Nephrostomy tube placement prior to percutaneous nephrolithotomy does not impact outcomes

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Introduction: *This study aims to compare outcomes of percutaneous nephrolithotomy (PCNL) performed with a nephrostomy tube placed prior to surgery versus access at the time of surgery.*

Materials and methods: *Between March 2005 and August 2014, 233 PCNLs were performed. One hundred and nine of those cases underwent placement of nephrostomy tubes at least 1 day prior to surgery (Group A), and the remaining 124 cases were performed in which access was obtained at the time of PCNL (Group B). Patient demographics, comorbidities, stone size, sepsis rates, and additional complication rates including bleeding and inability to access stone were compared.*

Results: *There were no significant differences in patient demographics, stone size, or comorbidities when comparing the two groups. Success rates were not significantly different, 92.7% in Group A compared to 94.4% in Group B. Similarly, there was no significant difference in complication rates or ICU admissions. The rate of sepsis in Group A was 1.83% compared to 2.42% in Group B, which showed no statistical significance. Notably, there were more patients with neurogenic bladders in the pre-placement group (p = 0.05).*

Conclusion: *Pre-placement of a nephrostomy tube prior to PCNL did not result in a decreased incidence of complications or sepsis and did not demonstrate increased success rates. Patients with neurogenic bladders may be more vulnerable to suffering from sepsis and therefore role of timing of nephrostomy tube placement must be further studied.*

Key Words: PCNL, nephrostomy tube, renal stone

Introduction

Percutaneous nephrolithotomy (PCNL) is an endoscopic technique reserved for the removal of large and complex renal calculi.[1] PCNL has been shown to yield higher stone-free rates than lithotripsy techniques but is more invasive. Although PCNL is generally considered safe, complications may occur, the most common of which include fever (2.5%-10.8%) and bleeding (2.8%-7%).[2,3] Less commonly seen are sepsis (1%-2%), thoracic complications (< 2%), urine leak (1.5%-3%), and pelvicalyceal system injury or other organ injury (< 0.5%).[2,3] Body mass index (BMI) > 40 kg/m^2 and metabolic syndrome have been associated with higher rates of general perioperative complications, but those specifically at risk for sepsis have been noted to have preoperative bacteriuria, neurogenic bladder, renal anomalies, high irrigation pressure during surgery, and increased operative times.[4-8]

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The success of PCNL is largely dependent upon the establishment of an effective percutaneous nephrostomy tract, which will guide the surgeon to the appropriate location for stone removal.[9] Percutaneous access may be acquired by either an interventional radiology (IR) specialist or urologist. This is done prior to the procedure in an IR suite or alternatively at the time of surgery under the same general anesthetic, referred to as a single-stage procedure. Frequently the nephrostomy tract is placed prior to PCNL for cases that are anticipated to be more complex and high risk, with the idea being that a previously secured tract and a shorter operative time will result in fewer complications and potential for improved patient outcomes;[4] however, it is acceptable to secure the nephrostomy tract concurrently with the nephrolithotomy procedure.

It has been suggested that establishing a nephrostomy tract prior to surgery may be associated with lower rates of systemic inflammatory response syndrome (SIRS) and sepsis.[10] However, it remains unclear if there are indeed definite advantages. The purpose of this study is to determine whether pre-placement of the nephrostomy tube improves outcomes or decreases complications such as sepsis, intraoperative bleeding, and ICU admission.

Materials and methods

This is a single institution IRB approved study that retrospectively reviewed 233 cases of PCNL performed by one of four surgeons between March 2005 and August 2014. Patients were divided into two groups based on whether the nephrostomy tract was secured prior to PCNL or at the same time as PCNL. In cases of pre-placement, percutaneous access was obtained by an interventional radiologist one or more days prior to PCNL. In cases of same-day placement, percutaneous access was obtained by an interventional radiologist in the operating room.

Patient demographics, comorbidities, surgical success rates, and complication rates were compared between the two groups. Demographics included age, BMI, and renal stone size. Patient risk factors and comorbidities included positive preoperative urine cultures, neurogenic bladder, anticoagulant use, diabetes mellitus, hypertension, coronary artery disease, and history of stroke. A successful outcome was defined as removal of all stones > 3 mm in diameter without the need for a repeat procedure within 6 weeks of the index PCNL. Estimated blood loss was calculated by the surgeon and was compared between groups. Surgical complications primarily included high intraoperative blood loss requiring transfusion (Clavien-Dindo II) and difficulty with nephrostomy access requiring additional IR intervention (Clavien-Dindo IIIa). Postoperative complications consisted of sepsis/SIRS (Clavien-Dindo II) and ICU admissions (Clavien-Dindo IV) within 30 days of PCNL.

Inclusion criteria included patients who underwent PCNL during March 2005 and August 2014. As our initial analysis showed a statistically significant proportion of patients with neurogenic bladder in the pre-placement group, we conducted two separate analyses: one which excluded neurogenic bladder, and one with our neurogenic bladder cases alone.

Statistical analysis included the following: two sample t-test assuming unequal variances for analysis of age, BMI, and renal stone size; two-tailed two sample t-test for proportions for analysis of risk factors and comorbidities such as positive preoperative urine cultures, neurogenic bladder, anticoagulant use, diabetes mellitus, hypertension, coronary artery disease, and stroke; and for outcomes such as success rates, surgical complication rates, sepsis/SIRS rates, and ICU admission rates. A chi-squared analysis for three categorical variables was done for estimated blood loss, in which categories were 0-99 cc, 100-499 cc, and > 500 cc. A chi-squared analysis for six categorical variables was done for stone location, in which categories were upper, middle, lower, ureteropelvic junction, staghorn, and multiple locations. The p value for determination of significance in this study was 0.05.

Results

Of the 233 PCNL cases analyzed, 109 had the nephrostomy tract obtained one or more days prior to the PCNL procedure, and 124 had a single-stage procedure. The groups did not differ significantly in terms of demographics or comorbidities, except for the presence of neurogenic bladder. There were significantly more cases of neurogenic bladder in the pre-placement group ($p = 0.05$). Therefore, it was decided to conduct two separate analyses; one excluding neurogenic bladder patients, and one examining neurogenic bladder cases alone.

For the non-neurogenic bladder analysis, there were 78 PCNLs performed on 65 patients in the pre-placement group, and 102 cases performed on 94 patients in the single-stage group. There were no significant differences in patient age ($p = 0.79$), BMI ($p = 0.71$), stone size ($p = 0.85$), and stone location ($p = 0.13$) between the pre-placement and single-stage groups. In terms of comorbidities, there were no significant differences in anti-coagulant use ($p = 0.71$), diabetes mellitus ($p = 0.07$),

hypertension (p = 0.62), CAD (p = 0.07), and stroke (p = 0.87) between groups, Table 1. Preoperative urine cultures were obtained in 66 cases in the pre-placement group, and in 82 cases in the single-stage group, with no significant differences in positive cultures between groups (p = 0.40). In terms of outcomes, success rates were comparable between groups, at 76.9% in the pre-placement group and 80.4% in the single-stage group (p = 0.69). Rates of intraoperative complications were comparable, with three cases in the pre-placement group and four cases in the single-stage group (p = 0.98). One complication in the pre-placement group included blood loss > 500 cc requiring blood transfusion, Clavien-Dindo II. There was an additional case of lost access, requiring further intervention with the IR team. In the single-stage group, all four intraoperative complications again were related to difficulty or inability to obtain access requiring additional procedures with the IR team for access (Clavien-Dindo IIIa). In looking specifically at complications related to access, there were higher rates of access issues in the single-stage group, but this did not reach statistical significance (p = 0.28). In terms of postoperative complications, rates of ICU admission were comparable. These were considered major complications (Clavien-Dindo IV), with two cases of ICU admission in the pre-placement group and one case

TABLE 1. **Non-neurogenic bladder analysis**

Patient characteristics	**Pre-placed (n = 78)**	**Single-stage (n = 102)**	**p value**
Age mean (years)	50.2	49.6	0.79
BMI mean (kg/m^2)	30.2	29.8	0.71
Stone size mean (cm)	3.0	3.1	0.86
Stone location			0.13
Upper pole	6	2	
Middle pole	0	2	
Lower pole	6	16	
UPJ	20	32	
Staghorn	13	12	
Multiple locations	32	38	
Comorbidities			
Anticoagulant use	10	15	0.72
Diabetes mellitus	21	16	0.07
Hypertension	35	42	0.62
CAD	6	2	0.07
Stroke	2	3	0.88
Outcomes			
Success	60	82	0.69
Intra op complication	3	4	0.98
Sepsis	0	0	
ICU admission	2	1	0.21
EBL			0.24
0-99 cc	59	76	
100-499 cc	17	26	
> 500 cc	2	0	
Preoperative urine cultures	**Pre-placed (n = 66)**	**Single-stage (n = 82)**	**p value**
Positive	14	13	0.40

BMI = body mass index; UPJ = ureteropelvic junction; CAD = coronary artery disease; ICU = intensive care unit; EBL = estimated blood loss

in the single-stage group (p = 0.21). Reasons for ICU admission included need for transfusion, hypotension, and AKI with leukocytosis. There was one additional postoperative complication in the single-stage group, which was a case of hemorrhage following stent removal. This did require an additional intervention including transfusion and embolization (Clavien-Dindo IIIb). Estimated blood loss was comparable between groups (p = 0.24). There were no cases of postoperative sepsis in either group.

For the neurogenic bladder analysis, there were 31 PCNLs performed on 18 patients in the pre-placement group, and 22 performed on 14 patients in the single-stage group. There were no significant differences in patient age (p = 0.24), BMI (p = 0.40), stone size (p = 0.80), and stone location (p = 0.31) between the pre-placement and single-stage groups. With regards to comorbidities among the two groups, there were no significant differences in anti-coagulant use (p = 0.08), diabetes mellitus (p = 0.63), hypertension (p = 0.33), CAD (p = 0.77), and stroke (p = 0.77), Table 2. Preoperative urine cultures were obtained in 24 patients in the pre-placement group and 20 in the single stage group, with no significant difference in positive cultures between

TABLE 2. **Neurogenic bladder analysis**

Patient characteristics	**Pre-placed (n = 31)**	**Single-stage (n = 22)**	**p value**
Age mean (years)	45.7	49.9	0.24
BMI mean (kg/m^2)	27.3	31.6	0.40
Stone size mean (cm)	2.95	2.86	0.80
Stone location			0.31
Upper pole	2	0	
Middle pole	0	1	
Lower pole	5	1	
UPJ	8	5	
Staghorn	5	3	
Multiple locations	10	12	
Comorbidities			
Anticoagulant use	4	0	0.08
Diabetes mellitus	12	10	0.63
Hypertension	14	13	0.34
CAD	2	1	0.77
Stroke	2	1	0.77
Outcomes			
Success	25	18	0.92
Intra op complication	4	3	0.98
Sepsis	2	3	0.39
ICU admission	4	2	0.67
EBL			0.65
0-99 cc	28	19	
100-499 cc	3	3	
> 500 cc	0	0	
Preoperative urine cultures	**Pre-placed (n = 66)**	**Single-stage (n = 82)**	**p value**
Positive	14	10	0.59

BMI = body mass index; UPJ = ureteropelvic junction; CAD = coronary artery disease; ICU = intensive care unit; EBL = estimated blood loss

groups (p = 0.59). In comparing outcomes, success rates were similar, 80.6% and 81.8% in the pre-placement and single-stage groups respectively (p = 0.92). Rates of intraoperative complications were comparable, with four cases in the pre-placement group and three cases in the single-stage group (p = 0.98). Complications in the pre-placement group included loss of access, requiring additional procedures (Clavien-Dindo IIIa). Complications in the single-stage group similarly included difficulties with access in addition to one case in which PCNL was delayed due to discovery of purulent infection while obtaining access. Estimated blood loss was comparable between groups (p = 0.65). Rates of ICU admission were comparable, with four cases of ICU admission in the pre-placement group and two cases in the single-stage group (p = 0.67). Reasons for ICU admission included hypotension and inability to extubate, hypertensive urgency, sepsis and septic shock. There was no significant difference in the rates of sepsis, with two cases of sepsis in the pre-placement group and three in the single-stage group (p = 0.39).

Discussion

Our initial review of the data showed significantly more patients with neurogenic bladder in the pre-placement group, and so we conducted two separate analyses; one excluding the neurogenic bladder population, and one only with neurogenic bladder patients. The patients in the retrospective review were well-matched in both analyses, with regards to predisposing factors that increase perioperative risk. Comorbid factors such as diabetes mellitus, hypertension, coronary artery disease, stroke, and anticoagulant use were equivalent between pre-placement and single-stage groups in both the non-neurogenic and neurogenic analyses. Furthermore, intraoperative complication rates, ICU admissions, and success rates were comparable between the groups, suggesting that percutaneous access impacts neither the complication rates nor success rates in both the non-neurogenic and neurogenic population. In addition, we found that rates of sepsis were higher overall in the neurogenic bladder group at 9.43%, as compared to 0% in the non-neurogenic bladder group. These findings are consistent with the literature.[8] Of note, all five patients in the neurogenic cohort that developed sepsis postoperatively did have stone composition consistent with infection, specifically struvite and carbonate apatite.

In the non-neurogenic population, our analysis revealed no significant differences in complications or success rates with regards to the timing of nephrostomy tube placement. Although not statistically significant, there was a higher rate of access issues among patients in whom the nephrostomy tract was established intraoperatively compared to preoperative securement, four patients versus one patient respectively. This may suggest a benefit to pre-placement in some patients who the surgeon predicts may have difficult anatomy, however no conclusion can be drawn from our study.

Increased surgical risk in patients with neurogenic bladders is multifactorial including difficult positioning in some cases, but these patients have been also noted to be predisposed to UTIs and pyelonephritis.[8,11] Accordingly, it is thought that these patients may benefit from percutaneous drainage prior to surgery. In our study, rates of positive preoperative urine cultures were statistically equivalent and rates of sepsis among neurogenic bladder patients were no different regardless of the timing of nephrostomy tube placement. There was a trend towards lower rates of sepsis among neurogenic bladder patients who had pre-placement of their percutaneous access, which is consistent with the findings of Benson et al that patients with positive pre-operative renal urine cultures had lower rates of urosepsis when the nephrostomy tract was placed prior to the definitive procedure.[10] That study, however, did not discuss neurogenic bladder as a risk factor. Overall there was a trend towards fewer complications with regards to access among non-neurogenic bladder patients in the pre-placement group, but this did not reach statistical significance. This same trend was not seen in the neurogenic bladder population. These findings may support pre-placement of nephrostomy access, particularly in the non-neurogenic bladder population, however a definitive conclusion cannot be drawn from our study. It should be noted that among the pre-placement cohort, tube placement occurred at a median of 2 days prior to surgery, with a range of 1 to 180 days. Those who had tubes in place for longer than 14 days simultaneously had comorbidities that obviated the need for surgical delay including sepsis on presentation, severe acute kidney injury, or hemodynamic instability. These all required emergent nephrostomy tube placement followed by eventual surgery when appropriate. In one instance, the patient sustained multiple cardiac events obviating the need for recovery and medical optimization prior to surgery.

There are several limitations to this study, the first of which is sample size. With such low rates of sepsis, ICU admission, and complications, it is difficult to reach statistical significance with our sample size. Another limitation is that our cases of PCNL were sourced from this institution's patient database using two specific

CPT billing codes assigned to PCNL. This method could potentially have led to the inadvertent exclusion of several cases of PCNL. The third limitation is that PCNLs were performed by four different surgeons, who may have differences in surgical techniques and subsequently may have affected complication rates, although this is less likely. Lastly, this study is limited in that it is a retrospective analysis, and so certain factors could not be controlled for, such as the aforementioned surgical technique. In addition, as it is retrospective, the timing of nephrostomy tube placement could not be randomized. Therefore, it is not possible to correct for subjective factors which may have influenced the decision to obtain nephrostomy access at a given time. Although we controlled for this in part by separating neurogenic bladder cases, there may have been other factors not accounted for which led to the decision to pre-place the tube, such as in cases that were anticipated to be more complicated. In objective measures, our study found patients in each group to be well-matched.

Conclusion

We find that pre-placement of the nephrostomy tract in PCNL did not reduce intraoperative complications, postoperative complications, or improve success rates. There was an overall trend towards benefit from pre-placement among non-neurogenic bladder patients, however no conclusion with regards to this can be drawn from our study. There is a need for additional research, particularly in patients with neurogenic bladder, to further elucidate our findings. □

References

1. Ganpule AP, Vijayakumar M, Malpani A, Desai MR. Percutaneous nephrolithotomy (PCNL) a critical review. *Int J Surg* 2016;36 (Pt D):660-664.
2. Labate G, Modi P, Timoney A et al. The percutaneous nephrolithotomy global study: classification of complications. *J Endourol* 2011;25(8):1275-1280.
3. Kyriazis I, Panagopoulos V, Kallidonis P, Özsoy M, Vasilas M, Liatsikos E. Complications in percutaneous nephrolithotomy. *World J Urol* 2015;33(8):1069-1077.
4. Sugihara T, Yasunaga H, Horiguchi H et al. Longer operative time is associated with higher risk of severe complications after percutaneous nephrolithotomy: analysis of 1511 cases from a Japanese nationwide database. *Int J Urol* 2013;20(12):1193-1198.
5. El-nahas AR, Eraky I, Shokeir AA et al. Factors affecting stone-free rate and complications of percutaneous nephrolithotomy for treatment of staghorn stone. *Urology* 2012;79(6):1236-1241.
6. Fuller A, Razvi H, Denstedt JD et al. The CROES percutaneous nephrolithotomy global study: the influence of body mass index on outcome. *J Urol* 2012;188(1):138-144.
7. Lee JK, Kim BS, Park YK. Predictive factors for bleeding during percutaneous nephrolithotomy. *Korean J Urol* 2013;54(7):448-453.
8. Kreydin EI, Eisner BH. Risk factors for sepsis after percutaneous renal stone surgery. *Nat Rev Urol* 2013;10(10):598-605.
9. Michel MS, Trojan L, Rassweiler JJ. Complications in percutaneous nephrolithotomy. *Eur Urol* 2007;51(4):899-906.
10. Benson AD, Juliano TM, Miller NL. Infectious outcomes of nephrostomy drainage before percutaneous nephrolithotomy compared to concurrent access. *J Urol* 2014;192(3):770-774.
11. Vigil HR, Hickling DR. Urinary tract infection in the neurogenic bladder. *Transl Androl Urol* 2016;5(1):72-87.