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ORIGINAL ARTICLE

Outcome of tubeless percutaneous nephrolithotomy in elder patients: A single-center experience from a developing country

Nadeem Iqbal[1]*, Sajid Iqbal[2], Aisha Hasan[3], Aimen Iqbal[4], Keron A. A. Blair[5], Dan M. J. Milstein[6], Saeed Akhter[1]

[1]Department of Urology and Kidney Transplant, Shifa International Hospital, Islamabad, Pakistan, [2]Department of Rehabilitation, Pakistan Navy PNS Hospital, Karachi, Pakistan, [3]Department of Biochemistry, Riphah International University, Rawalpindi, Pakistan, [4]Department of Medicine, Bahria University Medical and Dental College, Karachi, Pakistan, [5]Department of Medicine, American International School of Medicine, Georgetown, Guyana, [6]Department of Oral and Maxillofacial Surgery, Amsterdam University Medical Centre, Location: AMC, Amsterdam, Netherlands

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**Corresponding author:*
Nadeem Iqbal
Department of Urology and Kidney Transplant, Pakistan Kidney Institute, Shifa International Hospital Ltd. Pitras, Bukhari Road, Sector H-8/4, Islamabad, Pakistan.
E-mail: dr_nadeemiqbal84@yahoo.com

ABSTRACT

Background: Percutaneous nephrolithotomy (PCNL) has evolved as a standard procedure to treat large-sized renal stones. A nephrostomy tube is used frequently in this procedure; however, data regarding tubeless PCNL procedures in elder patients is scarce.
Aim: The aim of this study was to review the results and outcomes associated with tubeless PCNL procedures in the elderly population.
Materials and Methods: A retrospective review of patients aged ≥60 years at our hospital that was treated for renal stones by PCNL procedure. The patients were separated into two groups: Group 1 underwent tubed PCNL procedures and Group 2 received tubeless PCNL procedures. Information regarding variables were recorded in specified pro forma and then processed in Statistical Package for the Social Sciences statistics analyses. Statistical tests were utilized for continuous and categorical variables and a $P<0.05$ was considered statistically significant.
Results: 121 patients with a mean age of 65±5 years were included in the analysis. Mean stone size and body mass index were 3.4±1.5 cm and 26.2±4.3 kg/m^2, respectively. Mean operative time was longer in tubed PCNL as compared to the tubeless group. Mean hospital stay was similar among the tubed and tubeless PCNL treated groups. Mean analgesic doses were significantly lower in the tubeless group. The overall stone-free rate was 89/121 patients (74%).
Conclusion: Tubeless PCNL can be safely undertaken in geriatric patients and has potential advantages associated with shorter operative times and reduced necessity for analgesia.
Relevance for Patients: Tubeless PCNL is considered advantageous as it can reduce post-operative pain and analgesia necessity; shorten hospitalization and lower cost in young patients. However, there is no clear evidence with reference to virtue of tubeless PCNL in the elderly age groups. This study will analyze and review results and outcomes associated with tubeless PCNL in a cohort of elderly patients.

1. Introduction

Percutaneous nephrolithotomy (PCNL) was introduced in 1970s, at that time mainly it was an adjunct procedure to open surgery indicated for large renal stones [1-4]. Gradually, the PCNL procedure replaced open surgery for renal stones management due to its higher success rates, lower morbidity, and post-operative complications. Nowadays, PCNL is a procedure of choice for large (>2 cm) sized renal stones or nephrolithiasis [2-4]. Conventional PCNL is performed using a tube. The advantages of using a nephrostomy tube are ascribed to adequate drainage of the collecting system, tamponades effect to stop

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bleeding of the renal tract, prevention of urinary extravasation, and provision of opportunity for permission of future access for any elective second-look procedures (i.e., in case of incomplete stone removal by a first procedure).

The installation of a nephrostomy tube had its associated problems such as early postoperative discomfort, longer inpatient stay, and enhanced need for analgesics postoperatively [5,6]. Tubeless PCNL has several inherent advantages that include diminished post procedural pain and reduced necessity for analgesics, evading problematic symptoms related to *in situ* stents, brief inpatient stays, and reduced overall costs [6-8].

A lot of centers have reported outcomes of tubeless PCNL procedures in young patients. It is rapidly becoming a substitute for tubed PCNL procedures in young patients, where there is nominal bleeding or when seemingly the bulk of residual calculi is very small [6-9]. In cases of elderly aged patients reports of tubeless PCNL procedures are meager and shared by very few centers worldwide. To that end, a vivid affirmation regarding usefulness of tubeless PCNL procedure in the elderly is still required in order to determine their clinical benefits for geriatric patients. The elderly are often frail and have comorbidities which render them more prone to develop intraoperative or post-operative complications. Therefore, PCNL procedures in the elderly may prove challenging at times [9,10]. The aim of this study was to review and examine the variance in net results (e.g., stone-free rates and post-operative complications) between tubed and tubeless PCNL procedures in a cohort of elderly patients.

2. Materials and methods

We conducted a retrospective review of records available at the medical record keeping department at our hospital after formal review and approval by our institution's medical ethics committee and board. This review included all patients aged ≥60 years at our hospital who underwent surgical treatment for renal stones by PCNL procedures. These included patients treated between December 2010 and December 2019 at our department. The study aimed to draw comparison between tubeless and tubed PCNL and with regard to their body mass index (BMI), stone clearance, total operative time, post-operative complications (e.g., sepsis), blood transfusion, perinephric collection, and hospital stay. Subjects who had undergone standard tubed PCNL procedures were allocated to Group 1 and those who had tubeless PCNL procedure in Group 2; both were compared for variables as listed above. All patients that had renal stone dimensions exceeding 2 cm and that consequently underwent PCNL were included in this study. Patients who had shown bacterial growth in urine, had compromised renal function, open stone surgery on the ipsilateral kidney in the past, previous sessions of shock wave lithotripsy, those who required more than two tracts and had bleeding disorders were excluded from the final analysis.

Informed consent was taken from all the patients. All patients consented and underwent mandatory preoperative evaluation with complete hematological analysis, renal function tests, ultrasound of the kidneys, ureters and bladder (KUB), KUB radiograph, serum biochemistry, urine cultures, coagulation profiles, and non-contrast computed tomography (CT). At the initial outpatient clinic visit, detailed, and relevant history was noted in patient charts followed by pertinent physical examination. Radiological studies to evaluate size and location of the renal stones comprised of KUB radiographs, KUB ultra sonographic studies and ultimately CT. Stone complexity was graded by utilization of Guy's stone score [11].

Perioperative data included variables such as entry by supracostal/infracostal site, number of PCNL access tracts, the tract size, the calix for puncture, mean operative time and perioperative complications (e.g., adjacent organ injury and excessive bleeding with poor visual field during surgery), use of PCN tube after the procedure, hospital stay, and need for analgesics. Post-operative outcome assessment included stone-free status, residual stones found on post-operative KUB radiograph and KUB ultrasound. Complications were recorded according to the modified Clavien-Dindo classification system.

2.1. Surgical procedure

All PCNL procedures were performed with the patient laying in a prone position under general anesthesia. One dose of a first-generation cephalosporin antibiotic was administered intravenously at the time of the anesthesia induction. Triangular or Bull's eye technique was utilized according to case. A lower pole puncture was preferred to gain entry into the calyx while guided by contrast assisted opacification of the collecting system. An 18 G needle was passed into the desired place within the kidney. Then over the wire increasing size fascial dilators were passed. Later on, Alken metallic dilators were pushed over the olive tip for tract creation. Following this, an Amplatz sheath (24-30 Fr) was placed into the created tract and nephroscopy was carried out to locate and then retrieve the renal stones. Pneumatic lithoclast was applied for stone disintegration. Stone grasper (i.e., three-prong grasper) facilitated stone retrieval. The decision of excluding the use of a nephrostomy tube (i.e., the tubeless procedure) was decided when there were no signs of disruption of the pelvicalyceal system on fluoroscopy (i.e., evidence of leakage of the contrast), there was little bleeding during the procedure, if there was good visualization of stone fragments and complete stone removal and an uneventful surgical procedure or when residual stones left inside kidney were very small and insignificant (i.e., <4 mm).

2.2. Patient follow-up

On follow-up visits KUB ultrasound and KUB radiographs were obtained at 1 month and 3 months to inspect for any residual stone fragments. Patients were declared stone-free if they had <4 mm residual stones. The total costs incurred in the whole process included the preoperative office visits, investigations, operating finances, inpatient room charges, medications used, and charges of additional treatments involving if necessary readmissions for complications or repeat cultures tests and the need for shock wave lithotripsy procedures in case of failed PCNL.

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2.3. Statistical analysis

Data were collected in the pro forma by the urology resident and then entered in the statistical analysis file. Analysis was accomplished using Statistical Package for the Social Sciences (SPSS) (SPSS Statistics version 16, SPSS Inc., Chicago, USA). Mean±standard deviation was used for continuous variables (e.g., age and operative time). Frequency (e.g., post-operative complications) and percentages were used to represent categorical factors. A Student's t-test was used for comparing continuous factors and Chi-squared test was to be applied to weigh up categorical values between the groups. $P<0.05$ was judged as statistically significant.

3. Results

In total 121 subjects were incorporated in the final analysis. The overall mean age of patients was 64.60±5.17 years. While the mean calculus and BMI were 3.35±1.48 cm and 26.20±4.30 kg/m^2, respectively. Both tubed and tubeless PCNL groups had similarities in terms of mean age, laterality of stones, gender, stone size, and BMI (Table 1). The majority of stones in both groups were Guy's stone score 1 (Table 1). The complexity of stones formulated on Guy's stone score was similar in both groups.

The overall mean procedure time was significantly longer in the tubed PCNL procedure group versus the tubeless PCNL treated group (Table 2). Similarly, mean analgesic doses were significantly lower in the tubeless PCNL group in this cohort (Table 2). The inpatient stay was slightly longer (not statistically significant) in the tubed PCNL group in contrast to the tubeless PCNL group. The overall costs were US $1,410 versus US $1,388 in tubed PCNL versus tubeless PCNL groups; this was not significantly different (Table 2). Finally, the stone-free status was accomplished in 89/121 patients (74%) nevertheless, it too was not dissimilar among the two groups (P=0.54).

Complications were described in line with the Clavien-Dindo Classification. It is evident from Table 3 that most of the complications encountered in this cohort were of minor grades. Transfusion rate was a bit higher in the tubed PCNL procedure group in contrast to the tubeless PCNL procedure group; however, the difference was not significant (Table 3). Similarly, transient hematuria rates were higher in the tubed PCNL group; however, statistically it was not significant. One patient needed a bladder wash in the tubed PCNL procedure group due to minor clots blocking the Foleys catheter, this condition was managed successfully. Sepsis was encountered more in the tubed PCNL procedure group; still it was not statistically significant when compared to the tubeless PCNL procedure group (Table 3). Major complications such as excessive bleeding requiring angioembolization or nephrectomy were not observed in any of the groups.

Table 1. Demographic variables

	Tubed PCNL	Tubeless PCNL	*P*-value
Number	70	51	
Mean Age	65.37±4.34 years	63.55±6.01 years	0.069
Male	49 (70%)	37 (72.54%)	0.46
Female	21 (30%)	14 (27.45%)	
Right Renal stone	38 (54.2%)	17 (33.33%)	0.03
Left Renal stone	32 (45.8%)	34 (66.67%)	
Body mass index	26.75±4.26	25.37±4.28	0.10
Mean stone size (cm)	3.19±1.45 cm	3.57±1.50 cm	0.17
Guys Stone Score			
Guys Stone Score 1	34 (48.57%)	27 (52.94%)	0.85
Guys Stone Score 2	21 (30%)	15 (29.41%)	
Guys Stone Score 3	8 (11.42%)	5 (9.80%)	
Guys Stone Score 4	7 (10%)	4 (7.84%)	

Table 2. Details of procedure outcomes

	Tubed PCNL	Tubeless PCNL	*P*-value
Stone free rate	51 (72.85%)	38 (74.50%)	0.54
Residual stones	19 (27.15%)	13 (25.49%)	0.50
Mean operative time	153.91±75.48 min	137.8±118.8 min	0.03
Hospital stay	3.31±1.3 days	3.08±0.9 days	0.40
Analgesic doses	4.42±1.1	3.31±1.59	0.004
Costs	1410.13±182.03	1388.63±97.91	0.44

4. Discussion

There is scarcity of clinical information regarding studies concerning tubeless PCNL in the geriatric population. This study aimed to provide an overview and comparison between tubed PCNL and tubeless PCNL procedures in the elderly patient. A retrospective analysis of results and outcomes associated with tubeless PCNL procedures in a cohort of elderly patients was analyzed. The results indicate that postoperative morbidity and recovery are significantly improved with tubeless PCNL procedures in the elderly in comparison to tubed PCNL procedures. The results also provide an estimated favoring the safety and usefulness of tubeless PCNL procedures in elder patients.

It is considered standard practice to place a nephrostomy tube after completion of a PCNL procedure. Its main purpose is to provide an adequate drainage of kidney after PCNL procedures, create a tamponade effect on the PCN tract in order to stop bleeding from the tract and provide the opportunity for a second relook procedure to clear out remnant renal stone fragments (i.e., if not cleared by teh first PCNL procedure) [12]. Nowadays, tubeless and total tubeless procedure has been adopted widely in young age patients. Moreover, studies regarding outpatient PCNL is also under way [7-10,12]. All the progress and modifications associated with PCNL procedures are providing ample and suitable choices available to surgeons [9-12]. Tubeless PCNL procedures has become a favored practice among practicing urologists since it was first introduced [7]. Tubeless PCNL techniques have resulted in shorter inpatient stay, diminished post-PCNL pain and analgesic demands and without inflated rates of adverse outcomes [9-12]. In the present retrospective study, requirements for analgesics were reduced in the tubeless PCNL group.

Comorbidities such as atherosclerotic condition, cardiovascular disease, and intake of blood anticoagulating agents are frequent

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Table 3. Complications

Complication grade	Type complication	Tubed PCNL	Tubeless PCNL	*P*-value
1	Fever	1 (1.4%)	2 (3.9%)	0.31
1	Illeus without need NG tube	1/70 (1.42%)	0/51 (0%)	1.0
1	Pelvicalyceal puncture (extravasation)	3/70 (4.28%)	0/51 (0%)	0.26
1	Transient hematuria	8/70 (11.4%)	5/51 (9.8%)	1.0
2	Transfusion	4/70 (5.71%)	2/51 (3.9%)	0.10
2	Sepsis	4/70 (5.71%)	1/51 (1.96%)	0.29
3	Bowel injury	0%	0%	
3	Renal vascular injury requiring angioembolization	0%	0%	
4	Septic Shock ICU manage	0%	0%	
5	Death	0%	0%	

in geriatric patients. Despite these odds, PCNL has been adopted safely in few centers [11]. Epidemiological surveys have appraised the annual incidence of renal calculi around 2% in the United States in elder patients (≥65 years) [13]. Diminished pain and brief inpatient stays are desirable in elderly patients and can be attained by performing tubeless PCNL procedure. This, in turn, will result in decreased rates of myocardial infarction in this these patients. Early mobilization after tubeless PCNL procedures helps evade deep vein thrombosis in these vulnerable renal stone patients [14]. In the present study, there were no major complications after surgery. Various studies have found that reduced morbidity is achieved if smaller bore nephrostomy tube is placed after PCNL [15]. In a randomized study by Maheshwari *et al*., [16] a comparison of 28Fr tube versus 9Fr pigtail catheter was analyzed, the results showed a diminished intensity of pain, lower analgesic demands, minor seepage of urine, and curtailed span of inpatient stay in patients with pigtail catheters [16]. In the present study, the need for analgesia was reduced in the tubeless PCNL procedure cases as compared to the tubed PCNL procedure group. In one meta-analysis, Ni *et al*. [17] deduced that post-PCNL pain correlated with the width of tube used [17]. In yet another meta-analysis by Shen *et al*., it was noted that there was inflated transfusion rates, frequency of fever and risk of infections when increased diameter of a tube was placed [18]. In the present study, the rates of transfusion was relatively higher in the tubed PCNL procedure group (6% in tubed PCNL versus 4% in tubeless PCNL). Tubeless PCNL has been experimented efficiently in cases with recurrent stones and surgeries, obese patients, pediatric patients, and stones in solitary kidneys [9-23]. Our results are positive and encouraging as this study describes the initial experience of our center with elder patients and with fewer number of minor grade complications.

There are different studies with different systematic scales and cutoff points for assessing residual stone fragment size in order to define stone clearance. We had a cutoff value of <4 mm residuals in order to consider our patients stone-free, this explains the 74% success out of 121 patients. For example, in one study by Ozturk *et al*. [24], treatment success was defined as no residual stone fragment >5 mm on post-operative CT or abdominal radiography, and no need for any further intervention. If we had taken the 5 mm cutoff value then our stone-free rate would have reached above 90%. The mean stone size was 3.5 cm in a study by Lai *et al*. [25] and they achieved a stone-free rate of 78%. In the present study, we had mean stone size of 3.6 cm in the tubeless PCNL group. In yet another study by Ichaoui *et al*., with a renal stone size matching our study (3.6 cm), their stone-free rate reached 71% [26]. In yet another study by Kuntz *et al*. [27], the overall stone-free rate was 53%, their patients has a higher BMI than the patient cohort of our study.

Kara *et al*. [28] inferred in their study that tubeless PCNL procedures were acceptable and effectual in elders (≥60 years age) and that remarkably diminished analgesia demands in contrast to standard PCNL. Choi *et al*. did not notice any significant complications in tubeless PCNL group; however, the costs were appreciably reduced in the tubeless PCNL group [7]. In our study, the overall costs were slightly higher in the tubed PCNL group versus the tubeless PCNL group. Similarly, most of the complications encountered in present study were of minor grades. Transfusion requirement was elevated in the tubed PCNL procedure group, although this observation was not found to be statistically significant. Aghamir *et al*. [29] concluded that in atypical renal anatomy, the tubeless PCNL procedure resulted in a significantly enhanced period of recovery and reduced requirement of analgesic doses regardless of stone burden. In our study, the mean analgesic doses were significantly lower in the tubeless PCNL procedure group (4.4±1.1 in tubed PCNL versus 3.3±1.6 in tubeless PCNL group). Better pain control results in early mobilization of patients which is better for recovery, especially in elderly patients. Zilberman *et al*. [30] discovered disparity in terms and viewpoint regarding "tubeless" PCNL procedures amidst comparative studies and underscored the need for randomized trials to reduce inter-study bias. In study by Ozturk *et al*., the duration of operation was less for tubeless PCNL than for tubed PCNL. Similarly, in our study the mean operative time was significantly shorter in the tubeless PCNL group (137±119 min) when compared to the tubed PCNL group (154±75 min).

Ozturk *et al*. also noted an increased stone burden and prolonged procedure more commonly associated with the standard PCNL [24]. According to their observations, the duration of inpatient stay was 1.7 days in those who underwent tubeless

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PCNL procedures in contrast to 2.6 days in patients receiving the standard PCNL group (P<0.05). In the present study, the hospital stay was slightly longer in the tubed PCNL group when compared to the tubeless PCNL group, however it too was not statistically significant. In their study, the load of stone reached 900 mm^2 (304-4232) in the standard PCNL group while 600 mm^2 (220-2660) in the tubeless PCNL group (P=0.014). There was one patient in our study who required two tracts as he had a staghorn stone. Ozturk *et al*. [24] mentioned that stone burden exceeding 916 mm^2 raised the rate of standard PCNL. However, according to our study, tubeless PCNL could be performed in cases with complex stones in carefully selected patients. The complexity of stones based on Guy's stone score was similar among the two groups in the present study. Ozturk *et al*. did not take into account such stone complexity among the two groups, which we did. In one large series by Lai *et al*., relating to tubeless PCNL procedures, postoperative complications included urgent nephrectomy in one case (0.1%) and angiographic embolization in one (0.1%) patient [25]. We did not encounter any case of nephrectomy nor the need for renal artery angioembolization in any of our patients.

Since many of the patients in our study were on the panel of insurance companies, we could care for them relatively longer on the whole. Another point to be noted is that our hospital duration was counted from the time of admission to the hospital instead of postoperatively. We had to see the whole impact of hospitalization duration right from start of admission in the preoperative ward until their discharge day from the hospital, as the insurance panel also includes the day spent in pre-operative period in the inpatient ward. If we did not count the day before surgery then our hospital duration would have been 2–2.3 days which is still shorter as compared to recent studies conducted in young patients. For example, in study by Lai *et al*. [25] hospital stay was 3.7 days (i.e., longer duration than in our study). In another study by Ichaoui *et al*. [26] hospital stay was approximately 3.81 days.

Some limitations and points of consideration should be addressed. This study was a retrospective design due to paucity of elder age cases and was a single-center experience. Second, to the best of our knowledge, this study describes the largest number of elder patients studied for feasibility of tubeless PCNL procedures in world and is the first of its kind in elderly patients in Asia. Multicenter prospective studies have not been undertaken in this age group yet and should be considered in future randomized controlled trials.

5. Conclusion

This study is the first in Pakistan to have examined and elaborated on the end results associated with tubeless PCNL in a cohort of geriatric patients. Tubeless PCNL procedures can be safely undertaken in carefully selected geriatric cases and it has potential advantages that result in reduced operative times and reduced necessity for postoperative analgesia. Both tubed and tubeless PCNL procedures shared similarities related to mean hospital stays and treatment costs. We believe this is an important study with regard to tubeless PCNL procedures and its potential in reducing hospital stay due to decreased need for analgesia management and thus reduced health-care costs.

Conflict of interest

The authors have no conflict of interest to declare.

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