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Comparison between Standard Percutaneous Nephrolithotomy versus Tubeless Percutaneous Nephrolithotomy

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ABSTRACT

Background: Percutaneous nephrolithotomy (PCNL) technique has become a routine treatment for upper urinary calculi.
Objectives: To describe the socio-demographic characteristics of the patients and to compare the outcome of operated patients.
Materials And Methods: This was a retrospective study, of patients underwent PCNL in our Urology Center, between January 2020 and December 2022. Data of age, side, location of stone, size of stone, operating time, hospital stay, post operation pain, residual stones, fever, fistula, blood transfusion, and postoperative infection were recorded and compared between the two groups. Data were analyzed by using the SPSS version 22. Independent t-tests were used to analyze continuous variables, while for categorical variables chi-square test was used to compare two groups and a p value of less than 0.05 was determined as statistically significant.
Results: 51.1% of the patients were females and 48.9% were males, (P = 0.000).
The mean age was 38.1 ± 11.1 years. The highest number of patients were in the age group 30-39 years (40.0%), (P = 0.000). The location of stones was in pelvic (48.9%), lower calyces (30.0%) and pelvic + lower calyces (21.1%), (*P* = 0.000). Pain was more common as moderate in both groups PCNL (42.2%). Residual stones were (23.4%) only in standard PCNL group, (*P* = 0.000). Fever was in (7.8%) standard PCNL and in tubeless PCNL was in (2.2%), (p = 0.045). Blood transfusion was provided to (5%) for the standard PCNL patients and (3.3%) for tubeless PCNL patients. Patients who had standard PCNL had postoperative infectious (2.2%) was found in standard PCNL patients. Mean operation-time and mean hospital stay of standard PCNL was predominant.
Conclusion: Tubeless PCNL proved to be the safest and most effective.

Key words: Comparison, standard, tubeless percutaneous, nephrolithotomy.

INTRODUCTION

Renal stones remain one of the most commonly encountered urological problems worldwide, however, in this modern era of endourology with lots of technological advances in minimally invasive surgery have improved the efficacy and outcome of renal stone management [1,2].
Percutaneous nephrolithotomy (PCNL) was first completed by Fernstrom and Johannson in 1976 [3]. By now, this technique has become a routine treatment for upper urinary calculi with diameter larger than 2 cm or refractory to shock wave lithotripsy [4].
Placement of a nephrostomy catheter after PCNL is considered the standard procedure. The purpose of tube is to tamponade bleeding, aid in renal drainage, prevent

urinary extravasation and offer access for the future endoscopic procedures. Despite these apparent advantages nephrostomy tubes have been implicated in causing postoperative discomfort and increasing morbidity, prolonging hospital stay and continued urinary leakage. However, in recent years, with a growing realization of significant postoperative pain and morbidity after PCNL because of nephrostomy tubes, attempts have been made to modify standard PCNL [5,6].

PCNL is now considered the 'gold standard' treatment and has almost completely replaced open surgery for managing simple as well as large and complex renal calculi and the reported success rates are now exceeding 90% [4,7-9]. A newer approach named totally tubeless PCNL is a procedure without the placement of a nephrostomy or ureteral catheter, which has showed reasonable results in selected cases [10-12].

This study aimed to describe the socio-demographic characteristics of the patients and to compare the outcome of operated patients with standard and tubeless percutaneous nephrolithotomy.

MATERIALS AND METHODS:

This was a retrospective study, of patients underwent PCNL in Hatroom Urology Center, in Aden between January 2020 and December 2022. The study included 90 patients of both sexes. The patients were divided into two groups:

Group 1 (using tube in PCNL) (n = 41) in which the renal cavity drainage was provided by a nephrostomy tube and a double-J ureteral stent or ureteral catheter.

Group 2 (tubeless PCNL) (n = 49): No nephrostomy was performed and a double-J catheter was kept in for one month.

Inclusion criteria were patients of age less than 18 years, location of stone in kidney and stone size greater than 2 cm, while exclusion criteria included any anatomical abnormalities such as horseshoe kidney/ malrotated kidney, kyphoscoliosis, patients having positive urine cultures and coagulation disorders.

Stone fragments were removed by using stone graspers. Operative time was calculated from the onset of cystoscopic examination to the placement, and fixation of the nephrostomy tube to the skin or in case of tubeless PCNL the last stitch of the skin wound closure.

Patients were considered to be stone-free if there was no stone left after surgery, or when non-obstructive, asymptomatic and clinically insignificant residual fragments (CIRFs) of size less than 5 mm were observed on postoperative imaging of the urinary tract.

We considered bleeding as a major complication when a blood transfusion was needed. X-ray KUB, CT-scan and abdominal ultrasound were used for follow up imaging.

Data on patient age, side, location of stone, size of stone, operating time, hospital stay, post operation pain, residual stones, fever, fistula, blood transfusion, and postoperative infection were recorded and compared between the two groups.

Data were analyzed by using the IBM Statistical Package for the Social Sciences (IBM SPSS Statistics; Armonk, NY, USA) version 22. The data were shown as mean ± standard deviation for continuous variables. Categorical variables were presented in percentages. Independent t-tests were used to analyze continuous variables, while for categorical variables like stone-free rates chi-square test was used to compare two groups and a p-value less than 0.05 was determined as statistically significant.

RESULTS

Table 1 & Figure 1 reveal 90 patients were included in the study. Forty-six (51.1%) of the patients were females and 44 (48.9%) were males, (female: male ratio was 1.1: 1). The difference between sex related to tube and tubeless PCNL showed a significant difference, (P = 0.000).

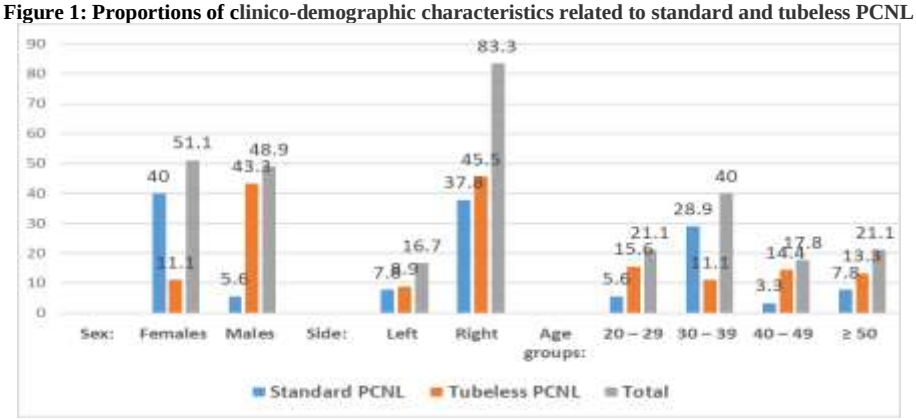
The age of the study patients ranged between 20 to 60 years and the mean age was 38.1 ± 11.1 years.

Additionally, Table 2 reveals the distribution of study patients related to age groups. The highest number of patients were in the age group 30 – 39 years (36 patients, 40.0%). Patient numbers were smaller in the age group 40 – 49 years (16 patients, 17.8%). The results of these analyses showed a significant difference between sex related to groups of standard and tubeless PCNL, (P = 0.000).

Table 1: Distribution of clinico-demographic characteristics related to tube and tubeless PCNL (n=90)

Variables	Tube and tubeless PCNL				Total		P-vale
	Standard PCNL		Tubeless PCNL				
	No	(%)	No	(%)	No	(%)	
Sex:							
Females	36	(40.0)	10	(11.1)	46	(51.1)	0.000
Males	5	(5.6)	39	(43.3)	44	(48.9)	
Sub-total	*41*	*(45.6)*	*49*	*(54.4)*	*90*	*(100)*	
Side:							
Left	7	(7.8)	8	(8.9)	15	(16.7)	0.573
Right	34	(37.8)	41	(45.5)	75	(83.3)	
Sub-total	*41*	*(45.6)*	*49*	*(54.4)*	*90*	*(100)*	
Age groups:							
20 – 29	5	(5.6)	14	(15.6)	19	(21.1)	
30 – 39	26	(28.9)	10	(11.1)	36	(40.0)	0.000
40 – 49	3	(3.3)	13	(14.4)	16	(17.8)	
≥ 50	7	(7.8)	12	(13.3)	19	(21.1)	
Sub-total	*41*	*(45.4)*	*49*	*(54.4)*	*90*	*(100)*	
Mean age (years)	35.1 ±10.4		40.5 ± 11.1		38.1 ± 11.1		0.021
Range of age (years)	20 – 59		25 – 60		20 – 60		

Figure 1: Proportions of clinico-demographic characteristics related to standard and tubeless PCNL



The various variables of the study were comparable between groups are listed in Table 2. The location sites of kidney stones were found in three sites: pelvic stone 44 (48.9%), lower calyces stone 27 (30.0%) and pelvic stone + lower calyces stone 19 (21.1%). They found to be highly statistically significant with (*P* = 0.000), as shown in Table 2.

Postoperative pain was more common as moderate in both groups PCNL 38 (42.2%) followed by severe pain in both PCNL groups 34 (37.8%). The differences between the values of post operation pain in both PCNL groups were not found to be statistically significant (p = 0.962).

Twenty-one (23.4%) patients in the standard PCNL residual stones were found but none in the tubeless PCNL detected residual stones. The difference was statistically highly significant with (*P* = 0.000), Table 2.

We found 7 (7.8%) patients of the standard PCNL have fever while the group of tubeless PCNL were 2 (2.2%) with fever. Regarding fever, statistically significant differences were noted (p = 0.045). Fistula was seen in 4 (4.4%) of the patients in the standard PCNL group and 3 (3.3%) in the tubeless PCNL group.

There were no significant differences in terms of fistula (p > 0.05), Table 2.

Blood transfusion was provided to 8 (8.9%) patients postoperatively, distributed as

follows: 5 (5%) for standard PCNL patients and 3 (3.3%) for tubeless PCNL patients, (p > 0.05).

Additionally, in Table 2 we found patients who had standard PCNL had postoperative infectious 2 (2.2%) and not found in patients who had tubeless PCNL. No statistically significant differences were noted for postoperative infections (p = 0.205).

Mean operation-time for patients of the group standard PCNL was 95.7 ± 10.5 minutes while for tubeless PCNL was 92.6 ± 12.9 minutes.

Also, Table 2 shows the mean duration of hospital stay for both PCNL groups. The mean hospital stay of tubeless PCNL group was 4.31 ± 0.96 days while the mean hospital stay of standard PCNL was 5.12 ± 1.45 days, and the relation between the two means statistically significant (p = 0.02).

Table 2: Distribution of various variables related to standard and tubeless PCNL (n=90)

Variables	Standard and tubeless PCNL				Total		P-vale
	Standard PCNL		Tubeless PCNL				
	No	(%)	No	(%)	No	(%)	
Location of stone:							
Pelvic stone	35	(38.9)	9	(10.0)	44	(48.9)	0.000
Lower calyces stone	6	(6.7)	21	(23.3)	27	(30.0)	
PS and lower calyces	0	(0.0)	19	(21.1)	19	(21.1)	
Post operative pain:							
Mild	8	(8.9)	10	(11.1)	18	(20.0)	0.962
Moderate	18	(20.0)	20	(22.2)	38	(42.2)	
Severe	15	(16.7)	19	(21.1)	34	(37.8)	
Residual stones:							
Stone	21	(23.4)	0	(0.0)	21	(23.4)	0.000
Free stone	20	(22.2)	49	(54.4)	69	(76.6)	
Fever:							
Yes	7	(7.8)	2	(2.2)	9	(10.0)	0.045
No	34	(37.8)	47	(52.2)	81	(90.0)	
Fistula:							
Yes	4	(4.4)	3	(3.3)	7	(7.7)	0.400
No	37	(41.2)	46	(51.1)	83	(92.3)	
Blood transfusion:							
Yes	5	(5.6)	3	(3.3)	8	(8.9)	0.262
No	36	(40.0)	46	(51.1)	82	(91.1)	
Postop. infection:							
Yes	2	(2.2)	0	(0.0)	2	(2.2)	0.205
No	39	(43.4)	49	(54.4)	88	(97.8)	
Operation time:							
Mean time (minutes)	95.7 ± 10.5.		92.6 ± 12.9		94.0 ± 11.9		P > 0.05
Hospital stay:							
Mean (days)	5.12 ± 1.45		4.31 ± 0.96		4.68 ± 1.27		P = 0.02

PS and lower calyces stone = Pelvic stone and lower calycas stone, postop infection = postoperative infection, PCNL = percutaneous nephrolithotomy.

DISCUSSION

Since the first description of percutaneous nephrolithotomy, it has become an integral part of renal stone management. The placement of percutaneous tube after the completion of the procedure has been considered standard practice to aid in hemostasis, to ensure proper drainage of urine and to facilitate easy access in case repeat PCNL is required. Despite these apparent advantages, nephrostomy tube has been implicated in postoperative discomfort and morbidity. To reduce discomfort and tube related morbidity, modifications have been made like the use of smaller nephrostomy tube or avoiding it completely after an uncomplicated procedure with complete stone clearance with double-J stent as tubeless PCNL. Because there is still apprehension without using a DJ stent, few have tried a totally tubeless PCNL [13].

As a common urological disease, the prevalence rates for urinary stones vary from 1% to 20%. In countries with a high standard of life such as Canada or the United States of America (USA), renal stone prevalence is notably high (>10%) [1]. Urinary stones can cause renal function injury, which has a great impact on public health. With the advances of surgical

technology, less invasive procedures such as PCNL have gradually become a preferred therapy for urinary stone in the last two decades [14,15]. Using a nephrostomy tube for drainage has been considered the standard procedure after PCNL [16]. Since Bellman first introduced tubeless PCNL in 1997 [17], the interest and enthusiasm of this surgical procedure had been widespread. PCNL without postoperative nephrostomy tube placement is defined as tubeless PCNL. When neither a nephrostomy tube nor a ureteral stent is used, the procedure is commonly regarded as total tubeless PCNL [18]. A large number of studies on tubeless PCNL have been performed and several previously published systematic reviews have reported its efficacy and safety [16].

In our current study, the study patients were 90. They were (51.1%) females and (48.9%) males and female:male ratio was 1.1: 1. The difference between sex related to standard and tubeless PCNL showed a significant difference, (P = 0.000).

In our present study, the age of the study patients ranged between 20 to 60 years and the mean age was 38.1 ± 11.1 years. The highest number of patients were in the age group 30 – 39 years (40.0%).

The results of these analyses showed a significant difference between sex related to groups of tube and tubeless PCNL, (P = 0.000).

Urolithiasis is a common disorder with a prevalence of 10.9% in males and 9.5% in a female with a lifetime risk of recurrence of 50% within 10 years [19,20]. With the increasing life standard of people, the prevalence is gradually increasing [21].

A study conducted in Nepal by Thapa et al [22] reported that the age of their study patients ranged from 18 years to 70 years with a mean age of 40.50 years (SD ± 10.69).

We found in our study that the location sites of kidney stones were found in three sites: pelvic stone (48.9%), lower calyces stone (30.0%) and pelvic stone + lower calyces stone (21.1%). They found to be highly statistically significant with (*P* = 0.000).

A study conducted in Pakistan, by Ahmad et al [23] reported in their study that the most common location of the stone in all the groups was the renal pelvis, followed by the lower calyx. Other less common locations included upper calyx, middle calyx, all calyces, pelvic ureteric junction, proximal ureter, distal ureter, and bladder.

In our present study, we found postoperative pain was more common as moderate in both groups PCNL (42.2%) followed by severe pain in both PCNL groups (37.8%). The differences between the values of postoperative pain in both PCNL groups were not found to be statistically significant (p = 0.962).

PCNL is the gold standard surgical treatment, and it plays an important role in managing especially large (> 2 cm) renal stones and/or staghorn renal stones. However, it is difficult to perform PCNL, which is greatly affected by the composition, size, and location of the stones. Severe cases are mainly complicated by septic shock and renal failure [24,25].

Haotian et al [26] showed that the incidence of moderate-to-severe postoperative pain after PCNL was about 60%. Postoperative pain after PCNL has important negative effects on patients' postoperative rehabilitation, daily activities, quality of life, and social and economic conditions [27].

In the current study, (23.4%) patients in the group of standard PCNL, residual stones were found but none in the tubeless PCNL detected residual stones. The difference was statistically highly significant with (*P* = 0.000).

Percutaneous nephrolithotomy is an effective procedure which is being considered as the gold standard in the treatment of large/complex renal calculi. Reported stone free rates are up to 90%, probably reflecting the level of experience, stone properties and equipment employed in the procedure [28]. Residual stone fragments are generally defined as stone fragments remaining in the urinary system

after the completion of an intervention extracorporeal shock wave lithotripsy (ESWL), ureterorenoscopy (URS) or PCNL. Clinically insignificant residual fragments (CIRFs) are described as asymptomatic, non-infectious and non-obstructive stone fragments (≤4 mm) which can occur in 70% of patients with large stones undergoing PCNL [29,30]. With no treatment, nearly half of these patients will experience a stone-related event, and among them, 50% of these will need a secondary intervention [31].

In a study by Ganpule et al [32], there were 2469 patients who underwent PCNL were evaluated and residual fragments were identified in 7.57% of the patients. The assessment of residual stones was made by a combination of ultrasonography and KUB at 48 hours, 1-month and 3 month follow-up.

Altunrende et al [33] evaluated the 3 year follow-up data of 430 patients who underwent PCNL. The residual fragments were identified in 22% of the cases and the assessment was made by KUB postoperatively.

In the present study, we found (7.8%) patients of the group standard PCNL have fever while the group of tubeless PCNL were (2.2%) with fever. Regarding fever, statistically significant differences were noted (p = 0.045).

Higher than our findings were reported by Kara et al study, in which fever was seen in (6.6%) of patients in the tubeless PCNL group and (10%) of patients in the standard PCNL group [34].

In the present study, blood transfusion was provided to (8.9%) patients postoperatively, distributed as follows: (5.0%) for standard PCNL patients and (3.3%) for tubeless PCNL patients, (p > 0.05).

A study conducted in Nepal [22] found that bleeding was slightly higher (4 vs. 2 patients) in tubeless PCNL than in standard PCNL. They mentioned that significant bleeding requiring blood transfusion was lesser in the tubeless PCNL group.

In our present study, patients who had standard PCNL had postoperative infectious (2.2%) and not found in patients who had tubeless PCNL. No statistically significant differences were noted for postoperative infections (p = 0.205).

Ahmed et al [23] found in their study to some extent similar results to our findings. They reported that the rate of problems during operation and postoperative complications was significantly higher in standard PCNL when compared to other techniques.

Istanbulluoglu et al [5] also showed that tube PCNL had the highest complication rates.

Desai et al [6] concluded that tubeless PCNL was better when they compared it with conventional large and small-bore PCNL.

In our present study, the mean operation-time for patients of the group standard PCNL was 95.7 ± 10.5 minutes while for tubeless PCNL was 92.6 ± 12.9 minutes.

Thapa et al [22] reported that of 100 patients the mean operating time in minutes in tubeless PCNL was 47.10 ± 5.67mins and in the standard PCNL was 49.36 ± 5.62mins (p = 0.04). Falahatkar et al [35] also observed that the average operative time was shorter in the tubeless group than in the standard group (93.76 v 109.98 minutes, respectively (p = 0.03).

In our current study, we found the mean hospital stay of tubeless PCNL group was 4.31 ± 0.96 days while the mean hospital stay of standard PCNL group was 5.12 ± 1.45 days, and the relation between the two means statistically significant (p = 0.02).

Mousapour et al [36] reported that hospital stay in patients, who underwent tubeless PCNL, was significantly lower than those in the standard PCNL group. Tefekli et al [37] reported that hospitalization time in patients, who underwent tubeless PCNL was reduced compared to standard PCNL (1.5 versus 3.2 days). This finding was much lower than in our study results.

Thapa et al [22] reported that the mean duration of hospital stay in our study for tubeless PCNL was 3.54 ± 0.91 and standard PCNL was 4.56 ± 0.91 days (p

<0.001). Different studies show the duration of the hospital is less in tubeless PCNL as compared to standard PCNL [36,38].

CONCLUSION

Tubeless PCNL proved to be the safest and most effective when compared to standard PCNL procedures, in terms of postoperative pain, residual stones, providing blood transfusion, postoperative fever, postoperative infectious, operation-time and duration of hospital stay. Tubeless PCNL does not carry any significant risk of postoperative complications. Tubeless PCNL also showed the highest stone-free rates, shorter operative time, and shorter hospital stay.

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