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Impact of Anesthesia Type on Stone Clearance and Morbidity in Ureteroscopy: General Versus Spinal Anesthesia

Atif Iqbal[1*], Syeda Javeriya Saeed[2], Khurram Liaqat[3], Fatima Ovais[4], Jawad Hussain Qamber[5] and Sarah Nadia Jamal[6]

[1]Department of General Surgery, Jinnah International Hospital, Abbottabad, Pakistan
[2]Department of General Surgery, Bacha Khan Medical Complex, Swabi, Pakistan
[3]Department of Anaesthesia, Federal Government Polyclinic Hospital, Islamabad, Pakistan
[4]Department of Anaesthesia, Faisal Masood Teaching Hospital, Sargodha, Pakistan
[5]Deapartment of Physiology, Sahara Medical College, Narowal, Pakistan
[6]Department of Anaesthesia, Dow University of Health Sciences, Karachi, Pakistan

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***Corresponding Author:**
Atif Iqbal
Department of General Surgery, Jinnah International Hospital, Abbottabad, Pakistan
dratifjadoon8@gmail.com

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ABSTRACT

Background: Anaesthesiologists prefer regional anesthesia for ureterorenoscopy to prevent difficulties after the procedure, whereas surgeons prefer general anesthesia in order to prevent ureteral damage. However, limited comparative data exist regarding the outcomes of these anesthesia techniques in ureteroscopy-assisted stone clearance **Objective:** To compare spinal and general anesthesia regarding efficacy, safety, and patient outcomes during ureteroscopy for ureteric stones. **Methods:** This quasi-experimental study included 90 patients aged between 20-60 years in total were chosen. Using a semi-rigid ureteroscope (8/8.4 fr), all individuals had ureteroscopic treatment for ureteric stones. Equal numbers of 45 patients were divided between the two groups. General anesthesia was administered to Group A, and spinal anesthesia was provided to Group B. The participants' demographic data, hospital stays, operating times, stone removal rates, and intra- and post-operative problems were all recorded. Data on intraoperative parameters, stone clearance, and postoperative complications were collected and analysed using SPSS 23.0. **Results:** General anesthesia significantly reduced the dilatation time (104.01 ± 12.772 vs. 130.552 ± 22.532 sec, $p < 0.001$) and time to reach the stone (126.68 ± 12.592 vs. 137.602 ± 17.841 sec, $p < 0.001$) compared to spinal anesthesia. However, no significant differences were observed in lithotripsy time, operation time, stone-free rates, or postoperative complications between the two groups. Patients in the GA group reported higher VAS scores and an increased frequency of nausea/vomiting after surgery. **Conclusion:** General anesthesia reduced the time for dilatation and stone access but showed no significant advantages in lithotripsy time, operation time, stone-free rates, or complications.

INTRODUCTION

The increasing prevalence of renal stones in modern populations is attributed to Western-style lifestyles and advancements in imaging technology. In Pakistan, this rise is further linked to higher consumption of animal protein [1]. Ureterorenoscopy has been the primary surgical method for managing ureteral calculi unresponsive to medical expulsive therapy since the 1980s [2]. It offers a better stone-clearance ratio than shockwave lithotripsy and lower complication rates compared to percutaneous nephrolithotomy [3]. The procedure's success is dependent on proper surgical techniques, advanced tools, and careful patient selection.

Ureteral access plays a critical role in the success of ureterorenoscopy, with factors such as axial pressure and preoperative preparation affecting the ease of access and stone-reaching efficiency [4]. The development of advanced surgical techniques and instruments has significantly improved the safety and success rates of ureterorenoscopy. Complication rates have decreased substantially, now ranging from 0% to 6%, while stone

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removal success rates remain consistently high [5]. Despite these advancements, potential complications persist, including ureteral perforation, urinomas, residual stone fragments, strictures, avulsions, bleeding, septic episodes, urinary retention, and postoperative pain [6-8]. Ureteral access is a critical factor for achieving successful ureterorenoscopy outcomes, as it directly impacts the ease of entry and the stone-reaching process [2]. Various techniques, including balloon dilatation, stent placement for passive dilation, and the use of α-blockers, enhance access but come with their own pros and cons [9, 10].
According to the European Association of Urology guidelines, ureterorenoscopy is typically performed under general anesthesia, although spinal and local anesthesia are feasible alternatives, particularly for distal ureteral stones [11]. Anaesthesiologists often favor regional anesthesia to minimize the risks associated with general anesthesia, while surgeons prefer general anesthesia to reduce the likelihood of ureteral injury [12, 13].
Despite advancements in ureterorenoscopy, the choice of anesthesia remains a topic of debate. Existing studies on this subject are often limited by small sample sizes and lack comprehensive analysis [9, 14]. Moreover, there is limited literature that comprehensively compares the impact of general versus spinal anesthesia on ureteroscopy-assisted stone clearance, particularly in different global, regional, and local contexts.
This study aims to address this gap by comparing stone clearance rates and associated outcomes in ureteroscopy performed under general versus spinal anesthesia. We hypothesize that general anesthesia facilitates quicker ureteral access and potentially higher stone clearance rates compared to spinal anesthesia.

METHODS

This quasi-experimental study was conducted on 90 patients undergoing ureteroscopy at the Urology Department of Jinnah International Hospital, Abbottabad, over 12 months from July 2023 to June 2024, following approval from the Institutional Review Board (JIHA/QMS/7642). The sample size was calculated using the two-proportion formula, based on stone-free rates reported in previously published studies. A study comparing ureteroscopy under general anesthesia versus spinal anesthesia reported stone-free rates of 92.3% and 71.0%, respectively [14].

$$n = \frac{\{Z_{1-\alpha/2}\sqrt{2\overline{P}(1-\overline{P})} + Z_{1-\beta}\sqrt{P1(1-P1) + P2(1-P2)}\}^2}{(P1-P2)^2}$$

P_1 (Expected stone-free rate for GA group), P_2 (Expected stone-free rate for SA group), $Z_{1-\alpha/2}$, $Z_{1-\beta}$, $\overline{P}=(P1+P2)/2$.
Using these rates, with a 90% confidence level ($\alpha = 0.10$) and 80% power ($\beta = 0.2$), the calculation yielded a minimum of 45 patients per group. Convenience sampling was used due to practical limitations in patient recruitment. Each patient was informed about the study to take the consent for participation. They were given the option to select the type of anesthetic, and data were gathered by convenience sampling. The anesthesiologist and surgeon, however, had the last say over the kind of anesthesia. Patients with radiologically detected lower ureteral stones below the sacroiliac joint, aged 20 to 60, were included in the study. Patients with upper ureteral lithiasis, hemorrhage, UTIs, ASA classifications III and IV, open surgery requirements, and comorbidities that would preclude general or spinal anesthesia were excluded. To ascertain their composition, the chemical analysis of every stone that was extracted was sent. 45 patients underwent the surgery under general anesthesia, while 45 patients underwent it under spinal anesthesia. The anesthetist's recommendation and the patient's preference guided the choice of anesthesia. The majority of patients spent the night after surgery after being admitted the morning after the procedure. Every patient's whole hospital stay was documented. Prophylactic antibiotics were regularly administered to all patients. Rigid cystoscopy was performed in all cases, with a guide wire inserted into the renal system under fluoroscopy. An 8/8.4 Fr semi-rigid ureteroscope was used for all procedures. When the ureteroscope could not easily pass through the ureter, balloon dilation was performed. Stone fragmentation was achieved using a pneumatic lithoclast, and stents were placed based on the surgeon's discretion. Surgical time, defined as the duration from cystoscope insertion to ureteroscope withdrawal, was documented. Patients were closely monitored for intraoperative complications. Stone fragmentation and clearance were evaluated using KUB radiography and/or excretory urography (in cases of radiolucent stones). Postoperative complications, such as fever, pain, hematoma formation, infection, and residual stones causing obstruction, were assessed in all patients. Visual analog pain scores were recorded post-surgery. Blood cultures and sensitivity tests were conducted if an infection was suspected, and abdominal ultrasound was performed for symptomatic patients presenting with abdominal swelling or suspected hematoma formation. The total hospital stays, measured in hours from admission to discharge, was documented for each patient. The overall health of the patient, the duration of their hospital stays, any difficulties following surgery (such pain and fever), and any complications resulting from anesthesia (like headache and vomiting) were used to determine morbidity. Stone clearance was defined as the absence of residual stones at the first follow-up on the seventh postoperative day, as determined by intravenous urography (IVU) or postoperative kidney/bladder radiography (KUB). Data were analysed using SPSS version 23.0. Qualitative

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variables, such as sex, ASA status, and complication rates, were presented as frequencies (percentages). Quantitative variables, including age, stone size, and hospital stay duration were presented as mean ± standard deviation (SD). Chi square test was applied to see association of qualitative variables in relation to type of anaesthesia and same with independent sample t-test. A p-value of less than 0.05 was considered statistically significant for all comparisons.

RESULTS

Two groups of ninety patients undergoing ureterorenoscopy were created: forty-five of them underwent spinal anesthesia (SA) and forty-five of them underwent general anesthesia (GA). Before the procedure, 500 mg of levofloxacin were given to each patient twice a day for five days. A general anesthetic was delivered to patients who were 55 years of age or younger. There were no discernible variations seen in the GA and SA groups for sex, ethnicity, BMI, or preoperative clinical features. The two groups also showed identical stone features as determined by computed tomography, patient comorbidities, and hydronephrosis prior to ureterorenoscopy (p >.05 for all parameters). However, patients in the GA group were significantly older, while those in the SA group had a greater proportion of ASA status II classifications, as shown in Table 1.
Stone clearance, the study's primary outcome, was defined as the absence of residual stones upon the first follow-up, assessed via IVU or KUB radiography. At the first follow-up, 39 patients (87%) in the GA group and 38 patients (84%) in the SA group were stone-free. This difference was not statistically significant (p = 0.773). The reported stone-free rates align with the study's operational definition of stone clearance. Table 1 shows that patients in the SA group had a larger number of patients with ASA status II and that patients in the GA group were older than those in the SA group.

Table 1: Demographics, Clinical, and Pathophysiological Features of the Patients

Parameter	General Anesthesia (GA)	Spinal Anesthesia (SA)	p-Value
Number of Patients	45	45	-
Sex (%)			
Male	36 (80%)	31 (69%)	0.208
Female	9 (20%)	14 (31%)	
Age (years)			
Mean ± SD	39.79 ± 8.42	25.22 ± 1.97	<0.0001
Body Mass Index (kg/m^2)	25.22 ± 1.97	11.35 ± 1.987	0.079
Hemoglobin (g/dL)	11.28 ± 2.31	11.35 ± 1.987	0.839
Serum Creatinine (mg/dL)	0.68 ± 0.11	0.69 ± 0.15	0.053
ASA Status (%)			
I	28 (63%)	19 (42%)	<0.0001
II	17 (37%)	26 (58%)	
Stone Size (mm)	11.45 ± 3.49	11.11 ± 2.89	0.286
Stone Volume (mm^3)	553.45 ± 25.45	552.12 ± 24.48	0.051
Stone Side (%)			
Right	22 (49%)	23 (51%)	0.782
Left	23 (51%)	22 (49%)	
Stone Status (%)			
Opaque	41 (91%)	39 (89%)	0.737
Semi-Opaque	2 (5%)	3 (7%)	
Non-Opaque	2 (4%)	3 (4%)	
Stone Localization (%)			
Upper	14 (31%)	13 (29%)	0.419
Middle	14 (31%)	16 (35%)	
Lower	15 (34%)	16 (36%)	
Comorbidity (%)			
Absent	40 (89%)	38 (84%)	0.508
Present	5 (11%)	7 (16%)	
Hydronephrosis (%)			
Absent	28 (63%)	26 (58%)	0.508
Grade I	5 (11%)	6 (13%)	
Grade II	6 (13%)	7 (16%)	
Grade III	6 (13%)	6 (13%)	

*p-Value <0.05 is considered significant. Student's t-test was applied

Compared to patients in the SA group, dilatation times in the GA group were substantially lower (104.01 ± 12.772 vs. 130.552 ± 22.532 sec, p < 0.001). Additionally, the GA group required less time to reach the stone than the SA group did (126.68 ± 12.592 vs. 137.602 ± 17.841 sec, p < 0.001). The length of hospital stays, lithotripsy duration, surgery duration, and intraoperative complications were not different significantly, between the groups (p >0.05 for all parameters) (Table 2).

Table 2: Characteristics of Patients, Operation Duration, and Complications during the Surgery

Parameter	General Anesthesia (GA)	Spinal Anesthesia (SA)	p-Value
Lithotripsy Time (min)	12.06.90 ± 2.07	11.94 ± 2.35	0.359
Operation Time (min)	39.12 ± 4.25	39.92 ± 3.15	0.449
Lithotripsy Time (min)			
- Modified SATAVA Grade 1	8 (18%)	9 (20%)	0.058
Length of Hospital Stay (days)	2.08 ± 0.25	2.05 ± 0.17	0.057

*p-Value <0.05 is considered significant. Student's t-test was applied

In the first table, the mean dilatation time for patients under GA was 104.01 ± 12.77 seconds, whereas for SA, the mean dilatation time was significantly longer (p < 0.0001) at 130.55 ±22.53 seconds (Figure 1 A). Similarly, the mean time to reach the stone was 116.68 ± 8.77 seconds for GA, while

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under SA, the mean time was 137.6 ± 12.53 seconds (Figure 1 B).

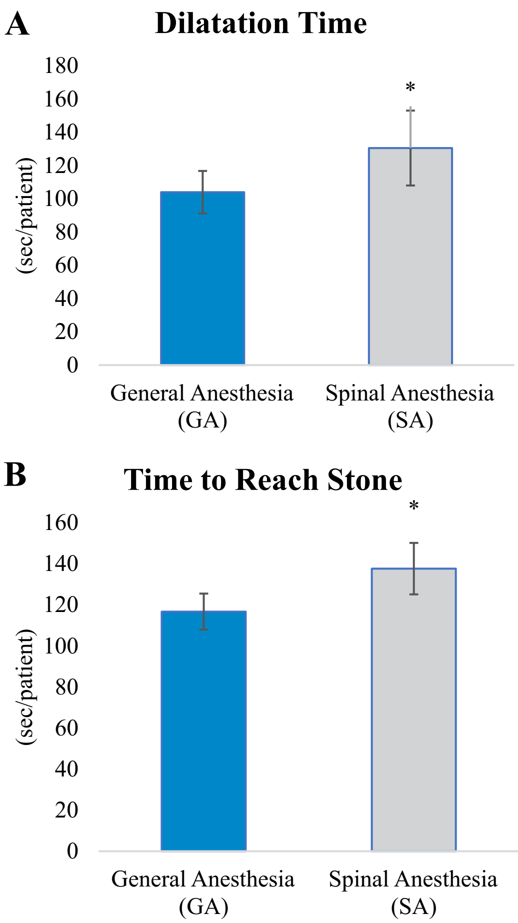

Figure 1: (A) The Time Required for Dilatation (B) Time Required to Reach the Stone

* p-value≤0.05 (Statistically significant). Student t-test was applied

Those in the GA group reported a greater VAS pain score at 8 hours post-surgery (5.01 ± 0.56 vs. 3.94 ± 0.51, $p < 0.001$) than those in the SA group. At the 24-hour mark following the procedure, the GA group continued this pattern, reporting higher pain levels than the SA group (3.13 ± 0.11 vs. 2.02 ± 0.39, $p < 0.001$) (Figure 2).

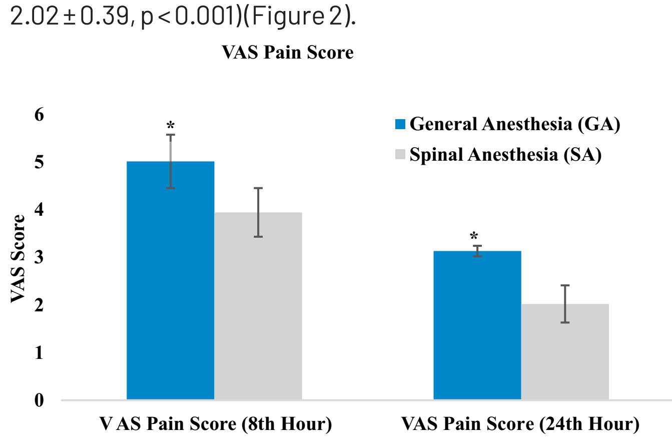

Figure 2: VAS Pain Score

* p-value≤0.05 (Statistically Significant). Student t-test was applied

Following the surgery, a total of 39 patients (87%) in the GA group and 38 patients (84%) in the SA group were clear of stones. There was no statistically significant difference in the groups' stone-free conditions (p = 0.773). Only problems classified as modified CLAVIEN I, II, IIIa, and IIIb were recorded over the 8-week postoperative period. Postoperative problems were not significantly differed between the two groups, with the exception of nausea and vomiting, which were more common in the GA group (p =0.013). According to Table 3, none of the patients had any disabilities upon discharge.

Table 3: Postoperative Complications with Modified CLAVIEN Classification Grade

Complication	General Anesthesia (GA)	Spinal Anesthesia (SA)	p-Value
Mucosal Injury (%)	5 (11%)	4 (9%)	0.859
Hematuria (%)	4 (9%)	4 (9%)	0.949
Fever (%)	1 (2%)	1 (2%)	0.859
Obstructive Diuresis (%)	1 (2%)	1 (2%)	0.975
Elevation in Renal Functions (%)	1 (2%)	1 (2%)	0.859
Retention of Urine (%)	3 (7%)	2 (4%)	0.981
Urinary Tract Infections (%)	4 (9%)	3 (7%)	0.989
Proximal Stone Migration (%)	3 (7%)	2 (4%)	0.993
Stent Migration (%)	2 (4%)	1 (2%)	-

Chi-square test was applied. p≤0.05 was considered significant

A bivariate regression analysis was conducted to evaluate the effect of various characteristics on anesthesia-related times, such as the time for dilation, time required for reaching to the stone, time for lithotripsy, surgery duration, and complications during the surgery. The analysis considered factors such as age, the American Society of Anesthesiologists (ASA) status, and stone volume (Table 4). Stone volume was a significant predictor of lithotripsy time and operation duration, with higher volumes associated with longer times (p = 0.045 and p = 0.046, respectively).

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Table 4: Effect of Anesthesia Time on Characteristics Using Independent Sample t-Test

Characteristics	Age		p-value	ASA Status		p-value	Stone Volume (mm^3)		p-value
	<55	≥55		II	I		<500	>500	
Dilation Time (min)	18.5 ± 2.3	19.7 ± 2.5	0.079	18.2 ± 2.6	19.4 ± 2.7	0.063	17.8 ± 2.2	20.1 ± 2.4	0.055
Time to Reach Stone (min)	7.4 ± 1.1	8.0 ± 1.2	0.072	7.3 ± 1.3	7.9 ± 1.4	0.074	7.1 ± 1.0	8.2 ± 1.1	0.063
Lithotripsy Time (min)	15.3 ± 1.9	16.1 ± 2.0	0.079	15.2 ± 1.8	16.2 ± 1.9	0.079	14.7 ± 1.7	16.5 ± 1.8	0.045*
Operation Time (min)	45.5 ± 4.1	47.3 ± 4.3	0.081	45.4 ± 4.2	47.5 ± 4.4	0.061	44.0 ± 3.9	48.2 ± 4.0	0.046*

The independent t-test was applied, and the results are shown as mean ± standard deviation (SD) for continuous variables and percentage {%(n)} for categorical variables. A p-value <0.05 is considered significant.

DISCUSSION

The results of our study indicate that general anesthesia for ureterorenoscopy significantly reduces both the time for dilatation and the time required to reach the stone, compared to spinal anesthesia. Specifically, the GA group had a dilatation time of 104.01 ± 12.77 seconds, while the SA group had a dilatation time of 130.55 ± 22.53 seconds (p<0.001). Although statistically significant, the clinical relevance of this finding is limited, as quicker dilatation did not translate into improved overall outcomes such as stone-clearance rates or postoperative recovery. These findings are consistent with previous studies that suggest general anesthesia provides better relaxation of the distal ureters, facilitating quicker and easier access to the stone [9]. Regional and spinal anesthesia may not be sufficient for optimal ureteral dilatation, which is crucial for successful stone access [15, 16]. Although medications such as α-blockers and calcium channel blockers could potentially enhance ureteral dilatation, studies examining their effects in this context are still lacking, necessitating further research [11]. Overall, general anesthesia appears to offer advantages in facilitating early ureteral dilatation and stone access [17]. However, the study results showed no significant changes between the general and spinal anesthesia groups in case of lithotripsy time (GA: 12.06 ± 2.07 minutes, SA: 11.94 ± 2.35 minutes, p = 0.359), duration of surgery (GA: 39.12 ± 4.25 minutes, SA: 39.92 ± 3.15 minutes, p = 0.449), complications during surgery, duration of hospital stay (GA: 2.08 ± 0.25 days, SA: 2.05 ± 0.17 days, p = 0.057), stone-clearance rates, or postoperative complications. These findings align with several prospective randomized studies that indicate intraoperative and postoperative outcomes are more closely related to individual patient recovery and surgical technique rather than the type of anesthesia used [18]. In contrast, a Quasi-experimental study reported contradictory results, likely due to a small sample size (type I error) [9]. Patients who received general anesthesia reported higher postoperative Visual Analog Scale (VAS) pain scores at 8 hours post-surgery (GA: 5.01 ± 0.56, SA: 3.94 ± 0.51, p < 0.001, Student's t-test) compared to those who received spinal anesthesia. At the 24-hour mark following the procedure, the GA group continued this pattern, reporting higher pain levels than the SA group (GA: 3.13 ± 0.11, SA: 2.02 ± 0.39, p ≤ 0.001, Student t-test) [19]. These higher pain scores under GA are likely due to its shorter analgesic effect compared to spinal anesthesia and should be weighed against other procedural advantages. Age did, however, influence the anesthesia technique, as general anesthesia was only applied to individuals under the age of 55, which could affect their VAS scores as well [20]. Moreover, urinary symptoms caused by larger-diameter ureteral stents are notably worse than those caused by smaller-diameter ureteral stents. Further investigation is necessary to clarify these relationships. The research discovered that both intraoperative and postoperative characteristics were impacted by stone volume. The results of the current investigation are in line with the results of a prospective study indicating that larger stone volumes are associated with worse intraoperative and postoperative outcomes [18]. Patients having 3rd grade ASA status were not included in the present study, as those with preoperative 3rd grade ASA can experience a 58% increase in major complications and a 49% increase in minor complications following surgery [9]. Excluding these patients limits the generalizability of the findings, as they represent a significant portion of real-world surgical populations. While this study contributes valuable insights to the field of urology, several limitations should be acknowledged. The non-standardized choice of anesthesia introduces potential selection bias, as decisions were influenced by institutional practices and individual preferences. Additionally, the small sample size reduces the statistical power and increases the likelihood of type I and type II errors. Variability in surgeon techniques likely impacted procedural times, emphasizing the operator-dependent nature of these results. The study used bupivacaine for spinal anesthesia, despite reports of the vasodilation properties of levobupivacaine, which may have influenced the outcomes. In the present study, the choice of anesthesia was not standardized and varied between hospitals, sometimes based on the surgeon's preference and other times on the anesthesiologist's recommendation.

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CONCLUSIONS

In conclusion, while general anesthesia demonstrated a statistically significant reduction in the time to reach the kidney stone, the clinical significance of this difference may be limited. Further research, ideally in the form of prospective, randomized trials, is needed to better understand the implications of anesthesia choice in ureterorenoscopy.

Authors Contribution

Conceptualization: AI
Methodology: SJS, AI
Formal analysis: AI, KL, SNJ
Writing, review and editing: FO, SJS, KL, JHQ

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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REFERENCES

[1] Shah MM. Assessment of Dietary Habits of Patients Suffering from Kidney Stone Disease in Public Sector Teaching Hospitals of Peshawar. Ann. Pak. Inst. Med. Sci. 2013; 9(4): 211-4.
[2] Ibis MA and Sarica K. Management of Ureteral Stones. The Ureter: A Comprehensive Review: Springer. 2024; 465-492. doi: 10.1007/978-3-031-36212-520.
[3] Cai H, Wu X, Chen X, Chen W. Comparison of the Effects of General, Spinal and Epidural Anesthesia on Ureter Access and Surgical Outcomes during Flexible Ureterorenoscopy for Transurethral Single Stone Removal Surgeries: A Monocentric Retrospective Study. Annals of Medicine.2021; 53(1): 2110-2119. doi: 10.1080/07853890.2021.1998596.
[4] Xiong M, Zhu X, Chen D, Hossain MA, Xie Y, Gou X, *et al.* Post Ureteroscopic Stone Surgery Ureteral Strictures Management: A Retrospective Study. International Urology and Nephrology.2020; 52: 841-849. doi: 10.1007/s11255-020-02375-4.
[5] Jun DY, Cho KS, Jeong JY, Moon YJ, Kang DH, Jung HD, *et al.* Comparison of Surgical Outcomes Between Single-Use and Reusable Flexible Ureteroscopes for Renal Stone Management: A Systematic Review and Meta-Analysis.Medicina.2022; 58(10): 1388. doi: 10.3390/ medicina58101388.
[6] De Coninck V, Keller EX, Somani B, Giusti G, Proietti S, Rodriguez-Socarras M, *et al.* Complications of Ureteroscopy: A Complete Overview. World Journal of Urology. 2020; 38: 2147-2166. doi: 10.1007/s00345-019-03012-1.
[7] Linehan J, Schoenberg M, Seltzer E, Thacker K, Smith AB. Complications Associated with Ureteroscopic Management of Upper Tract Urothelial Carcinoma. Urology.2021; 147: 87-95. doi:10.1016 /j.urology .2020. 09.036.
[8] Oztekin U, Caniklioglu M, Atac F, Kantekin CU, Gurel A, Isikay L. Comparison of Safety and Efficiency of General, Spinal and Epidural Anesthesia Methods Used for the Endoscopic Surgical Treatment of Ureteral Stones: Which One is Better to Access the Ureter and Reach the Stone? Urology Journal.2020; 17(3): 237-342. doi: 10.1089/lap.2019.0548.
[9] Taguchi K, Yamashita S, Hamamoto S, Deguchi R, Kawase K, Okada T, *et al.* Ureteroscopy-Assisted Puncture for Ultrasonography-Guided Renal Access Significantly Improves Overall Treatment Outcomes in Endoscopic Combined Intrarenal Surgery. International Journal of Urology.2021; 28(9): 913-919. doi: 10.1111/iju.14603.
[10] Fahmy O, Shsm H, Lee C, Khairul-Asri MG. Impact of Preoperative Stenting on the Outcome of Flexible Ureterorenoscopy for Upper Urinary Tract Urolithiasis: A Systematic Review and Meta-Analysis. Urologia Internationalis.2022; 106(7): 679-687. doi: 10.1159/000518160.
[11] Geraghty RM, Davis NF, Tzelves L, Lombardo R, Yuan C, Thomas K, *et al.* Best Practice in Interventional Management of Urolithiasis: An Update from the European Association of Urology Guidelines Panel for Urolithiasis 2022. European Urology Focus. 2023; 9(1): 199-208. doi: 10.1016/j.euf.2022.06.014.
[12] Dohlman LE, Kwikiriza A, Ehie O. Benefits and Barriers to Increasing Regional Anesthesia in Resource-Limited Settings. Local and Regional Anesthesia. 2020: 147-158. doi: 10.2147/lra.s236550.
[13] Topaktaş R, Altin S, Aydin C, Akkoç A, Ürkmez A, Aydin ZB. Is Spinal Anesthesia An Alternative and Feasible Method for Proximal Ureteral Stone Treatment? Central European Journal of Urology.2020; 73(3): 336. doi: 10.5173/ceju.2020.0049.
[14] Kwon O, Lee JM, Park J, Cho MC, Son H, Jeong H, Ryang SH, Cho SY. Influence of anesthesia methods on surgical outcomes and renal function in retrograde intrarenal stone surgery: a prospective, randomized controlled study. BMC anesthesiology. 2019 Dec;19:1-8.
[15] Channa AA, Ashfaq S, Ahmad MZ, Asif M, Shahid MW, Ahmed N. Ureteroscopy under General Anesthesia Versus Spinal Anesthesia: Stone Clearance and Morbidity. Pakistan Journal of Medical & Health

DOI: https://doi.org/10.54393/pjhs.v6i1.2374

Sciences.2022May;16(04):624.doi:10.53350/pjmhs 22164624.
[16] Whitehurst L, Pietropaolo A, Geraghty R, Kyriakides R, Somani BK. Factors Affecting Operative Time During Ureteroscopy and Stone Treatment and its Effect on Outcomes: Retrospective Results over 6.5 Years. Therapeutic Advances in Urology.2020; 12: doi: 10.11 77/1756287220934403.
[17] Duan M, Chen Y, Sun L. Outcomes of Retrograde Intrarenal Surgery Performed under Neuraxial vs. General Anesthesia: An Updated Systematic Review and Meta-Analysis. Frontiers in Surgery.2022; 9: 8538 75. doi: 10.3389/fsurg.2022.853875.
[18] Pelit Es, Binici O, Kati B, Yağmur İ, Demir M, Arslan E, *et al*. A Prospective Randomized Study Comparing Retrograde Intrarenal Surgery Under Spinal Anaesthesia Versus General Anaesthesia. Journal of Reconstructive Urology.2020;10(1).doi:10.5336/ urology.2020-75691.
[19] Sahan M, Sarilar O, Akbulut MF, Demir E, Savun M, Sen O, *et al*. Flexible Ureterorenoscopy and Laser Lithotripsy with Regional Anesthesia vs General Anesthesia: A Prospective Randomized Study. International Brazilian Journal of Urology.2020; 46(6):1010-1018. doi:10.1590/s1677-5538.ibju.2019. 07 70.
[20] Bosio A, Alessandria E, Vitiello F, Vercelli E, Agosti S, Gontero P. Flexible Ureterorenoscopy under Spinal Anesthesia: Focus on Technique, Results, Complications, and Patients' Satisfaction from a Large Series. Urologia Internationalis.2022; 106(5): 455-45 60. doi: 10.1159/000518159.