Minimally invasive surgery via minimally invasive anesthesia: Is laryngeal mask airway sufficient for supine percutaneous nephrolithotomy?

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ABSTRACT

Introduction: While endotracheal tube (ETT) is the traditional airway modality for percutaneous nephrolithotomy (PCNL), the adoption of supine positioning has opened the door for alternative strategies. Laryngeal mask airway (LMA) offers potential advantages, but its safety profile in supine PCNL remains understudied. This study aimed to compare urologic and anesthesia-related outcomes between LMA and ETT in patients undergoing ultrasound-guided supine PCNL.

Methods: In this retrospective study, 206 adult patients undergoing supine PCNL under general anesthesia between March 2023 and June 2024 were analyzed. Patients were grouped by airway modality: LMA (n=156) or ETT (n=50). Exclusion criteria included body mass index (BMI) >35 kg/m², American Society of Anesthesiologists (ASA) score ≥4, chronic obstructive pulmonary disease (COPD), pregnancy, or incomplete data. Urologic outcomes included intraoperative complications, 30-day complications, and postoperative pain. Anesthesia-related outcomes included hemodynamic instability, post-anesthesia care unit (PACU) stay, airway placement/removal times, and anesthesia-related complications. Outcomes were compared between the groups, and multivariable regression and sensitivity analysis were used to adjust for confounders.

Results: Overall complications were significantly lower in the LMA group (13% vs. 28%, p=0.01), and LMA was negatively associated with them in univariable analysis (odds ratio [OR]

0.378, 95% confidence interval [CI] 0.174‒0.821, p=0.01). LMA use remained independently associated with a reduced risk of overall anesthetic and urologic complications after ad-hoc adjustments for preoperative risk factors, stone characteristics, and intraoperative factors. Airway placement and removal times were shorter in the LMA group; otherwise, no significant differences were observed in anesthesia-related outcomes. No procedures were aborted or converted due to airway complications.
Conclusions: In our limited study, LMA seems to be a safe and effective alternative to ETT for airway management in appropriately selected patients undergoing supine PCNL. Prospective, randomized studies are needed to confirm these findings.

INTRODUCTION

Traditionally, PCNL has been performed with the patient positioned prone in order to minimize the possibility of damage to bowel and visceral organs.[1] It is also most commonly performed under general anesthesia with an endotracheal tube (ETT).[2,3] ETT is the safest airway for operations in the prone position and for procedures with an extended operative time, as it is the only secured airway. Additionally, it offers advantages in providing a reliable means of oxygenation, reliable end tidal CO2, the ability to provide positive pressure ventilation, and protects against pulmonary aspiration. It also allows for control of tidal volumes during percutaneous access to reduce the risk of injury to the pleura and lungs.[2–5]

As supine PCNL has gained momentum in recent years, ETT is not always necessary, and it is up to the anesthesiologist's discretion to decide on the most appropriate airway management device. The benefits of a supraglottic laryngeal mask airway (LMA) include that it is less invasive, patients can continue to breathe spontaneously, placement does not require administration of muscle relaxant or laryngoscopy, potentially resulting in less tachycardia and hypertension, less airway trauma and reduced postoperative complaints of sore throat and hoarseness.[6,7] These advantages make LMA a gentler airway option in appropriately selected cases. LMA is typically used for operations performed in supine position with shorter operative times, for patients with no significant medical comorbidities, and for procedures that don't increase the potential for gastric aspiration such as laparoscopy .[8] LMAs are common practice in anesthesia with a broad safety profile but are not without risks, such as dislodgement and loss of airway, pulmonary aspiration, vomiting and gastric insufflation. However, studies have demonstrated comparable safety and efficacy profiles between ETT and LMA across a range of surgical procedures.[9–13] In a randomized clinical trial comparing ETT and LMA in patients undergoing thoracic and abdominal surgery lasting over two hours, no significant differences in intraoperative and postoperative outcomes between groups has been reported.[12]

Literature regarding optimal airway management for patients undergoing general anesthesia for supine PCNL remains limited. While case reports exist describing the use of LMA in PCNL,[14] to our knowledge, there are no rigorous studies comparing surgical and anesthesia outcomes between LMA and ETT in supine PCNL. Herein, we seek to evaluate the non-inferiority of LMA compared to ETT with respect to the urological and anesthetic safety profiles of patients undergoing supine PCNL.

METHODS

Study design

This is an IRB-approved (STUDY-14-00879; Ichan School of Medicine) retrospective study of our PCNL registry including 250 adult patients who underwent ultrasound-guided supine PCNL under general anesthesia at a single institution between March 2023 and June 2024. In our PCNL practice, procedures are being performed under general anesthesia and airway management decisions are based exclusively on anesthesia considerations and patient suitability. Exclusion criteria included factors rendering the use of a LMA inappropriate: body mass index (BMI) >35 kg/m^2, a history of chronic obstructive pulmonary disease (COPD), American Society of Anesthesiologists (ASA) score ≥4, and pregnancy. Patients with insufficient data were also excluded. After exclusion, 206 patients remained for analysis, categorized based on the intraoperative airway modality as LMA (N=156) or ETT (N=50) (Figure 1).

Urological outcomes included intraoperative surgical complications, pain scores in the post anesthesia care unit (PACU) and 30-day postoperative complications. Anesthesia-related outcomes included procedure abortion due to anesthesia concerns, time to airway placement (time interval from initiation of induction to the completion of airway placement), time to airway removal (time interval from the end of the procedure to airway removal), and intraoperative hemodynamic instability (defined as the occurrence of one or more of the following: two consecutive measurements of mean arterial pressure (MAP) <60 mmHg, arterial oxygen saturation (SaO_2) <90% lasting more than 2 minutes, or heart rate (HR) >80 beats per minute (bpm) sustained for more than 5 minutes). Although no single universally accepted definition of intraoperative hemodynamic instability exists, clinically meaningful thresholds are commonly used in perioperative research. Intraoperative MAP <60–65 mmHg has been consistently associated with adverse postoperative outcomes, while SaO_2 <90% represents clinically significant hypoxemia, and elevated heart rate reflects physiologic stress during anesthesia.[15–19] PACU length of stay and 30-day postoperative anesthesia-related complications were also included in the outcomes. Pain scores were measured based on the visual analogue scale (VAS),[20,21] and postoperative complications categorized based on Clavien-Dindo (CD) classification.[22]

Statistical analysis

Categorical variables were presented as frequencies and percentages, while continuous variables were reported as medians with interquartile ranges (IQR) due to their non-normal distributions. Independent group comparisons for categorical variables and outcomes were conducted using chi-square or Fisher's exact tests, whereas continuous ones were analyzed with the Mann–Whitney U test. Univariable and multivariable logistic regression models were used to assess associations using odds ratio (OR) and 95% confidence intervals (CI) between airway modality and outcomes. Covariates were selected for inclusion based on their clinical relevance to postoperative complications, baseline imbalance between groups, or statistical significance on univariable analysis. Ad hoc sensitivity analyses were performed to address potential confounding factors in order to evaluate the independent effect of airway modality on outcomes.

Based on a previous study from our institution finding an overall complication rate of 18% for supine PCNL,[23] our sample size of 206 patients in an approximately 1:3 ratio provides a simulated power analysis of 80% and significance of 5% to demonstrate the non-inferiority of LMA within a 13% margin. A two-sided p-value <0.05 was considered statistically significant for comparisons of baseline characteristics and anesthesia-related outcomes. For the assessment of LMA non-inferiority with respect to urological safety outcomes, a one-sided p-value <0.05 was used, provided the observed differences indicated worse outcomes for LMA. If the observed differences favored LMA over ETT, the corresponding two-sided p-value was reported instead. All statistical analyses were performed using IBM SPSS Statistics (Version 25, IBM Corp., Armonk, NY, USA, 2017) and Microsoft Excel (Microsoft Corp., Redmond, WA, USA, 2016).

General anesthesia and airway management

Anesthesia airway management began with preoxygenation using 100% oxygen via face mask to optimize oxygen reserves. Once adequate preoxygenation was achieved, induction agents such as propofol were administered to facilitate loss of consciousness, combined with opioids and/or muscle relaxant if necessary if an ETT was used. Following induction, either an LMA or ETT were placed. The LMA was advanced into the hypopharynx and positioned over the laryngeal inlet, whereas the ETT was inserted into the trachea under direct or video laryngoscopy. Proper placement of the LMA/ETT was confirmed by capnography and bilateral chest auscultation. Throughout the process, continuous monitoring of oxygen saturation, heart rate, and blood pressure were maintained. Once the airway was secured and ventilation confirmed, anesthesia was maintained with inhalational agents or total intravenous anesthesia as the surgical procedure began.

Surgical procedure

Patients were placed supine into the Barts flank-free position. Cystoscopy was performed to facilitate the insertion of an open-ended ureteral catheter into the renal pelvis for saline infusion and/or retrograde pyelography. Renal access was obtained with an 18-gauge trocar needle using ultrasound guidance and the tract dilated sequentially using a fascial dilator and then a 24F balloon with access sheath. Stone disintegration was performed with a dual-energy lithotripter when indicated. The procedures were done tubeless, with no nephrostomy placed and a temporary 5F open end catheter or double pigtail stent used for drainage along with a foley catheter. Most patients were discharged on the day of surgery. Antibiotic prophylaxis was provided both during and after the operation to reduce the risk of infection.

RESULTS

Patients' characteristics

Clinical baseline characteristics including age, BMI, antiplatelet/anticoagulant use, ASA score, Charlson comorbidity index and laboratory results were similar between LMA and ETT groups. LMA patients had significantly smaller and less complex stones than the ETT group, with lower median stone volume (906 mm^3 vs. 2495 mm^3, $p<0.001$), shorter linear stone burden (20 mm vs. 29 mm, p=0.003), higher percentage of Guy's Stone Score (GSS) 1 (34% vs. 16%), and lower percentage of GSS 4 (13% vs. 20%). The duration of surgery was shorter in the LMA group, with a median of 62 minutes (IQR 47-81) compared to 73 minutes (56-109) in the ETT group. Stone location, need for multiple accesses and stent placement upon completion were marginally different (p=0.06 for each). Table 1 summarizes the comparison of clinical, stone and operative characteristics between the airway modality groups.

Urological safety outcomes

For the entire cohort, the surgical intraoperative, 30-day overall, 30-day minor and 30-day major complications rates were 1%, 16%, 12% and 4%, respectively. Three patients (2%) received blood transfusions, 1 patient (0.5%) had a liver injury managed conservatively, 1 patient (0.5%) had a pleural injury requiring chest tube, and 6 patients (3%) developed a urinary tract infection, including 4 cases of urosepsis (according to SIRS criteria) and 2 cases of uncomplicated infection. VAS pain scores in the PACU were available for 155 patients (117 LMA, 38 ETT) with a median score of 4 in each group (IQR 0-7). Overall complications were less frequent in the LMA group, occurring in 13% of cases compared to 28% ($p = 0.01$), primarily due to a lower rate of minor complications (8% vs. 26%, $p < 0.001$). Major complications and pain scores were comparable between groups (Table 2).

Anesthesia-related outcomes

The LMA group demonstrated anesthesia-related outcomes that were comparable or superior to those of the ETT group (Table 3). No cases were aborted or converted due to anesthesia-related causes. Rates of intraoperative hemodynamic instability were similar between groups (46% for LMA vs. 56% for ETT, p=0.19), although the ETT group experienced more frequent episodes of tachycardia. Airway placement and removal times were significantly shorter in the LMA group (p=0.004 and p=0.02, respectively), while PACU stay duration was comparable (p=0.84). Two anesthesia-related complications occurred overall: one pneumonia in the LMA group and one syncope due to hypotension without bleeding in the ETT group (p=0.39).

Regression models and sensitivity analysis

In univariable analysis, LMA was found to be negatively associated with overall complications with a protective OR of 0.378 (95%CI 0.174-0.821, p=0.01). Age, ASA score, Charlson comorbidity index and multiaccess procedures were also found to be associated with overall complications in an univariable analyses (Table 4). Given the relatively low number of overall complications (34 cases, 16%), inclusion of a large number of covariates within a single multivariable model was not feasible. Thus, we constructed 3 separate parsimonious multivariable models to evaluate the independent association between LMA use and overall complications. The models adjusted for (1) preoperative risk factors, (2) stone characteristics, and (3) intraoperative factors. Across all models, use of LMA remained independently and statistically significantly associated with a lower risk of 30-day overall complications (Table 4). Multiple renal accesses were the only additional covariate that remained strongly and significantly associated with overall complications in the multivariable models (OR=6.587, 95%CI 2.129-20.380, p=0.001).

A sensitivity analysis was conducted to assess the robustness of our findings and evaluate whether the need for multiaccess approach confounded the association between airway type and overall complications. To isolate the effect of airway management, the regression model was repeated including only patients who underwent single-access procedure (N=190: 147 LMA, 43 ETT). Under these restricted conditions, rates of overall complications remained significantly lower in the LMA group (LMA: 15 patients, 10% vs. ETT: 10 patients, 20%; p=0.03), and the use of LMA was significantly protective against overall complications (OR=0.375, 95%CI 0.155–0.910, p=0.03). These findings support the stability of the primary results.

DISCUSSION

LMA is gaining popularity in anesthesia practice due to its rapid insertion, reduced hemodynamic perturbation, decreased airway trauma, and shorter recovery time compared to ETT.[4,6,24] In a systematic review of 19 studies, LMA was found to be non-inferior to ETT in terms of perioperative airway complications.[5] Given the benefits of LMA and data suggesting its non-inferiority to ETT, LMA has been increasingly adopted as the airway of choice for a variety of procedures, including low-risk surgeries, particularly in ambulatory settings.[5,9,25–27]

LMA utilization has been previously described for several urological procedures. Multiple studies have reported the safety and feasibility of using LMA for transurethral procedures performed in dorsal lithotomy position.[28,29] Sun et al. demonstrated the safety of LMA for laparoscopic renal and adrenal surgery performed in lateral decubitus position.[30] For PCNL, ETT remains the traditional airway modality used, largely due to PCNL historically only being performed in a prone position. Furthermore, concerns for extended operative times and intraoperative bleeding have guided anesthesiologists in their choice to utilize an ETT.[31] However, as PCNL has continued to transition to a safer procedure that can be performed outpatient in supine position, the risk landscape has changed, permitting anesthesiologists to reconsider airway strategies. Supine positioning provides a more stable hemodynamic profile, easier airway access intraoperatively, and facilitates more rapid emergence from anesthesia – factors that support the preference of LMA for supine PCNL.

This study of 206 patients demonstrates that the use of LMA during supine PCNL is not only non-inferior but may be superior to the more traditional ETT in terms of surgical and anesthesia-related outcomes. Notably, LMA patients experienced lower overall complication rates, shorter airway placement and removal times, and no abortions or conversions to ETT due to anesthesia-related issues. The LMA group had less complex stone burdens as reflected by reduced stone volume and burden, lower GSS, fewer multiaccess procedures and shorter operative times. This may be attributed to preoperative discussions between the anesthesiologist and urologist regarding the expected complexity and/or duration of the procedure. In cases involving larger or more complex stones, anesthesiologists may be more likely to favor ETT over LMA. Although the protective association of LMA with postoperative complications remained statistically significant after adjustment in multivariable logistic regression and sensitivity analyses, LMA cannot be interpreted as an independent determinant of improved safety outcomes. This finding should be interpreted with caution, as the study is subject to selection bias, and the observed effect might reflect preferential use of LMA in patients with more favorable baseline characteristics rather than a true causal relationship. Given the limited literature on LMA use in supine PCNL, our study represents the largest comparative analysis to date. Our hypothesis-generating association suggests that for selected patients undergoing supine PCNL classified as low to moderate risk from an anesthesia standpoint, LMA is probably safe alternative to ETT, although any apparent protective effect cannot be interpreted causally.

Concerns regarding the use of LMA in PCNL have centered on the adequacy of ventilation during high intra-abdominal pressure, the risk of aspiration, and the potential need for airway conversion in the setting of surgical complications or prolonged operative times. There may be concerns that the use of an LMA during PCNL provides less control over the patient's breathing and a higher respiratory rate. This could interfere with renal access or stone clearance, potentially increasing adverse events and reducing treatment efficacy. However, no patient in our study had to undergo a conversion from LMA to ETT intraoperatively, and no patients had their procedure aborted due to airway related concerns. Furthermore, intraoperative hemodynamic instability rates in our study were comparable between LMA and ETT groups. There were no significant increases in aspiration events or oxygenation issues in the LMA group, suggesting that proper patient selection can mitigate theoretical risks. Ultimately, we present a cohort of 156 patients who underwent supine PCNL under LMA, demonstrating favorable complication rates across a heterogeneous population. These results mirror those in the literature involving other surgical procedures, with no significant differences in anesthesia-related outcomes found between airway modality groups.

Despite our findings supporting the safety of LMA during PCNL, it is important to acknowledge its limitations, particularly the reduced ability to fully control ventilation compared to ETT. Although controlled ventilation is feasible with LMA, its insecure airway seal limits peak inspiratory pressures, increases the risk of air leaks and gastric insufflation, reducing precision. In procedures requiring optimal ventilatory control, ETT remains preferred. Notably, Kourmpetis et al. demonstrated that low ventilation (≤8 breaths/min, tidal volume <500 mL) during retrograde intrarenal surgery improved surgical performance without compromising safety.[32] These findings may be explained by the reduction of renal mobility.[33] Similar effects were seen in extracorporeal shock wave lithotripsy, where up to 40% of shocks missed the stone due to respiratory motion.[34] While direct evidence for PCNL is lacking, it is reasonable to assume that respiratory movement may impact kidney puncture and access, potentially influencing the number of punctures, operative time, efficiency and complications. Unfortunately, computed tomography–based stone-free rates and stone removal efficiency were not available in our dataset and were therefore beyond the scope of this study.

Despite the encouraging findings, our study has several limitations. First, its retrospective design introduces inherent selection bias, particularly as airway modality was determined at the anesthesiologist's discretion rather than randomized. We acknowledge that residual confounders between the groups, notably stone characteristics, may still influence the results and increase uncertainty, and the limited statistical power precludes definitive conclusions. Second, the study is insufficient to formally confirm non-inferiority, as the number of outcome events is relatively low, resulting in wide confidence intervals. Similarly, the study lacks sufficient power to establish superiority, given the small size of the comparator (ETT) arm. Third, our findings may not be generalizable due to selection bias and exclusion of patients with multiple co-morbidities. Fourth, we lacked access to the anesthesiologists' rationale for airway selection, limiting our ability to provide a more nuanced discussion of decision-making. Finally, we also lacked data regarding intraoperative anesthesia medications and dosages which may contribute to the observed differences.

CONCLUSIONS

In appropriately selected patients undergoing supine PCNL, LMA is probably a safe and feasible alternative to ETT for airway management, for both surgical and anesthesia-related safety outcomes. Although the findings suggest adoption of LMA in supine PCNL surgery, any observed protective association does not imply a causal relationship. Our findings should be corroborated in a prospective randomized trial that would be able to meaningfully evaluate whether LMA offers true clinical benefit.

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FIGURES AND TABLES

Figure 1. Flowchart diagram. ASA: American Society of Anesthesiologists; BMI: body mass index; COPD: chronic obstructive pulmonary disease; ETT: endotracheal tube; LMA: laryngeal mask airway; PACU: post-anesthesia care unit; PCNL: percutaneous nephrolithotomy.

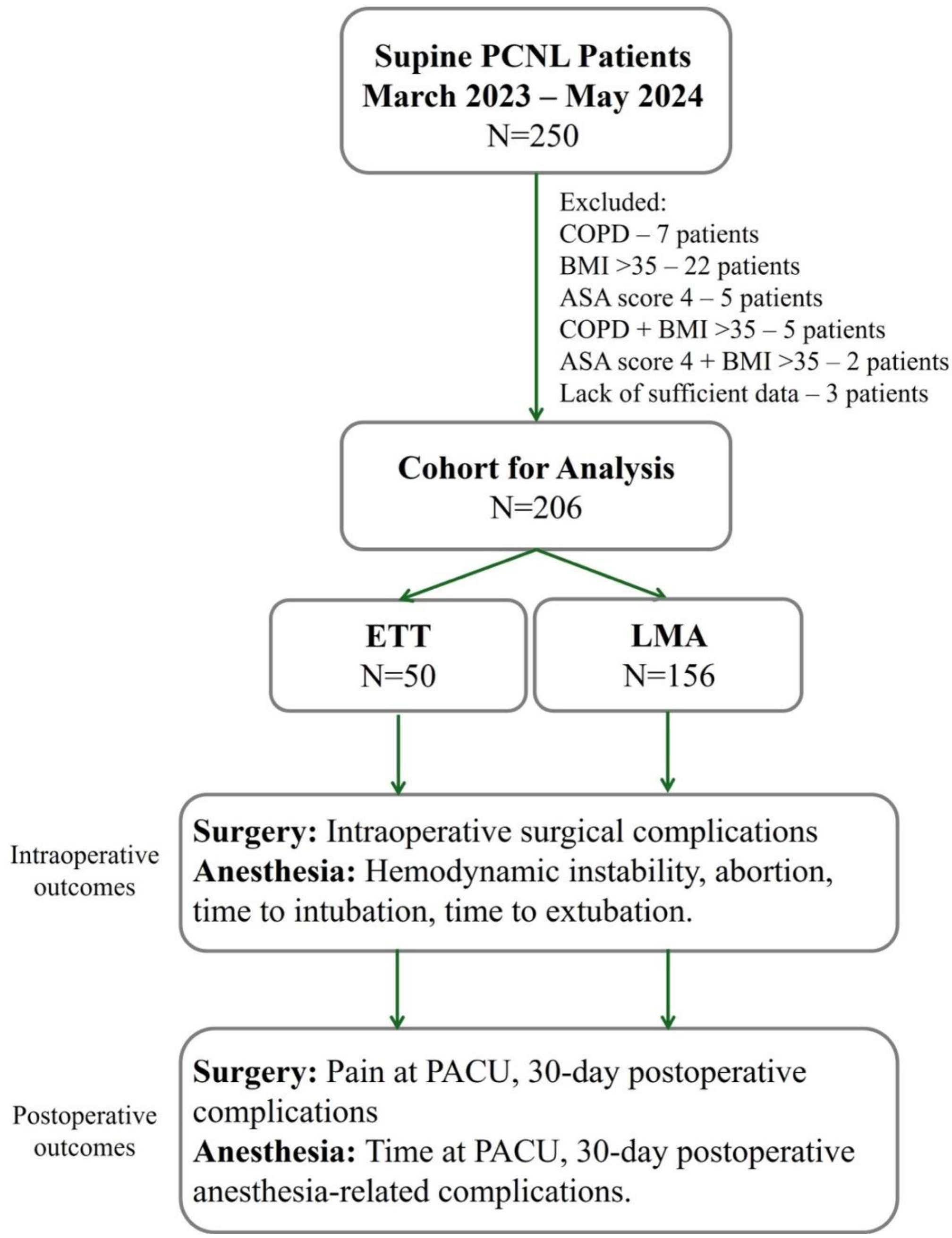

Table 1. Clinical, stone, and operative characteristics of the study cohort categorized by airway modality

	LMA (n=156)	ETT (n=50)	p (2−sided)
Clinical characteristics			
Age (years), median (IQR)	62 (48−70)	64 (40−73)	0.74
BMI (kg/m^2), median (IQR)	26.5 (23.6−29)	26.5 (24.8−29.5)	0.38
Sex, n (%)			0.72
Male	95 (61%)	29 (58%)	
Female	61 (39%)	21 (42%)	
Blood thinners, n (%)			
Antiplatelets	14 (9%)	8 (16%)	0.19
Anticoagulation	8 (5%)	3 (6%)	0.81
ASA, n (%)			0.69
1	2 (1%)	2 (4%)	
2	110 (71%)	31 (62%)	
3	44 (28%)	17 (34%)	
Charlson comorbidity index, median (IQR)	2 (1−3)	2 (0−4)	0.91
Pre-op WBC count ($10^3/\mu L$), median (IQR)	6.8 (5.8−8.4)	6.9 (5.9−8.3)	0.76
Pre-op eGFR[$] (mg/dL), median (IQR)	87 (67−100)	88 (67−101)	0.71
Anatomic abnormalities, n (%)	10 (7%)	2 (4%)	0.44
Complete/incomplete duplicated system	3 (2%)	0 (0%)	
Calyceal diverticulum	6 (4%)	1 (2%)	
Collecting system reconstruction	1 (1%)	1 (2%)	
Stone/patient characteristics			
Laterality, n (%)			0.91
Left	95 (61%)	30 (60%)	
Right	61 (39%)	20 (40%)	
Linear stone burden (mm), median (IQR)	20 (13−29)	29 (17−40)	**0.003**
Stone volume (mm^3), median (IQR)	906 (483−2374)	2495 (888−7407)	**<0.001**
Stone location, n (%)			
Upper pole	31 (20%)	16 (32%)	0.08
Lower pole	102 (65%)	40 (89%)	0.06
Interpolar	45 (29%)	12 (24%)	0.50
Renal pelvis	89 (57%)	32 (64%)	0.38
Guy's stone score, n (%)			**0.04**
1	53 (34%)	8 (16%)	
2	46 (29%)	22 (44%)	
3	37 (24%)	10 (20%)	
4	20 (13%)	10 (20%)	
Pre-existing stent, n (%)	26 (17%)	8 (16%)	0.91
Pre-existing nephrostomy, n (%)	1 (1%)	3 (6%)	**0.01**
Operative characteristics			
Location of access, n (%)			0.91

Upper pole Interpolar Lower pole	20 (11%) 26 (16%) 110 (73%)	4 (8%) 9 (18%) 37 (74%)	
Multiaccess procedure, n (%)	9 (6%)	7 (14%)	0.06
Stent placement, n (%)	76 (49%)	32 (64%)	0.06
Length of surgery (minutes), median (IQR)	62 (47−81)	73 (56−109)	**0.04**

Bold indicates significance (p<0.05); Chi-squared/Fisher's exact tests for categorical variables. Mann-Whitney U test for continuous variables. [$]According to 2021 CKD-EPI calculator. ASA: American Society of Anesthesiologists; BMI: body mass index; EET: endotracheal tube; eGFR: estimated glomerular filtration rate; IQR: interquartile range; LMA: laryngeal mask airway; PCNL: percutaneous nephrolithotomy; WBC: white blood cells.

Table 2. Comparison of urological safety outcomes between airway modality groups

	LMA (n=156)	**ETT (n=50)**	**p**
Intraoperative complications, n (%)	2 (1%)	0 (0%)	0.21[*]
30-day overall complications, n (%)	20 (13%)	14 (28%)	**0.01**[#]
30-day minor complications (CD 1−2), n (%)	12 (8%)	13 (26%)	**<0.001**[#]
30-day major complications (CD 3−5), n (%)	8 (5%)	1 (2%)	0.17[*]
Blood transfusions, n (%)	3 (2%)	0 (0%)	0.16[*]
Visceral injury, n (%) Urinary tract infection, n (%)	2 (1%) 3 (2%)	0 (0%) 3 (6%)	0.21[*] 0.13[#]
VAS pain score in PACU			
Number of patients with data	117	38	
Median (IQR)	4 (0−7)	1 (0−7)	0.17[*]

Bold indicates significance (p<0.05); Chi-squared/Fisher's exact tests for categorical variables. Mann-Whitney U test for continuous variables. [*]1-sided, [#]2-sided. CD: Clavien-Dindo; EET: endotracheal tube; IQR: interquartile range; LMA: laryngeal mask airway; PACU: post-anesthesia care unit; VAS: visual analogue scale.

Table 3. Comparison of anesthesia−related outcomes between airway modality groups			
	LMA (n=156)	**ETT (n=50)**	**p (2-sided)**
Intraoperative hemodynamic instability, n (%)	71 (46%)	28 (56%)	0.19
MAP <60 mmHg in 2 measurements	36 (23%)	8 (16%)	0.29
SaO_2 <90% more than 2 minutes	6 (4%)	1 (2%)	0.53
HR >80 bpm more than 5 minutes	34 (22%)	22 (44%)	**0.002**
Abortion of procedure/conversion, n (%)	0 (0%)	0 (0%)	1.00
Time to intubation (minutes), median (IQR)	9 (7−12)	11 (9−15)	**0.004**
Time to extubation (minutes), median (IQR)	2 (1−6)	3.5 (2−8)	**0.02**
PACU stay (minutes), median (IQR)	174 (104−270)	187 (108−266)	0.84
30-day anesthesia-related complications, n (%)	1 (1%)	1 (2%)	0.39

Bold p-values indicate significance (p<0.05); Chi-squared/Fisher's exact tests for categorical variables. Mann-Whitney U test for continuous variables. ETT: endotracheal tube; HR: heart rate; IQR: interquartile range; LMA: laryngeal mask airway; MAP: mean arterial pressure; PACU: post-anesthesia care unit; SaO_2: arterial oxygen saturation.

Table 4. Univariable and multivariable adjustment models for prediction of 30-day postoperative overall complications: Model 1-LMA and preoperative risk factors, Model 2-LMA and stone characteristics, Model 3-LMA intraoperative factors						
Variable	**Univariable analysis**			**Multivariable analysis**		
	OR	**95% CI**	**p**	**OR**	**95% CI**	**p**
Model 1-Preoperative risk factors						
Age (per 1 year)	0.966	0.943−0.990	**0.005**	0.986	0.940−1.034	0.557
BMI (per 1 unit)	1.023	0.935−1.119	0.621	–	–	–
ASA score (per 1 category)	0.340	0.140−0.825	**0.017**	0.466	0.177−1.229	0.123
Charlson Comorbidity Index (per 1 unit)	0.716	0.558−0.918	**0.008**	0.874	0.539−1.418	0.586
Anticoagulation use	0.491	0.061−3.967	0.505	–	–	–
LMA (vs. ETT)	0.378	0.174−0.821	**0.014**	0.358	0.159−0.807	**0.013**
Model 2-Stone characteristics						
Left side (vs. right)	1.056	0.496−2.250	0.887	–	–	–
Stone volume (per 100 mm^3)	0.998	0.990−1.005	0.582	0.998	0.988−1.009	0.771
Linear stone burden (per 1 cm)	1.047	0.834−1.314	0.692	0.925	0.620−1.380	0.703
Guy's stone score (per 1 point)	0.914	0.633−1.319	0.631	0.821	0.509−1.324	0.419
Upper pole location	1.520	0.668−3.460	0.318	–	–	–
Lower pole location	0.931	0.423−2.048	0.859	–	–	–
Interpolar location	0.930	0.405−2.136	0.864	–	–	–
Renal pelvis location	1.163	0.547−2.475	0.695	–	–	–

LMA (vs. ETT)	0.378	0.174−0.821	**0.014**	0.342	0.147−0.794	**0.013**
Model 3−Intraoperative factors						
Multiaccess procedure	8.486	2.900−24.827	<**0.001**	6.587	2.129−20.380	**0.001**
Stent placement	1.578	0.743−3.353	0.235	–	–	–
Length of procedure (per 1 minute)	1.004	0.996−1.013	0.327	–	–	–
Location of access (per 1 level higher)	1.511	0.932−2.450	0.094	1.321	0.768−2.272	0.315
LMA (vs. ETT)	0.378	0.174−0.821	**0.014**	0.421	0.183−0.966	**0.041**

Bold indicates significance (p<0.05). ASA: American Society of Anesthesiologists; BMI: body mass index; EET: endotracheal tube; LMA: laryngeal mask airway.