCNL, equal number of patients was included in each group = 32 patients. Assessment of patients includes pre-operative, operative and post-operative assessment. Preoperative measures included history taking, physical examination and laboratory as well as radiological investigations. Intraoperative measures included: patient's position, type of anesthesia, radiation time operation time, vital signs, operative techniques, operative time, radiation time, energy used and intra-operative complications. Post-operative measures included vital signs, urine output, hematuria, CBC, serum creatinine, need for blood transfusion and other post-operative complications. **Results:** Both studied groups were matched in demographics and stone characteristics, also there was no significant difference regarding the preoperative investigations& data. Regarding operative assessment, there was no significant difference between the two groups except that patients of standard PCNL group tended to need the use of nephrostomy tube more than the group of mini-PCNL, on the other hand significantly longer operative times were recorded in mini-PCNL group than patients of standard PCNL group. There were also significant differences between the two studied groups regarding intra operative complications, including bleeding & Hb loss with more significant bleeding noticed in the standard technique. Postoperative complications included: post-operative pain, fever, sepsis, urinary leakage & 2ry hemorrhage. All were more in standard group than in miniperc group. Hospital stay, Mini-PCNL group spent less time in hospital after operation, than standard group, due to less post-operative pain &complications. However both groups showed insignificant difference as regard efficacy & stone free rates which were comparable in both groups. **Conclusion:** The findings in this study indicate that both standard PCNL and mini-PCNL had nearly the same efficacy in treatment of renal stones; however mini-PCNL was superior to standard technique as it had less intra operative & post-operative complications.

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Key words: renal stones, PCNL, mini-PCNL.

1. Introduction:

In order to decrease morbidity associated with renal parenchymal damage, and hemorrhage related to renal parenchymal dilation up to 30 French in standard PCNL, a modification of the technique of standard PCNL has been developed. This is performed with a miniature endoscope via a small percutaneous tract (11–20 F) and was named as minimally invasive PCNL or mini-PCNL or mini Perc **(1)**. Historically, the-mini-perc technique was first developed for children and reported by Helal et al in 1997.Additionally, Jackman et al., in 1998defined the-mini-perc as a percutaneous nephrolithotomy achieved through a sheath too small to accommodate a standard rigid nephroscope **(2).** The use of smaller access sheaths resulted in reduced intraoperative blood loss, less postoperative pain and shorter hospital stay. An advantage of mini-PNL over the conventional procedure was noted in terms of a

significantly reduced hemoglobin drop (0.53 g/dl vs. 0.97g/dL) and the need for blood transfusion (1.4% vs. 10.4%) **(3).** Analgesic requirement has also been found significantly decreased in mini-PCNL when compared to standard PCNL (55.4 g vs. 70.2 g tramadol) **(4).** Hospital stay was significantly shorter after mini-PNL (3.2 days vs. 4.8 days) **(4, 5).** Similar SFRs between mini-PNL and PNL have been reported by many authors. Limitations of the procedure include the necessity to disintegrate stones into small enough fragments to fit through a reduced-size sheath which results in longer operative times. However, a better stone clearance rate was demonstrated for multiple caliceal stones when mini-PNL compared to PNL (85.2% vs. 70%) **(3).** Higher SFR was achieved in the treatment of staghorn stones with mini-PNL and the creation of multiple access tracts than PNL (89.7% vs. 68%) **(6).** Nevertheless, longer operative times are usually observed with mini-PNL (average time155.5 min vs. 106.6 min) **(4, 7).** Mini-PNL seems to be more effective when treating smaller (<20 mm) rather than larger (>20 mm) renal stones (SFR 90.8% vs. 76.3%) **(8).**

Objectives:

Comparison between mini PCNL and PCNL, as regard efficacy and rate of complications.

2. Patients and methods:

A total of 64 patients were randomly allocated in this prospective study, including 32 patients in each group (mini PCNL versus standard PCNL) inclusion criteria included: stone size more than 2 cm, radio opaque and radiolucent stones, and adult age groups. Exclusion criteria included**:** Complete staghorn stones, Stone size less than 2 cm, Active UTI, Uncorrected coagulopathy, skeletal deformities and Patients with incisional hernias in the percutaneous access. intra operative and post-operative data (operative time, technique, energy used, vital signs and energy) complications (bleeding, pelvic perforation, post-operative fever, urine leakage, hospital stay and residual stones) were collected and analyzed.

3. Results

Demographic characteristics of patients:

The age, sex and BMI of both study groups, had no significant difference between both groups of standard and mini PCNL. as shown in Table **(1).**

Table 1:demographic criteria

Characteristics		Standard PCNL	Mini PCNL	P- Value
Age	Mean (SD)	39.38±12.778	36.78±13.767	0.438
	Range	16-65	16-59	
BMI	Mean (SD)	25.791±4.7126	26.184±3.3234	0.701
	Range	20.5-36.5	20.0-31.2	
Sex	M	18(56.2)	17(53.1)	0.801
	F	14(43.8)	15(46.9)	

Laboratory investigations:

The range of Hb:

In standard group was 10.2-16 with a mean ± SD of 13.22±1.33, while that of mini group was 11.7-15.3 with a mean ± SD of 13.78±0.96, no significant difference between the two groups.

The range of serum creatinine:

In the first group was 0.6-3.6 with a mean ± SD of 1.16±0.59, whereas in the other group creatinine range was 0.5-1.5 (mean ± SD of 0.98±0.29), no significant difference between the two groups.

Table2: laboratory investigations

Laboratory investigations		Mean	SD	Range	P-Value
Preoperative Hb gm/dl	Standard	13.22	1.33	10.2- 16.0	0.055
	Mini	13.78	0.96	11.7-15.3	
Creatinine	Standard	1.16	0.59	0.6-3.6	0.128
	Mini	0.98	0.29	0.5-1.5	

Radiological investigations:

CTUT: was performed for all patients of standard and mini groups.***IVU:** was performed for 10(31.2%) of patients in standard group and 7 (21.9%)of patients in mini group, there was no significant difference in number of patients between the two groups (P-value=0.3). ***Pelvicalyceal system dilatation:** There were 12(37.5%) and 16(50%) patients of standard and mini groups respectively suffered moderate hydronephrosis, while 17(53.1%) patients of standard group and 13(40.6%) patients of mini group suffered marked hydronephrosis, only 3(9.4%) in each group had no

hydronephrosis,there was no significant difference between the two groups regarding degree of hydronephrosis (P-value=0.5).

Stone characteristics:

Stone sites: right sided stones were more common in standard 18(56.2%) than mini group 19(59.4%), (P-value=0.8). Regarding site, the most common sites in standard group were lower calyceal 16(50%), followed by pelvic 9(28.1%) and then both pelvic and lower calyceal 7(21.9%), while in mini group, the most common sites were pelvic 16(50%), followed by both pelvic and lower calyceal 9(28.1%) and then lower calyceal 7(21.9%), there were no significant differences between the two groups regarding stone distribution (P- value= 0.057).**•Stone number:** patients who performed standard PCNL, had one stone 23(71.9%), while 8(25%) had 2 stones and only one (3.1%) had 3 stones, also most of patients who performed mini-PCNL had one stone and they were 24(75%), then those who had 2 stones 7(21.9%) and only one case (3.1%) had 3 stones, (P- value of stone number among the two groups=0.9).**•Stone size**: the range of stone size was 2-4 Cm, with a mean of 2.87±0.49 in the first group and from 2 to 3.5 cm with a mean of 2.68±0.47in the other group, (P-value=0.95), with no significant difference.**• The radio-opacity of the stones**: was investigated in both groups, in the first group there were 28(87.5%) found to have radio-opaque stones, and 4(12.5%) only had radio-lucent stones, whereas in the other group there were 23(71.9%) and 9(28.1%) had stones with radio-opaque and radio- lucent characters respectively, (P-value=0.1).

Table 3: Imaging investigations

Preoperative imaging			Study group		P value
			Standard PCNL	Mini PCNL	
Hydronephrosis	No	N	3	3	0.576
		%	9.4%	9.4%	
	Moderate	N	12	16	
		%	37.5%	50.0%	
	Severe	N	17	13	
		%	53.1%	40.6%	
Side	L	N	14	13	0.800
		%	43.8%	40.6%	
	R	N	18	19	
		%	56.2%	59.4%	
distribution	Pelvic	N	9	16	0.057
		%	28.1%	50.0%	
	Pelvic & lower	N	7	9	
		%	21.9%	28.1%	
	Lower	N	16	7	
		%	50.0%	21.9%	
Number	1	N	23	24	0.957
		%	71.9%	75.0%	
	2	N	8	7	
		%	25.0%	21.9%	
	3	N	1	1	
		%	3.1%	3.1%	
Opacity	Radio-opaque	N	28	23	0.120
		%	87.5%	71.9%	
	Radiolucent	N	4	9	
		%	12.5%	28.1%	
Stone size	mean±SD		2.87±0.49	2.68±0.47	0.959
	Range		2-4	2-3.5	

P value: significant if < or equals.05% and not significant if >or =.05%

Intraoperative data:

The operative details of all patients in both groups were recorded. In patients who have been subjected to standard PCNL, there were 12(37.5%) patients in whom stent was fixed, all patients under went serial dilation, 29(90.6%) had one puncture and only 3(9.4%) had two punctures, the majority 29(90.6%) used 2 wires and only 3(9.4%) used three wires, 20(62.5%) used nephrostomy tube and 12(37.5%) used tubeless nephrostomy and DJ stents were fixed for them. In the second group of patients who have been subjected to mini PCNL, there were 10(31.25%) patients used stent, and all patients underwent

serial dilation, the majority had one puncture 30(93.6%), while only 2(6.2%) had two punctures, there were 30(93.8%) used two wires and 2(6.2%) used three wires. As regard the use of nephrostomy tubes: 9(28.1%) in mini PCNL and 23(71.9%) in standard group needed nephrostomy tubes. Statistically significant difference was found between the two groups as regard using of nephrostomy tube.(P-value=0.006). The mean of **radiation** times for standard PCNL group was 8.19± 2.4 min, while for mini PCNL group it was 7.81± 2.14 min, there was no significant difference between the two groups (P-value=0.5). The mean of MBP intra-operative was 62.44± 8.8 for standard group and 59.94± 6.55 for mini group, with no significant difference between the two groups (P- value=0.2). The mean of **HR** intra-operative for standard and mini groups was 71.28± 8.35 and 73.78± 9.94 respectively, with no significance found (P-value=0.06). **The mean of operative time**: was less in standard group 94.06± 28.325(range from 50 to 150 min) than that in mini group 118.59 ± 26(range from 60 to 160 min), with **a significant difference** (P-value< 0.01), The mean± SD of **HB loss** in standard group was 1.325±0.99 while in mini group it was 0.91±0.48, there was **a significant** difference between the two groups (P-value=0.04).

Table 4: Operative data

Operative measure		Standard PCNL (n=32)	Mini PCNL (n=32)	P-value
Stent (%)	Yes	12(37.5)	10(31.25)	0.5
	No	20(62.5)	22(68.75)	
Puncture (%)	One	29(90.6)	30(93.8)	>0.99
	Two	3(9.4)	2(6.2)	
Used wire (%)	2	29(90.6)	30(93.8)	0.99
	3	3(9.4)	2(6.2)	
Nephrostomy tube (%)	Tube	20(62.5)	9(28.1)	0.006*
	Tubeless	12(37.5%)	23(71.9%)	
Radiation Time	mean± SD	8.19±2.4	7.81±2.15	0.613
	Range	5-13	4-13	
MBP Intraoperative	mean± SD	62.4±8.8	59.94±6.56	0.202
	Range	50-80	50-74	
HR Intraoperative	mean± SD	71.28±8.3	75.78±9.95	0.055
	Range	58-84	58-95	
Operative Time/min	mean± SD	94.06±28.32	118.59±26.0	0.001*
	Range	50-150	60-160	
Hb Loss mean(SD)	mean± SD	1.325 ±0.99	0.916±0.48	0.04*
	Range	0-5.3	0-2	

(*) refers to significant pvalue < or equals 05%.

Post-operative measures:

The mean **hospital stay**, duration of standard group was longer (3.66± 1.18days) than that of mini group (2.25± 0.56 days) there was significant difference between the two groups (P-value< 0.01).There was also significant difference between the two groups as regard **post-operative pain;** the percent of patient with pain & requirement of analgesia was more in standard than mini PCNL.

Table 5: Postoperative measures

Post-operative Measure	Standard PCNL	Mini PCNL	P value
HospitalStay in days means (SD) Range	 3.66±1.18 1-6	 2.25±.56 1-3	 <0.01
Pain, ◦Nil ◦Yes: Mild Moderate Severe	 8(25.0) 5(15.6) 10(31.3) 9(28.1)	 16(50.0) 12(37.5) 4(12.5) 0	 0.005

Complications: Intra-operative:

The majority of patients who performed standard PCNL 23(73.82. %) had no intra-operative complications, while 9 cases (28.12%) had complications, 7(18.75%) had bleeding, but only 3 cases of them needed blood transfusion due to HB drop below10 gms/dl, one case received 2 unites & 2cases received 1 unite of packed RBCs for each of them, 2(6.25%) suffered pelvic perforation. The majority of patients who performed mini PCNL had no intra- operative complications 28 (93.75%), while 2(6.25%) suffered complications, 2(6.25%) suffered bleeding (was not severe & with no need for blood transfusion) and were managed conservatively.

Table 6: Intraoperative complications

Intra operative complication	Standard PCNL		Mini PCNL		P value
	N	%	N	%	
Significant Bleeding	7	18.75	2	6.25	0.150
Pelvic Perforation	2	6.25	0	0	0.473

Post-operative:

There were 19(59.3%) of standard group patients had no complications, while 13(41.7%) had complications, in the form of fever 3cases (9.38%) and were treated by antipyretics & antibiotics according to culture and sensitivity. Urinary leakage occurred in 6 cases (18.75%) from the nephrostomy track: 3 cases were due to distal ureteric obstruction by down migration of sizable fragments, cannot pass spontaneously after and were treated by ureteroscopy, the other 3 cases were treated conservatively as the leakage was mild and stopped 2 days after nephrostomy removal. ICU admission for sepsis and septic shock were encountered 2 cases (6.25%) and were managed as following:•ICU admission. •I.V Fluids & colloids according to CVP. •I.V broad spectrum antibiotics& against gram negative, gram positive and anaerobes.• Vasopressors and cardiac positive inotropes in ICU under monitoring. Monitoring of BP, HR, fever chart, urine output, CBC (total leucocyte count). •US: to exclude obstruction or collection Secondary hemorrhage was encountered in 2 cases (6.25%): due to secondary infection after 6 days from the operation and were managed by bed rest, I.V fluids, I.V broad spectrum antibiotics, anti-bleeding measures, and ICU admission for monitoring. However in The mini PCNL group 26 cases (81.25%) of patients had no complications, whereas only 6(18.75%) had complications, fever and urine leakage were suffered by 4(12.5%), and 2(6.25%) respectively. Urine leakage occurred in tubeless cases treated conservatively, and there was a significant difference between the two groups as regard post- operative complications. (P-value=0.03).Stone free rates: There were 27 cases (84.4%) of standard group free of residual stone, and 5 cases (15.6%) had residual stone, while in the mini PCNL group, there were 25 cases(78.1%) had no residual stone, whereas 7 cases (21.9%) had residual stone, there was no significant difference between the two groups (P-value=0.5). Auxiliary measures:•ESWL: in 2 cases of the standard group and 4 cases of the mini PCNL group & for sizable fragments failed to pass spontaneously, ESWL was decided as the residual stones were of small size less than 1cm.• URS: was performed for 3 cases of residual stones of the standard PCNL group, as the stones were migrated down in the ureter causing ureteral obstruction& prolonged urine leakage from the nephrostomy track.• conservative management were presented to the 3 cases of residual stones in the mini PCNL group, as the residual stones were small, fragmented

Table 7: Post-operative complications

post-operative complication	Standard PCNL		Mini PCNL		P value
	N	%	N	%	
Fever	4	12.5	3	9.38	0.999
Prolonged Leakage of urine	3	9.2 5	2	6.25	0.256
ICU admission for sepsis and septic shock	2	6.25	0	0	0.473
2ry Hemorrhage	2	6.25	0	0	0.473

N.B: Patient may have more than one complication

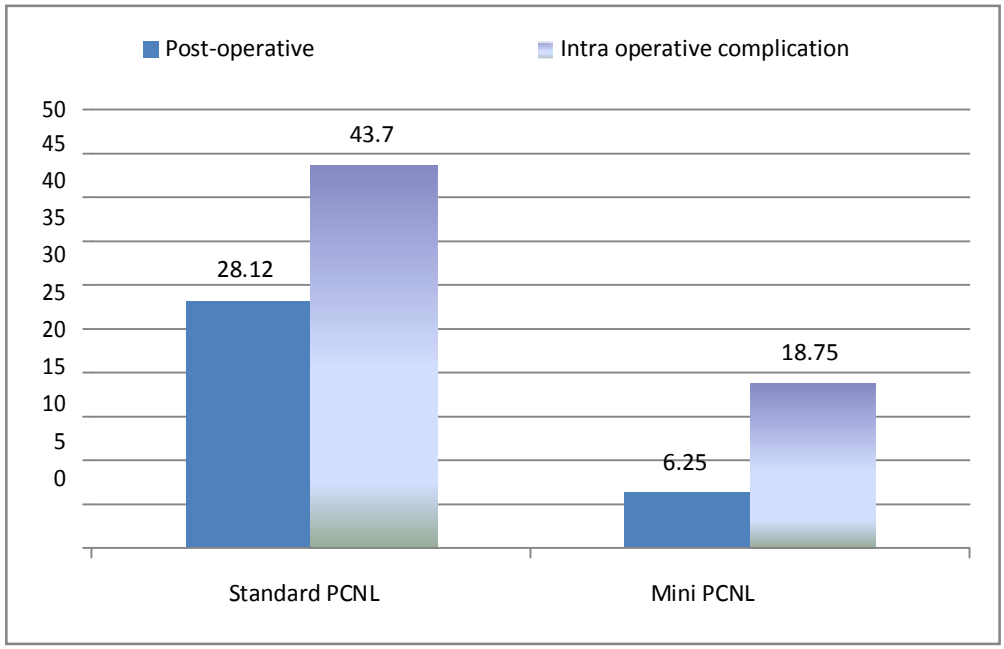

Figure 1: Percent of Overall intraoperative and postoperative complications

4. Discussion

According to the European association of urology, urolithiasis guidelines 2018, radiopaque renal stones greater than 2 cm, PCNL is the first choice, on the other hand, for treatment of stones less than 1 cm, SWL or RIRS is the first choice. PNL is a safe procedure with a high SFR but it is more invasive and had a higher complication rate. Complications, related to access tract number and size, can be decreased by the availability of the miniature nephroscope and the miniperc technique **(9)**.

In the present prospective randomized study, we aimed to investigate the outcome and complications of the PCNL using standard and mini-PCNL procedures, to evaluate the effect of miniaturization of tract size and instruments on reduction of complications related to PCNL and also in the stone free rate difference between both techniques. So we randomly divided patients into two groups, patients who performed standard PNCL and those who performed mini- PCNL. We investigated the intra- operative data& complications and post-operative outcome and complications.

Regarding pre-operative criteria, there was a match between the two studied groups. There were no significant differences between the two groups in demographics including age, BMI and sex distribution. Also there were no significant differences in lab investigations (Hb, serum creatinine) and stone characteristics of patients.

A study was conducted to compare tubeless mini PCNL with retrograde internal surgery for stones ≤2Cm, also showed matching in the two studied groups in gender, age, stone size, pre-operative Hb**(10).** Regarding stone size for mini PCNL, Kumar et al included single stones only, one to two cm in maximal diameter with mean stone size was 13.3± 1.3mm, all stones were radiolucent **(11),** while in Kruck et al work the mean stone size was 12.6± 1.2mm **(12).** This was different from our study, as we included patients with larger size of stones, also we studied radiolucent & radio-opaque stones, thus giving strength to our study, but this may be at the expense of lengthy operative time. We intended to select the patients without obvious differences in the preoperative characteristics especially stone size and number, which may affect the outcomes, as operative time, rate of complications and stone free rate.

From the technical aspect we intended as possible to do similar steps and maneuvers in both groups, except for the only technical difference that was the size of tract (18 French in mini-PCNL and 28 Fr in standard PCNL).There were no significant differences between the two groups as regard, vital signs, observed during the operation and radiation time (fluoroscopy time). Mean radiation time was8.19min in standard PCNL & 7.8 min in mini –PCNL group (P value=0.513), indicating statistically insignificant difference. Also placement of DJ stents showed insignificant difference between both groups (P value =0.5)

On the other hand, there were statistical differences in two variables: the total operative time, nephrostomy tube placement. With more

lengthy total main operative time in the mini-PCNL group, total operative time was 94.06min in standard technique &118.59 min in mini- PCNL technique (P value <0.01) indicating significant difference.

This difference in time can be explained to be due to several factors: use of semi rigid ureteroscope (8.9/ 11.5french) in mini-PCNL with smaller field of vision, and weak irrigation in comparison to 24 French rigid nephroscope used in the standard technique. Weaker lithotripsy probe of ureteroscope, thus stone disintegration requires more time. Stones must be disintegrated into much smaller fragments than in standard PCNL, to be delivered outside through the small diameter working sheath in mini-PCNL. The other different variable is nephrostomy tube placement. Tubeless technique was more in patients of mini PCNL group (23 patients), while in standard PCNL nephrostomy tube placement was done for larger number of patients (20 patients) (P-value=0.006), which was statistically significant. This finding in our opinion is due to surgeon preference & experience, influenced by small size of the track, and less bleeding in mini-PCNL and use of DJ stent in some cases, favoring distal drainage thus decreased the need for nephrostomy.

Use of DJ stent was not statistically different among the two groups; in general, DJ stents were fixed for different causes as: presence of residual stones, pelvic perforation & in tubeless procedures specially in standard technique to promote distal drainage of the pelvicalyceal system, enhance closure and healing of large size tracts..It was reported that reported that stent and nephrostomy tube were placed in 45% and 88% of patients of standard group respectively; while in our study only 37.5% and 62.5% of standard PCNL patients used stent and nephrostomy tube respectively **(13).** This difference in percentage of cases for them stent was used is due to less percentage of cases with residual stones in the present study and also due to less complications as bleeding and pelvic perforation. Another study reported that both stent and nephrostomy tube were used in 100% of mini PCNL patients **(14)**, and this was mostly due to surgeon preference, whereas in our study 31.25% and 28.1% of mini PCNL patient group used stent and nephrostomy tube respectively. In a previously reported large series of tubeless PNL in Kasr Elainy, **(15)** the safety and efficacy of tubeless PNL, was retrospectively studied, in a total of 128 patients from May 2001 to May 2004, The stone sizes ranged from 2 to 7 cm with a mean of 4.1 cm and they concluded that tubeless PNL with an externalized ureteral catheter is a safe procedure that is suitable for any patient who can be rendered stone free with a single procedure& no need for 2nd look procedures regardless of the stone burden.

It was reported that the lengthy operative time was a drawback of mini PCNL **(7, 16),** and this was in agreement with our findings. In our study the mean operative time for standard PCNL was94.06 min, while much longer time was reported in a previous study where the operation time was162 min **(13).**

Operative time for min-PCNL patients was reported to be 71.66 min in a previous study **(10)** which was less duration than in our study. The mean operative time was 61±1.3 minutes **(11),** which was much shorter than mean operative time in our study, this difference can be explained, as they studied group of patients with single small sized stones, But operative time was shorter than other studies like Akbulut et al, as the mean operative time was 91.9±37.6 minutes **(17).**

The main advantages of Mini-PNL were clear when we analyzed the intra and post-operative complications which were significantly better than standard technique as a whole and in each separate complication including: urinary leakage, blood transfusion, sepsis, and renal pelvis perforation. Consequently, more secondary interventions were required to manage complications in the standard-PNL group. Bleeding and blood transfusion were the most commonly studied complications in literature review and they were lower in Mini-PNL group in the present study.

Bleeding after PCNL is the most concerned complication and the cause of bleeding returns to the increase in operation time, multiple punctures and large size of the tract **(18).**Other two studies reported clinical factors that assist in increasing the risk of bleeding either during or after PCNL such as diabetes mellitus, access tracts, increase operation time, modality of access guidance, utilization of a mature nephrostomy tract and concomitant surgical complications **(19,20)**, reported angio-embolization in (1.2%) patient in standard-PCNL**.** In ameta-analysis study that included many studies comparing Mini-PNL vs standard-PNL, the rate of blood transfusion was also significantly more in standard PNL (5.8%) compared to Mini-PNL (0.84%) **(21).** similarly, higher complications rates, were reported in standard-PNL group (29 vs 16.7%) specially major complications (8.1 vs. 0%; p= 0.02) including leakage, urinary obstruction and abortion of the procedure due to bleeding which occurred only in standard-PNL group**(22).**

As regards to perforation of renal pelvis, other studies showed no significant deference between both groups (3.7–6.8% in Mini-PNL vs 4– 8% in standard) which may be due to the small number of patients in these studies (**4, 5, 6**).

A significantly higher rate of urinary leakage, was reported in standard-PNL (8%) compared to Mini-PNL (3.4%) **(6).** In the same

study, they also reported pneumothorax in one (3.4%) patients in Mini-PNL group, while no cases of pneumothorax were reported in the current study, as there were no supracostal punctures. urinary leakage occurred only in the standard-PNL group**(22).** also a higher incidence of urinary leakage with standard PNL in other study**(23).**

urinary leakage was reported in one (1.2%) patient in Mini-PCNL and three (3.7%) patients in standard-PCNL. Fever and UTI were significantly higher with standard-PNL group. This was unexpected as the smaller tract in mini-PCNL might be associated with higher renal pelvic pressure (RPP) **(20).** in the current study, the ureteroscope was smaller than the sheath by at least 8.5 Fr (8.5/11.5 Fr ureteroscope in 18 Fr sheath). This helped to lower the incidence of fever and UTI following Mini-PNL. On the other hand, the higher rate of fever and UTI following standard-PNL may be due to presence of infection calculi or a higher rate of complications; pelvicalyceal perforation, leakage, hematoma and obstruction.

It was reported that one of standard PCNL drawbacks was increased hospital stay and complications **(24),** There were found in our study the longer hospital stay and Hb loss and this was explained by larger size of the track of standard technique and more parenchymal trauma, leading to more bleeding and may the need for blood transfusion, more postoperative pain and need for analgesia and hospital stay. The same findings were reported in a previous study, where both mean of Hb drop and hospital stay were significantly higher in standard PCNL group than in mini PCNL group (P-value=0.0098, < 0.0001 respectively) **(4)**. An Indian study reported that there were no significant differences regarding intra-operative complications including, pelvic perforation, bleeding and fever **(4)**. Another study showed that only 5% of patients who performed mini PCNL suffered significant intra-operative bleeding **(10).**

Our study showed that there was variable difference between the two groups in intra-operative complications as bleeding and pelvic perforation. in the immediate postoperative period, with clinical and laboratory evaluation of patients, it was found that complications (specifically bleeding) were less in mini-PCNL group**, The present study** demonstrated that, there were significant differences between the two groups regarding both Hb loss and hospital stay (P-value=0.04, <0.01 respectively). Standard PCNL group was found to have higher in mean loss of Hb than mini group, also patients in standard group had mean length of hospital stay longer than that of mini group.

As regard hospital stay after mini- PCNL, Akbulut et al, in their comparative study between mini-PCNL and RIRS for treatment of renal stones, reported that the mean hospital stay was 2.7±1.6 days **(17),** and thus was nearly similar to our findings.

A prospective, Randomized Comparative study of Shock Wave Lithotripsy, Retrograde Intrarenal Surgery and Miniperc for Treatment of 1 to 2 cm Radiolucent Lower Calyceal Renal Calculi reported that the main hospital stay was 3.1 days, in mini-PCNL group **(11)**, also Mishra et al reported that the main hospital stay was 3.2±0.8 days **(4)**.These findings were slightly different from our study. **Zhu, et al** (**21),** studied Minimally invasive versus standard percutaneous nephrolithotomy in meta-analysis study,reported that hospital stay was significantly less in mini-PCNL group, which was similar to our findings.

It was reported that the mini-PNL procedure had a longer operation time and lesser haemoglobin drop for simple and complex renal stones; findings are consistent with our present study. These outcomes may be attributed to the influence of the smaller size of renal access in mini-PCNL, which led to its introduction as a safe and effective procedure in the treatment of renal and upper ureteric stones **(25).**

Another study reported that the mean length of hospital stay for standard PCNL patients was1.79 days **(13)**, which can be explained by less rate of complications, while in our study the mean duration of hospital stay was longer as it was 3.66 days. The fever rate after PCNL was almost one third of patients; while sepsis rate is lower in case of using perioperative antibiotics **(4).**

As regard to the effectiveness of mini-PCNL technique, represented by stone free rates, several series with mini PCNL revealed that stone free rate was 60% - 90% (**7**). Reported SFRs were 90.3% **(17),** 95.1 %**(11)** and 96% **(4).**

Also no significance in stone free rate was reported by a previous Turkish study **(26**). Another study SFR was significantly lower for the large (≥2cm) than for the small stones (76.3 vs 90.8%) when treated with Mini PNL In the same study, they reported no significant deference in SFR between large and small stones after one auxiliary procedure (second-look Mini-PNL, URS, or ESWL)(94.6vs98.9%)**(22).** In the present study, stone free rate were nearly 90% in standard technique and 80% in mini PCNL, yet there was no significant difference. Other studies as discussed above had more stone free rates due to factors related to stone characteristics, availability of equipments as mini scope and laser energy, and finally recent development of the technique in our department.

On the other hand, SFRS in Mini-PNL and standard-PNL was similar in studies on comparable stone size, as stone free rates reported

by these studies ranged from (78–96% in Mini PNL and 79.4–97.1%in standard-PNL) **(5,6,20, 22).**

In the two groups, there was no significant difference in residual stones (P-value=0.5)**.**

Limitations

Limitations of this study were**:** unavailability of mininephroscope, also laser energy was available in small number of cases, and recent application of the mini-PCNL technique in our department. **The Points of strength :** large number of cases which resulted in statistically significant results, also randomization and including variable sizes of stones excluding only complete stag horn stones.

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