Interdisciplinary planning improves radiologist obtained access for percutaneous nephrolithotomy

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Introduction: *Proper antegrade access for percutaneous nephrolithotomy (PCNL) is essential for success but can be challenging. Previous work evaluating access obtained by interventional radiology (IR), largely in the emergent setting, has shown high rates of additional access at the time of PCNL. We hypothesize that efforts to improve pre-procedural communication between urology and IR can impact the utility of the access for subsequent PCNL.*

Material and methods: *We conducted a retrospective review of patients undergoing PCNL at a single hospital from January 2011 to December 2022. Adult patients undergoing PCNL with established preoperative access were included.*

Results: *A total of 141 cases were identified with preoperative access. A total of 111 patients had evidence of planning with IR prior to antegrade access. There were high rates of anatomic abnormality (50%) and staghorn calculus (53%). Patients with planned access had higher body mass index (BMI). While preoperative access was initially utilized in 97% of cases, 6% required additional access to be obtained intraoperatively; this included a low rate of new access in those that were previously discussed with IR (4% vs. 17%, p = 0.02). Overall stone free rates (91%), rates of second stage procedures (55%) and complications (14%) were similar between planned and unplanned groups.*

Conclusion: *In this retrospective study of complex patients with large stone burden presenting for PCNL with preoperative antegrade access obtained by IR, the rate of new access was far lower than prior reports. This was likely influenced by urologist involvement in planning access.*

Key Words: percutaneous nephrolithotomy, antegrade access, patient outcomes, nephrolithiasis

Introduction

Percutaneous nephrolithotomy (PCNL) is the gold standard for treatment of large renal stone burden by professional society guidelines.[1] PCNL offers improved stone free rates for larger stone burdens compared to staged ureteroscopy but carries increased risk of complications and longer hospital stay.[2,3] Percutaneous access is arguably the most difficult portion of the procedure and can be accomplished by urologists or interventional radiologists (IR) with fluoroscopy or ultrasound guidance. Societal guidelines do not provide recommendations on the optimal manner of obtaining access.

There is ongoing debate regarding the suitability of access obtained by IR in preparation for future PCNL. Access obtained by urologists has been associated with higher stone free rates and lower complication rates compared to cases of similar difficulty with

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access obtained by interventional radiology.[4-6] Contradicting studies have shown similar success and complication rates regardless of the specialty obtaining access.[7] Regardless of source, the rates of secondary access intra-operatively following initial access by radiologists in the emergent setting has been high, between 22%-53%.[5,8-10] Despite these issues, radiologist obtained access is used frequently and may be required in some situations. While 77% of endourological society members report obtaining their own access intraoperatively, insurance claim data suggests that the overall proportion of cases where a urologist obtains de novo access may account for only one-third of all PCNL procedures.[11,12]

Previous studies have not reported the success of radiologist obtained access in non-emergent settings or evaluated the impact of interdisciplinary communication between urology and IR prior to placement. This study evaluates the utility of preoperatively obtained access by IR in a practice emphasizing interdisciplinary planning prior to placement. The hypothesis is that routine preoperative discussion between urology and IR will decrease the need for additional access at the time of surgery in our population. This may increase the availability of PCNL among different settings of practice and improve patient access to this procedure.

Materials and methods

Patient identification and data collection

Following approval by the institutional review board (University of Pittsburgh, STUDY21120134), we identified patients who underwent PCNL at a single tertiary care center and performed a retrospective review of patient charts. Cases were identified through Boolean search of operative reports within our electronic health record using the term percutaneous nephrolithotomy. This collected PCNL procedures completed between January 1, 2011, and December 31, 2021. Inclusion criteria consisted of adult patients with existing preoperative nephrostomy tube access at the time of anesthesia induction for PCNL. Bilateral PCNL was considered a separate procedure for each kidney and patients undergoing multiple procedures in the time queried were included as separate cases.

We utilized chart review to collect patient demographics, procedure details and outcomes. Anatomic abnormalities were considered adult congenital pathology such as spina bifida or cerebral palsy, spinal pathology with contractures, urinary diversions or congenital renal anomalies. Stone sizes were measured in greatest dimension by review of radiology films in axial and coronal dimensions. Stone free was defined as a CT scan with no residual fragments greater than two millimeters.[13] Patients were considered a planned access if they had outpatient IR consult order from the proceduralist performing the eventual percutaneous nephrolithotomy. It is the standard practice in this situation to communicate with IR of a calyx of preference. For those seen on an emergent or inpatient basis, only those with a clear documentation of communication with IR or a delineation of a desired calyx within the order text were considered a planned access. If there was no documentation or communication was unknown, they were considered an unplanned access.

Procedures and practices

The practice of planning with IR at our institution was by phone or email with occasional in-person meeting when feasible. The urologist and IR physician both review the images and together decide which calyx would be ideal and at what angle. Tract length is also discussed, particularly if the patient is morbidly obese. Back-up options if the preferred access is not feasible are discussed. Any challenges encountered at the time of the procedure are discussed via phone. Lastly, access at the tip of the calyx in biplanar fluoroscopy is requested. Standard patient referrals to IR for preoperative access were for those with complex anatomy, adjacent organ proximity, infectious calculi, and those at higher risk due to medical comorbidities. Same day percutaneous nephrolithotomy was not performed for these patients to allow the tract to mature, minimize continuous operating room time or in the case of infection, obtain maximal drainage and a directed kidney culture. Over the 10-year study period, several different radiologists evaluated and performed procedures on patients. At this center, only a single surgeon performed PCNL. In general, given high rates of patient complexity and immobility, there was a low threshold for second stage procedures to clear any residual stone burden greater than two millimeters.

Statistical analysis

The primary outcome in our analysis was need for secondary intraoperative access. Secondary outcomes included stone free rates, secondary procedures and complications. Patients were evaluated as a whole as well as by subsets in those with evidence of preoperative planning with interventional radiology. Groups were compared by Kruskal-Wallis tests, Chi-squared tests and Fisher's exact tests. Analyses were two-sided. All analyses were carried out using R statistical software (R Core Team, 2021).

TABLE 1. **Patient preoperative characteristics**

Characteristic	Overall (n = 141)	Planned nephrostomy		p value
		Yes (n = 111)	No (n = 30)	
Age, median (IQR)	61 (49-70)	60 (51-69)	63 (49-70)	0.83
BMI, median (IQR)	29 (24-34)	29 (24-35)	26 (22-31)	0.02
Male gender, n (%)	45 (32)	35 (32)	10 (33)	0.85
Comorbidities, n (%)				
COPD/asthma/OSA	24 (17)	19 (17)	5 (17)	0.95
CAD/CHF	15 (11)	14 (13)	1 (3)	0.19
DM	25 (18)	17 (15)	8 (27)	0.15
HTN	68 (48)	54 (49)	14 (47)	0.85
CKD	20 (14)	16 (14)	4 (13)	0.88
Stroke	12 (9)	9 (8)	3 (10)	0.72
Anatomic abnormality, n (%)	70 (50)	50 (45)	20 (67)	0.06
Urinary diversion	28 (20)	18 (16)	10 (33)	0.07
Abnormality due to neurologic insult	47 (33)	35 (32)	12 (40)	0.38
Horseshoe kidney	2 (1)	2 (2)	0 (0)	1.00
Positive preoperative urine, n (%)	93 (66)	67 (60)	26 (87)	0.01
Staghorn calculus, n (%)	75 (53)	63 (57)	12 (40)	0.10
Stone burden (cm), median (IQR)	3.1 (2.1-4.0)	3.2 (2.2-4.1)	3.0 (2.0-3.8)	0.25
Time with nephrostomy (days), median (IQR)	11 (7-14)	8 (7-14)	41 (26-72)	< 0.01

BMI = body mass index; IQR = interquartile range; COPD = chronic obstructive pulmonary disease; OSA = obstructive sleep apnoea; CHF = congestive heart failure; CAD = coronary artery disease; DM = diabetes mellitus; HTN = hypertension; CKD = chronic kidney disease

Results

Population characteristics

Chart query identified 119 patients who underwent PCNL with established preoperative nephrostomy tube access. Overall, 141 individual PCNLs were performed with 111 having evidence of strategically planned preoperative access. Characteristics of the patient populations can be seen in Table 1. Patients had a median age of 61, body mass index (BMI) of 29 and anatomic abnormalities were present in 50%. Patients with a planned preoperative access had a significantly higher median BMI (29 vs. 26, p = 0.02) and those without planned access trended toward a higher rate of anatomic abnormality (67% vs. 45%, p = 0.06). Staghorn calculi were common at 53% and stone burden was high with a median maximal stone length of 3.1 centimeters. Other comorbidities were similar between groups. Time with nephrostomy tube in place was significantly shorter in the planned access group with a median of 8 days versus 41 days for the unplanned group (p < 0.01).

Procedure outcomes

Existing access was dilated at a similar rate between groups (97% overall). For all procedures, 6.4% of patients required a new intraoperative access. This rate was significantly lower in the group with evidence of preoperative planning (4% vs. 17%, p = 0.02, Figure 1). A second stage procedure was required in 55% of patients overall with a similar rate between groups. This was recommended to all patients with residual burden over two millimeters. While not meeting statistical significance, a planned preoperative access tended to be followed by second stage ureteroscopy in 35% of patients (compared to 20% in unplanned group) as opposed to percutaneous nephroscopy in 19% (compared to 37% in unplanned group, p = 0.08). Overall stone free rates were similar at 91%. The complication rate overall was 14% and tended to be higher in the preoperative planned access group, however this was not statistically significant (15% vs. 3%, p = 0.12). The most frequent complications were sepsis or systemic inflammatory

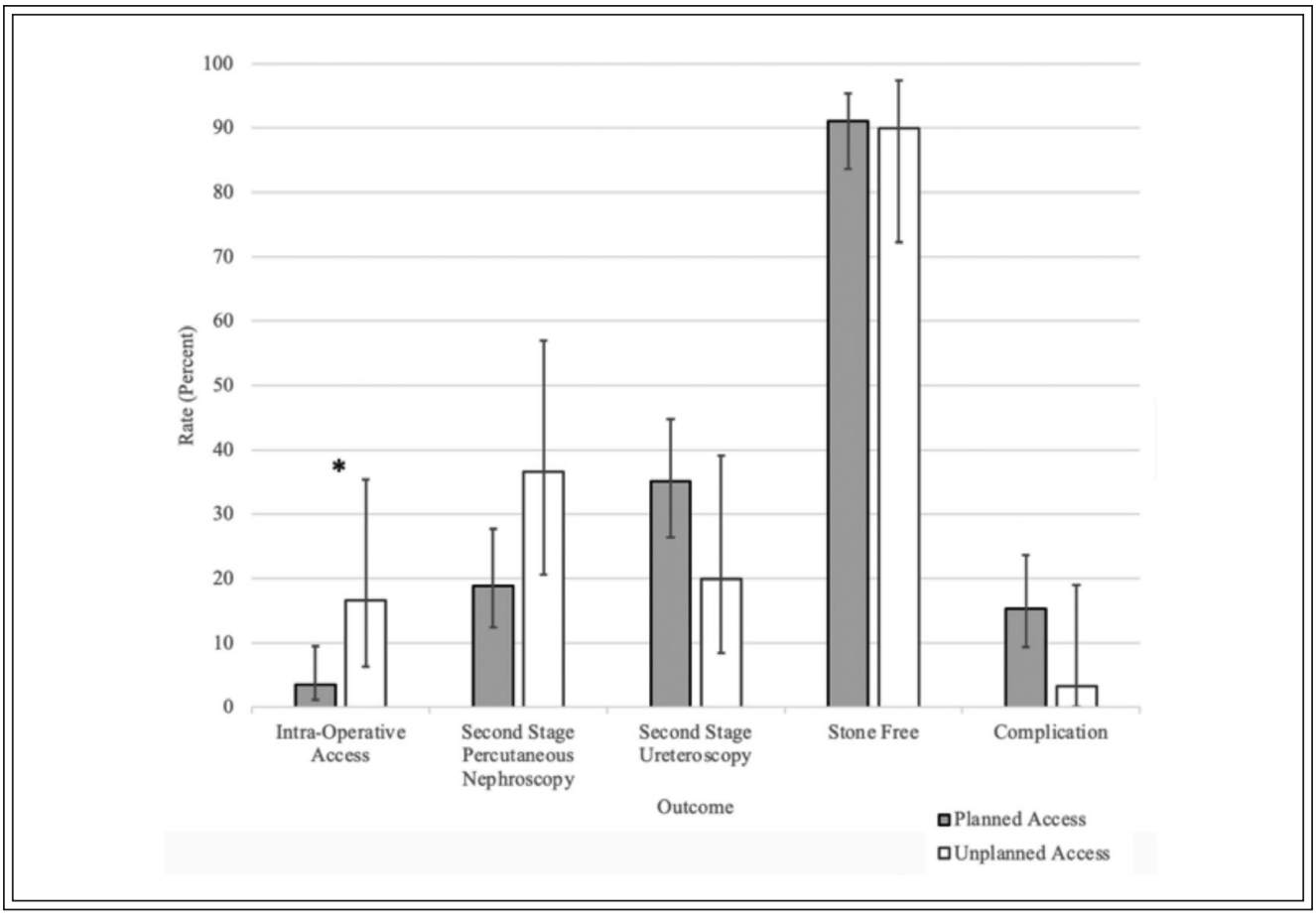

Figure 1. PCNL outcomes vary with interdisciplinary planning. New intraoperative access occurred at lower rates in patients with evidence of preoperative interdisciplinary planning. The frequency of other outcomes was not significantly different between groups. (*p = 0.02).

TABLE 2. **Procedural complications**

	Overall (n = 141)	**Planned nephrostomy**		**p value**
		Yes (n = 111)	**No (n = 30)**	
Total, n (%)	18 (13)	17 (15)	1 (3)	0.12
Following access, n (%)	7 (5)	7 (6)	0 (0)	0.35
Following PCNL, n (%)	12 (9)	11 (10)	1 (3)	0.46
Clavien-Dindo grade, n (%)				0.19
I-II	10 (7)	9 (8)	1 (3)	
III-IV	8 (6)	8 (7)	0 (0)	
Complication, n (%)				
Sepsis/SIRS	8 (6)	7 (6)	1 (3)	1.00
Pleural effusion	4 (3)	4 (4)	0 (0)	0.58
Pseudoaneurysm	2 (1)	2 (2)	0 (0)	1.00
Other	4 (3)	4 (4)	0 (0)	0.58

PCNL = percutaneous nephrolithotomy; SIRS = systemic inflammatory response syndrome

response in eight patients, while others included pleural effusion, pseudoaneurysm, perinephric hematoma, respiratory failure, and uncontrolled pain, Table 2.

Discussion

This retrospective study of all patients undergoing percutaneous nephrolithotomy with preoperative nephrostomy tube access placed by interventional radiology examined the outcomes of patients including analysis of those with interdisciplinary planning prior to access. Overall, the complexity of cases was high with over half of the population having an anatomic abnormality or staghorn calculus and a significant median stone burden over 3 cm. In this population, our study demonstrated a low overall rate of new access at 6%. A key emphasis at our center has been interdisciplinary communication regarding access prior to placement. While this planning is difficult to quantify and our study is retrospective, rates of new access were 4% in the population with evidence of planning, compared to 17% without evidence of planning. This supports the hypothesis that planning is likely driving the overall decrease relative to previously published rates of 22%-53% in the emergent setting.[5,8-10] Even with no evidence of planning, the 17% rate of new access is near the lower end of previously published reports, suggesting that a close working relationship may improve the quality overall.

Secondary outcomes of this study included stone free rates, second stage procedures and complications. Prior reports have criticized that cases in which access was obtained by interventional radiology were associated with a higher stone free rate compared to those in which a urologist obtains access.[4-6] While a direct comparison was not made in this study, the stone free rate was similar to those previously reported in the literature for PCNL as a whole (73% to 100%) providing some evidence in favor of access obtained by IR.[14] Second stage procedures occur at a similar rate between groups. However, there is a trend toward second stage ureteroscopy as opposed to PCNL in patients with planned access compared to those with unplanned preoperative access. This has the potential to decrease the burden of percutaneous procedures and associated complications but needs further study. While not meeting statistical significance, a surprising finding in light of the low rate of new access was the trend toward a higher complication rate in the planned access population. This may be a result of retrospective review underestimating complication rates especially in the unplanned access group which more commonly had nephrostomy tubes placed at outside centers and may have missing instances of complication. This may also be related to the small sample size of the unplanned access group and would be expected to equilibrate in a larger population. Despite the difference, the overall complication rate of 14% is similar to prior documented rates.

These findings have implications for both academic urologists as well as those practicing within the community. In a recent survey of the Endourologic Society in 2014, Sivalingam et al noted that 77% of practicing urologists obtain their own access and 18% obtain access by IR.[11] Fellowship trained urologists were more likely to obtain their own access. In the academic community, this study may serve as a reminder to discuss these cases and create a working relationship with IR colleagues for those instances when an antegrade or retrograde access is difficult and interdisciplinary assistance with antegrade access would benefit the patient. In addition, urologists are often consulted in emergency situations and recommend nephrostomy tube due to stone characteristics or the acuity of the patient presentation. These data could provide an impetus to denote a calyx of preference to target even in the emergent setting. Often in these situations, hydronephrosis can make multiple calyces easily accessible and thus a more opportune calyx may be available without added complication or delay in access. Outside of academic urology, a more recent study of insurance claims noted 33% of PCNL procedures had de novo access claimed by a urologist compared to 40% of access claimed by a radiologist.[12] A practice of interdisciplinary communication regarding preoperative access could improve the efficiency of these procedures and may expand the use of and access to PCNL in the community setting.

This study has inherent limitations. It is a retrospective design, involving only a single center and surgeon. The group of patients with an unplanned access is small relative to those with a planned preoperative access and, as previously mentioned, characterizing planning retrospectively can be difficult. The greatest limitation is that many of the unplanned events were done in the emergent setting without communication while the planned events were done in a controlled setting with communication, which may call into question whether the urgency of placement or the planning is contributing to the improvement in utility. Further evaluation of this issue would be beneficial as an ideal study would compare communication alone in a population of either routine or emergent procedures. However, obtaining

these data may be difficult within the constructs of a typical practice. Keeping these limitations in mind, prior data are bleak when describing radiologist obtained access. This real-world population in a practice where interdisciplinary communication is regularly emphasized should provide some confidence in radiology placements and spur future investigation and collaboration.

Conclusions

In this study of complex nephrolithiasis patients with preoperative access obtained by IR, we found a lower rate of secondary access than previously reported. The population was likely influenced by the regular involvement of the operating urologist in discussions with IR prior to access. This highlights that with good preoperative interdisciplinary planning, radiologist-obtained access can achieve high utilization rates. Further study is needed to evaluate the effects of communication independent of the urgency of placement. □

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