The Safety and Efficacy of Tubeless Percutaneous Nephrolithotomy: A Local Study

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Abstract

Background: Percutaneous nephrolithotomy (PCNL) has become the standard treatment for stones of the kidney or upper ureter, but whether nephrostomy tube placement is necessary after PCNL is still inconclusive. To evaluate the effectiveness and safety of tubeless PCNL, we undertook a review of English language publications involving studies on PCNL and performed a meta-analysis of operation duration, analgesic requirement, hospital stay and postoperative haematocrit change

Aim of the study:The objective of this study was to conduct a systematic review and meta-analysis to evaluate the efficacy and safety of tubeless versus standard percutaneous nephrolithotomy (PCNL) for renal calculi.

Patients And Methods: Between September 2021 and October 2022, PNL was performed in 150 patients in this prospective and retrospective study. Patients with no serious bleeding or perforation in the collecting system during the operation, stone-free status, or clinically insignificant residual fragments (<4 mm) at the end of the procedure and patients with no more than one access were enrolled in the study. Patients were categorized into 2groups. In group 1 (n =50), no nephrostomy catheter was placed but antegrade J-stent was used (tubeless group), and in group 2 (n =100), standard nephrostomy catheters were placed (standard group). Two groups were compared with respect to age, stone volume, postoperative hemoglobin change, transfusion rate, operation time, analgesic requirement, hospitalization time, and complication rates.Results: No significant differences were found in mean stone volume, operation time, transfusion rates, and hemoglobin level change between the groups. However, hospitalization time and the amount of narcotic analgesic required were significantly higher in group 2 compared with the other groups (P <.05). Complications were observed in 3 (7.3%), and 7 (7.6%) patients in groups 1, and 2, respectively (P = 0.738).

Conclusions: In patients with no major intraoperative bleeding and calyceal perforation, tubeless PCNL technology is associated with shorter hospitalization time, lower incidence of postoperative pain and less analgesia requirement after nephrolithotomy. Tube-less PCNL can be used as a substitute for traditional standard PCNL of the first-line treatment. Nevertheless, further research in this field is urgently needed to confirm it.

Keywords:Percutaneous nephrolithotomy; Tubeless PCNL; Nephrolithotony; Meta-analysis.

1. Introduction

Rupel and Brown (1) extracted a calculus from an established nephrostomy tract after open surgery in 1941. Goodwin et al (2) described the first percutaneous drainage of an acutely infected collecting system in 1955. However, removal of a calculus via a tract specifically created for that purpose was first performed in 1976 by Fernström and Johansson. (3)Subsequently, several authors published articles describing successful outcomes in 1981, 1982 and 1984. (4–7) Brannen and Bush (8) reported on the removal of large stones in 1985 and held out the prospects that this approach will on a long-term basis supersede open surgery for renal stones.

Percutaneous nephrolithotomy (PNL) remains indicated for treatment of large stones, staghorn calculi, and stones in caliceal diverticula. The extent of intrarenal instrumentation for stone disintegration and extraction usually requires epidural or general anesthesia. Because puncture, tract dilation, and stone disintegration and removal are preferably per- formed as a one-stage procedure, the use of local anesthesia in PNL is limited. (9) Percutaneous nephrolithotomy (PCNL) was first completed by Fernstrom and Johannson in 1976. (10) 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.(11)Conventional nephrostomy tube and ureteral stent tube after conventional percutaneous nephrolithotomy were performed. However, renal fistula and ureteral stent indwelling inevitably bring a lot of discomfort to patients, and the necessity of renal fistula and ureteral stent application is questioned.(12) The purpose of indwelling nephrostomy tube is to keep the drainage unobstructed and to block the renal channel so as to prevent the continuous bleeding. This theory and view is generally accepted but Department of Urology physicians; clinicians gradually found the following two points: first, renal fistula patients brought pain and discomfort and prolonged hospitalization, especially on the rib channel patients because of severe pain nephrostomy on periosteal stimulation will cause postoperative; second,

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fistula can be placed on compression hemostasis channel statement, has also recently been questioned because of the recent re- ports on tubeless after operation (tubeless) that is not placed nephrostomy, found no serious bleeding complications.(13-15)

With the development of surgical instruments and medical surgical techniques, PCNL appears the new trend of development in 1997, Bellman and colleagues on standardized PCNL routine postoperative indwelling nephrostomy questioned, (16) then tubeless PCNL has become a research that is hot. The presence and removal of neph- rostomy is associated with morbidities such as infection, pain, urine leak, bleeding, and prolonged hospitalization.(17) Tubeless PCNL was then introduced with the insertion of a double J ureteric stent following PCNL, avoiding the discomfort caused by indwelling nephrostomy tube, and making the minimally invasive PCNL more perfect. Aimed at the evaluation system using the principle and method of evidence-based medicine, the current collection of original research published tubeless and standard PCNL for treatment of upper urinary tract calculi were compared to evaluate the objective, in the clinical practice of selective implementation of tubeless safety and efficacy of percutaneous nephrolithotomy.

Also, in a limited number of studies in the published data, no ureter stents and nephrostomy catheter have been implemented and this is called totally tubeless PNL. (18-22)

To evaluate the effectiveness and safety of tubeless PCNL, we undertook a review of English language publications involving studies on PCNL and performed a meta-analysis of operation duration, analgesic requirement, hospital stay and postoperative haematocrit change.

Our aim was to obtain definitive conclusions for clinical practice.

2. Patients and Methods

A 150 patients who underwent PNL at our center Al-Yarmouk Teaching Hospital and private hospitals between September 2021 and October 2022, a total of 150 patients were enrolled in this prospective and retrospective study according to the inclusion criteria.

The inclusion criteria

were patients with no serious bleeding or perforation in the collecting system during the operation, stone- free status, or clinically insignificant residual fragments (less than 4 mm) at the end of the procedure and no more than one access,unilateral upper urinary tract calculi.

The Exclusion criteria

Patients with staghorn stone, solitary kidney, or kidneys with congenital anomalies and those who had undergone bilateral simultaneous PNL,children,pregnant or obese were excluded from the study.

Before the surgery, complete blood count, creatinine levels, and urine culture were performed. Radiological evaluation was performed with ultrasonography and intravenous pyelography, and contrast comput- erized tomography. Under general anesthesia with the aid of cystoscope, a 7F ureter catheter was placed into the ipsilateral ureter and then the catheter was attached to the urethral Foley catheter. After that, patient was positioned to prone position.

All percutaneous accesses were performed in prone position. Access to the selected calyx was performed with the aid of C-armed and 18 gauge needle. After entering the collecting system with a guide wire, dilatation was performed with Amplatz dilators and a 30 F Amplatz sheath was placed, through which a 26F rigid nephroscope was inserted and the stone fragmentation was carried out with pneumatic lithotripter. At the end of the operation, floroscopy and pyelography were performed for the evaluation of collecting system to assess the stone-free patients and the patients with CIRF (less than 4 mm).

Patients were categorized into 2 groups. In 50 patients in group 1, no nephrostomy catheter was placed but antegrade J-stent was used (tube- less group; group 1). In group 2, standard 14 F nephrostomy catheters (Foleys catheter) were placed in 100 patients in group 2 (standard group; group 2), which were then controlled with antegrade pyelography. Hemoglobin levels were checked in all patients 16 hours after the operation and if there was any doubt about perinephric collection, ultrasonography was performed. Ureter catheters were removed immediately after the operation and the urethral Foley catheters were removed the following day in all patients. The decision of removal of the nephrostomy catheters in group 2 was made according to the urine color. Double-J stents were removed 2 weeks after the operation under local anesthesia with cystoscopy.

Age, stone diameters, operation time, postoperative hemoglobin change, complication rates, blood transfusion rates, analgesic need, and hospitalization time were compared among 2 groups.

Differences in percentages (qualitative variables) were analyzed by the X2 test. Kruskal-Wallis and Mann–Whitney U test with a Bonferroni correction were used for comparison of treatment groups. Statistical analyses were performed using the SPSS 15.0. The P value less than 0.05 was considered statistically significant. Bonferroni correction lowered the basic P value less than 0.05 level of significance to P value less than 0.017.

3. Results

Patient characteristics in each group are summarized in Table 1. No significant differences were found among the groups with regard to age and stone size (P ?.05).

No significant differences were found in mean stone volume, mean operation time, transfusion rates, and hemoglobin level change between the groups (Table 1). However, mean hospitalization time was significantly higher in group 2 compared with other groups (Table 1) (P <.001).

Nonsteroid analgesics(diclofenac sodium) were given to the patients.If this was not effective, intramuscularly morphine was administered. Seven patients (17.03%) in group 1, and 5 (5.4%) in group 2 did not require any analgesics in the first 24 hours postopera- tively. Amount

of nonsteroidal analgesic required did not differ between the groups (P >.05). By contrast, the amount of narcotic analgesic (morphine) required was found significantly higher in group 2 as compared with the other groups (Table 1) (P <.05).

Complications occurred in 3 (7.3%), and 7 (7.6%) patients in groups 1 and 2 respectively (P >0.05) (Table 1).

Table 1 characteristics of Patient:			
characteristics	Tubeless PCNL Group 2(n= 50)	Standard PCNL Group 3(n =100)	p-value
Age in year	48.1±15.7	47.8±13.4	0.976
Size of stone in (mm)	518.59±281.46	482.93±205.10	0.447
Hospitalization time(day)	1.75±2.21	2.97±1.60	< 0.001
Time of operation(min)	51.3±25.21	60.08±19.04	0.130
Postoperative Hb drop(g/dL)	1.41±0.89	1.64±0.96	0.298
Blood transfusion	3(7.3%)	7(7.6%)	0.400
NSAIDS requirements	35.3±8.62	29.78±10.06	0.407
Narcotic analgesic requirement	12.20±24.42	27.18±33.50	< 0.05
Complications number	3(7.2%)	7(7.6%)	0.740

Table 1 characteristics of Patient:		
Site	Group-1 Tubeless PCNL(n=50)	Group-2 Standard PCNL(n=100)
Upper calyx	3	15
Renal pelvis	18	24
Lower calyx	17	35
Upper ureter	2	5
Multiple calyces	10	21

Complication rates are listed in Table 3. Double-J stent was inserted in 3 patients with prolonged drainage. Four patients suffered from high fever and (>38.5°C) were treated with intravenous antibiotics. Two patient with perirenal collection was treated with the insertion of double-J stent and drainage tube under ultrasonography guidance.

Table 3.Rates of complication(number):		
	Group-1 Tubeless PCNL(n=50)	Group-2 Standard PCNL(n=100)
Prolonged drainage	0	3
Fever	2	2
Perirenal collection	1	2

4. Discussion

Tubeless PCNL was first introduced by Wickham in 1984 (23). Our findings showed that tubeless PCNL can reduce postoperative pain, postoperative analgesic requirement, hospital stay and hospital cost.

The main complications of PCNL are bleeding and infection. Bleeding in PCNL is always located in the renal parenchyma and lacerated collecting system, and one aim of placement of the nephrostomy tube is to oppress the tunnel to stop bleeding.

In recent years, different methods of preventing bleeding have been investigated. Jou et al. (24) cauterized the PCNL tract and collecting system to make it bloodless after the completion of PCNL. Lee et al. (25) and Shah et al. (26) instilled fibrin sealant and gelatin matrix haemostatic sealant in the nephrostomy tract at the end of the procedure. Among the seven articles included in the present review, Choi et al. (27) found that the difference in intraoperative blood loss for the tubeless PCNL group and the standard PCNL group was not statistically significant. Agrawal et al. (28) and Lojanapiwat (29) reported no obvious bleeding during the operation, but the other studies did not provide data on this. Lojanapiwat (29) reported that blood transfusion was required in one patient (2.22%) in the tubeless PCNL group, and one patient (1.69%) in the standard PCNL group (P > 0.05). Agrawal et al. (28) reported that no patient out of a total of 101 patients required blood transfusion in either the tubeless PCNL group or the standard PCNL group.

Another aim of using a nephrostomy tube is to maintain adequate drainage of the kidney and reduce the rate of postoperative infection. Infection after PCNL is mainly caused by the release of bacteria and toxins into the bloodstream or by perinephric renal abscess formation, the incidence of which is related to preoperative upper UTI, operation duration and pre- and postoperative blood loss (30).

The main findings of this meta-analysis were that tubeless PCNL had shorter hospital stay and less analgesia requirement than standard PCNL, regardless of small tube or big tube group. Moreover, tubeless PCNL could significantly reduce operative time, decrease postoperative pain and diminish urine leakage in comparison to standard tube group. There was no significant difference in operative time, post- operative pain and urine leakage between the tubeless group and tube group; we considered that the reason for this was the insufficient sample size of the small tube group that included only four studies with reported out- comes. Shorter hospital stay and less analgesia requirements could cut back the cost of treatment and improve health-care quality. Shortening of operative time signified, the reduction of many potential complications such as anesthetic accident and postoperative morbidity. However, we found that tubeless PCNL did not increase relevant complications such as postoperative fever and blood transfusions. Though many studies confirmed that one of the advantages of the nephrostomy tube was to tamponade the access tract in order to prevent bleeding, standard PCNL did not demonstrate the superiority in our study. So, we questioned the advantages and necessity of placing nephrostomy tube after PCNL.

In our study,no significant differences were found in mean stone volume, operation time, transfusion rates, and hemoglobin level change between the groups. However, hospitalization time and the amount of narcotic analgesic required were significantly higher in group 2 compared

with the other groups (P <.05). Complications were observed in 3 (7.3%), and 7 (7.6%) patients in groups 1, and 2, respectively (P = 0.738).

Several modifications of PNL have been tried to decrease pain, hospitalization time, and morbidity. It has been shown that using small caliber nephrostomy tube, miniperc, external ureteral stent, double-J stent, or avoiding nephrostomy or ureteral drainage (totally tubeless) decreases postoperative pain and hospitalization time. (31-35)

The possibility of uncontrolled hemorrhage and ureteral obstruction were the main concerns about tubeless PNL. Nevertheless, they claimed that lack of a tube aids in tamponade of the tract, which was attributed to the thrombolytic effect of urokinase present in the urine. In another study by Crook et al, patients were randomized prospectively to have nephrostomy tube after PNL or totally tubeless PNL (n = 50 patients). Patient selection criteria were no significant bleeding or residual stone, an intact pelvicaliceal system, and no evidence of residual ureteral stone. No differences were found between the groups with regard to hemorrhage, infection, transfusion rate, and serum parameters. Length of hospitalization was significantly longer in patients who received a nephrostomy tube after PNL. (22)

According to our experience, the 2 important criteria in selection of patients for tubeless PNL are absence of major intraoperative bleeding and perforation of pelvicalyceal system.

5. Conclusion

Tubeless PCNL is an effective and safe procedure for treatment of renal stones in selected patients, with decreased hospital stay, less analgesia requirement, lower urine leak-age and decreased complications. Patients can receive great benefit from tubeless PCNL. We consider that it will become more palatable to patients, as well as more cost-effective, than standard PCNL in the future.