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?

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Purpose: The aim of this study is to evaluate the effects of anesthesia methods on the success of urethral access and stone access achievement in endoscopic treatment of urolithiasis.

Materials and Methods: In this prospective randomized study, 105 patients who underwent primary ureterorenoscopy (URS) procedure for ureteral stones were evaluated. The patients were randomized into three groups by permuted block randomization according to the applied anesthesia method: General anesthesia (GA): 33 patients, Spinal anesthesia (SA): 31 patients, and Epidural anesthesia (EA): 31 patients. Ten patients, whose ureteral access was not successful, were dropped out. The success of the three anesthesia methods on the success of the ureter access and its effects on surgical outcomes were compared.

Results: There was no statistically significant difference among the three groups in terms of the demographic values and preoperative features except the American Society of Anesthesiologists (ASA) status. Dilatation and the access time to stone were statistically significantly longer in SA and EA group compared to the GA group. There was no statistically significant difference among the groups in terms of operation, lithotripsy time, stone-free rate (SFR), and complication rates. The Visual Analog Scale (VAS) scores in the 8th and 24th hours were statistically significantly higher in the GA group.

Conclusion: In patients who decided to undergo primary ureterorenoscopy procedure, it can be suggested to treat with GA to provide a better relaxation of the ureter if there are no contraindications.

Keywords: anesthesia methods; endoscopy; epidural anesthesia; spinal anesthesia; ureteral stone; ureterorenoscopy

INTRODUCTION

Ureterorenoscopy (URS) has been a routine surgical procedure since 1980[(1)]. The success rate has increased, and the indications have expanded with the use of advanced technology and modern equipment[(2)]. It is widely used as a minimally invasive method in the endoscopic treatment of urinary stone disease, which is a common problem. The stone disease may show a prevalence of 20% due to geographic, climatic, ethnic, dietary, and genetic factors[(3)].

Patient selection, proper use of surgical instruments, and the appropriate technique increase the reliability and success. Ureteral access is one of the critical steps in URS. The success of ureteral access and the process of reaching the stone depend on the axial force in the orifice[(4)]. In primary surgery, the ureteral access may not always be possible, and ureteral injury secondary to excessive force may happen[(5)].

There are several studies for more successful surgical results by increasing ureteral access achievement in the literature. Among them, methods that improve the ureteral access achievement have been stated, such as; ureteral balloon dilatation, preoperative stent implantation with passive dilatation, and preoperative alpha-blocker usage. There are various advantages and disadvantages of these methods. Active balloon dilatation is an option, but the risks such as ureteral edema, postoperative discomfort or secondary stenosis cannot be excluded[(6)]. This is one of the challenging topics in urology to avoid these risks and increase the success of ureteral access. There is no study in the literature evaluating the effect of anesthesia type on this stage of ureteroscopy.

As mentioned in the European Association of Urology (EAU) guidelines, although most procedures are performed under general anesthesia (GA), however local or spinal anesthesia (SA) can be the other options. Intravenous sedation can also be suggested in female patients with distal ureteral stones[(7)]. However, there are not enough studies in the literature showing the effects of anesthetic methods on ureteral access and surgical success.

The applied anesthesia method may affect the manipulation in ureteral access and influence ureteral entrance and surgical success. The aim of this study is to evaluate the effects of anesthesia methods on the surgical results of spinal, epidural, and general anesthesia procedures and the success of urethral access and stone access achievement.

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Table 1. The Demographic Values And Preoperative Features

	General Anesthesia (n=33)	Spinal Anestesia (n=31)	Epidural Anesthesia (n=31)	*p*
Age (±SD)	40.82 ± 10.63	44.39 ± 16.44	49.03 ± 15.51	.078
Gender (n,%)				61
Male	25 (75.8%)	22 (71.0%)	20 (64.5%)	.
Female	8 (24.2%)	9 (29.0%)	11 (35.5%)	
BMI (±SD)	27.07 ± 5.18	26.47 ± 3.99	29.97 ± 6.97	.20
Stone size (mm)(±SD)	10.93 ± 4.3	10.25 ± 3.57	10.90 ± 2.72	.52
Stone volume (±SD)	483.85 ± 463.06	354.72 ± 396.27	348.50 ± 232.66	.309
Preoperative Cre (mg/dl)(±SD)	0.85 ± 0.20	1.0 ± 0.30	0.92 ± 0.27	.19
ASA (n,%)				.018
ASA 1	20 (60.6%)	15 (48.4%)	8 (25.8%)	
ASA 2	13 (39.4%)	16 (51.6%)	23 (74.2%)	
Stone side (n,%)				.69
Right	19 (57.6%)	15 (48.4%)	15 (48.4%)	
Left	14 (42.4%)	16 (51.6%)	16 (51.6%)	
Stone location (n,%)				.965
Upper	10 (30.3%)	10 (32.2%)	11 (35.4%)	
Mid	14 (42.4%)	11 (35.4%)	12 (38.7%)	
Lower	9 (27.2%)	10 (32.2%)	8 (25.8%)	
Stone opacity(n,%)				.52
Opaque	24 (72.7%)	20 (64.5%)	26 (83.9%)	
Semiopaque	1 (3%)	1 (3.2%)	0 (0%)	
Non-opaque	8 (24.2%)	10 (32.3%)	5 (16.1%)	
Co-morbidity (n,%)				.53
Absent	30 (90.9%)	29 (93.5)	26 (83.9%)	
Present	3 (9.1%)	2 (6.5%)	5 (16.1%)	
Hydronephrosis (n,%)				. 681
Absence	4 (12.1%)	4 (12.9%)	2 (6.4%)	
Grade1	3 (9.1%)	5 (16.1%)	4 (12.9%)	
Grade 2	23 (69.7)	20 (64.5%)	24 (77.4%)	
Grade 3	3 (9.1%)	2 (6.4%)	2 (6.4%)	

Abbreviations: BMI, Body Mass Index; ASA, American Society of Anesthesiologists; SD, Standart Deviation; mm, milimeter.

MATERIALS AND METHODS

After the approval of the local ethics committee (2018-KAEK-189_2018.01.25_03), the study was designed prospectively. The informed consent form was obtained from all patients, and an assessment was made by the Helsinki Declaration. Between February 2018 and February 2019, 105 patients whom URS was planned due to the ureteral stones in our clinic were included in the study. Patients older than 18 years of age, who underwent primary surgery, were included in the study. Patients who had chronic pain treatment, double J stent, previous surgery, previous minimal invasive procedures, neurogenic disease, urethral and ureteric stenosis, kidney anomaly, multiple stones, contraindications for regional anesthesia (RA) and whose ureteral access was unsuccessful or anesthesia method was changed preoperatively were excluded. Also, patients with an American Society of Anesthesiologists (ASA) score of ≥ grade 3 were excluded from the study. ASA classification system is defined as: ASA grade 1: a normal healthy patient, ASA grade 2: a patient with mild systemic disease, ASA grade 3: a patient with severe systemic disease, ASA grade 4: a patient with severe systemic disease that is a consistent with threat to life and ASA grade 5: a moribund patient who is not expected to survive without the operation[8]. At the end of the study, the patients whose ureteral access was not successful were dropped out because the duration could not be calculated, and the data of 95 patients were evaluated. Among the dropped outpatients, 4 of them were in spinal anesthesia (SA) group, 4 of them were in epidural anesthesia (EA), and two patients were in the GA group. The patients were randomized into three groups according to the applied anesthesia method: GA: 33 patients (Group 1), SA: 31 patients (Group 2), and EA: 31 patients (Group 3).

All patients were evaluated by direct urinary tract X-ray, urinary system ultrasonography (USG), and computed tomography (CT) by the stone protocol. Proximal, middle, and distal ureteral stones were included in the study. Preoperative, intraoperative, and postoperative data including age, gender, body mass index (BMI), stone size (longest diameter measured by computed tomography), volume, preoperative creatinine level, ASA status, stone side, localization, opacity, co-morbid diseases, were recorded. Duration of dilatation (the duration starting from the urethral meatus access with ureteroscopy, under the guidance of the guidelines, until the orifice entry) and access to stone (the duration from the start of the orifice entry until the stone is seen), the period of stone crushing and operation (the duration from the beginning of the urethral meatus access to the end of the double j stent placement operation), rates of intraoperative and postoperative complications, Visual Analog Scale (VAS) score in 8th and 24th hour and stone-free rates (SFR) were recorded. The patients were administered with intravenous 3rd generation cephalosporin prophylactically 30 minutes before the operation. Patients who had germs in the urine culture were operated after the treatment with an appropriate antibiotic for the culture. Informed consent was obtained from all patients.

Anesthesia Method

All patients underwent anesthesia with the same anesthesiologist. Vascular access was established to the patients by using a 20 G intravenous cannula in the preparation room for the operation. The patients were monitored, and Systolic Arterial Pressure (SAP), Di-

Table 2. Intraoperative and Postoperative Comparison of The Outcomes

	General Anesthesia (n=33)	Spinal Anestesia (n=31)	Epidural Anesthesia (n=31)	*p*
Dilatation Time (sec)(mean±SD)	80.45 ± 52.96	156.45 ± 66.20	176.29 ± 90.42	< .001
Time to reach to stone (sec)(mean±SD)	105.54 ± 34.13	151.61 ± 98.46	181.93 ± 115.33	.003
Operation time (min)(mean±SD)	37.08 ± 14.8	30.42 ± 12.4	36.94 ± 20.59	.156
Litotrpsy time (min)	12.25 ± 6.05	11.53 ± 9.92	15.19 ± 14.9	.35
VAS Score				
8th Hour(SD)	4.06 ± 1.98	2.35 ± 2.04	2.48 ± 1.78	.001
24th Hour(SD)	2.55 ± 1.54	1.00 ± 1.18	1.39 ± 1.58	< .001
Stone Free Rates (n,%)*	29 (87.9%)	28 (90.3%)	27 (87.1%)	.918
Complication rate (n,%)**				
Intraoperative	3 (9.1%)	7 (22.6%)	9 (29.0%)	.125
Postoperative	5 (15.2%)	7 (22.6%)	4 (12.9%)	.566
SATAVA				
Grade 1	3 (9.1%)	7(22.6%)	9 (29.0%)	.125
CLAVIAN				.566
Grade 1	1 (3.0%)	5 (16.1%)	4 (12.9%)	
Grade 2	3 (9.1%)	2 (6.5%)	0 (0.0%)	
Grade (IVa/IVb)	1 (3.0%)	0 (0.0%)	0 (0.0%)	

Abbreviations: SD, Standart Deviation; Sec, Second; Min, minute.

astolic Arterial Pressure (DAP), Mean Arterial Pressure (MAP), Heart Rate (HR), and Oxygen Saturation (SpO_2) measurements were performed noninvasively and recorded.

Group 1: The patients undergoing GA were preoperatively oxygenized with 100% oxygen for 3-5 minutes after monitoring. In the induction of anesthesia, 2 mcg / kg fentanyl, 2-3 mg / kg propofol and 0.5 mg / kg rocuronium were administered. Endotracheal intubation was performed after muscle relaxation was provided. In the cases, controlled ventilation was provided by adjusting the tidal volume as 8-10 ml/kg and the respiratory frequency as 10-12 min. Maintenance of anesthesia was provided with 50% O_2 and 50% N_2O in 1% MAC sevoflurane.

Group 2: Patients undergoing SA were preoperatively hydrated with a balanced electrolyte solution (500 ml) half an hour before the operation. After the patient, taken to the operating room was monitored, skin cleaning was performed in the sitting position, and 25 G or 26 G spinal needle was used through L3-4 or L4-5 range; the spinal range was entered with midline approach technique. After the clear CSF flow was observed, 0.5% hyperbaric bupivacaine3 ml (5 mg/ml) was administered slowly. Sensory block levels of the patients were evaluated with the pinprick test. The surgical procedure was initiated when the level T8-T6 reached the area of the dermatome.

Group 3: After regular monitoring in the EA group, skin cleaning was performed in the sitting position, T11 to T12 range was entered with 18 G toughy needle, the epidural range was found by negative pressure method, and the epidural catheter was placed. After applying 3 mL of prilocaine (Citanest® 2% 20 mg) as a test dose, 1.5 mL of prilocaine was added for each segment. When the sensory block was provided at the T6 level, the surgery started.

URS Technique

All procedures were performed by two experienced surgeons. After anesthesia, a ureteral 0.038-inch hydrophilic guidewire was inserted in the modified dorsal lithotomy position, and dilatation was achieved by entering the ureter with 9.5 F ureterorenoscope (Karl Storz®, Tuttlingen, Germany). After the stone was seen, a probe compatible with 200 µm of holmium laser (Quanta System®, Litho 30W, Milan-Italy) was used. Lithotripsy was performed with a frequency of 8-15 Hz and power of 1.2-3.0 joules. After the stones were completely fragmented, the process was terminated. After the procedure, JJ stent was placed in all patients. In the postoperative first day, the place of the stent and the status of the fragmented stones on X-Ray and non-opaque stones were evaluated by USG imaging. The pain levels of all patients were assessed with VAS in the 8th and 24th hours. Four weeks later, the patients were called for control, the stent was withdrawn, and the CT was performed without contrast. The absence of stones in the CT image and patients with a stone size of ≤3mm were considered as stone-free.

Intraoperative and postoperative complications were recorded, and intraoperative complications were classified according to Satava complication classification, and postoperative complications were classified according to the Modified Clavian classification system [9,10]. At the end of this study, the success of the three anesthesia methods on the success of the ureter access and its effects on surgical outcomes were compared.

Kolmogorov-Smirnov and Shapiro-Wilk tests are conducted for the assessment of normal distributions in our sample group. Differences in the categoric parameters between the three groups were calculated using the Chi-Square test. Pearson Exact test was performed for all categorical parameters. For numerical parameters, Kruskal-Wallis analysis was performed except age, and preoperative Haemoglobin, which were assessed using One-Way ANOVA analysis because of their distributions were normal. $P < .05$ was considered statistically significant. The three groups were compared with regard to ureteral orifice dilatation time, time to reach to stone, total surgery time, VAS scores in 8th and 24th hours of operation, SFR (the rates given in the table belongs to the patients without any stone) and both intraoperative and postoperative complication rates (the rates given in the table belongs to the patients with any complications). In the case of *p*-value was smaller than .05, Pairwise comparisons were performed to find the parameter that was responsible for the difference.

Tablo 3. P values for each group comparisons after pairwise comparisons.

	General vs. Spinal	General vs. Epidural	Spinal vs. Epidural
Dilatation Time	< .001	< .001	.69
Time to reach the stone	.054	.003	.61
8th Hour VAS Score	.004	.004	.99
24th Hour VAS Score	< .001	.013	.62

Abbreviations: VAS, Visual Analog Scale.

RESULTS

Ninety-five patients who were enrolled and met the study criteria were included in the study. There was no statistically significant difference among three groups in terms of age, BMI, stone size, volume, preoperative creatinine level, stone side, localization, opacities, concomitant comorbidities, hydronephrosis levels, and preoperative hemoglobin levels except ASA status. (**Table 1**).

Dilatation and stone access durations were significantly different among the groups. In the GA group, the duration was shorter than SA and EA groups. There was no statistically significant difference among the groups in terms of operation, lithotripsy time, SFR, and complication rates. A statistically significant difference was found between the 8th and 24th hour when VAS scores were compared (p <.05). VAS score was higher in the GA group. (**Table 2**)

In the binary comparisons which were made to determine which group causes the differences, it was found that the differences, in terms of the dilatation, duration to reach the stone, 8th, and 24th-hour VAS scores, were derived from the group GA. The pain score was higher in the GA group (**Table 3**).

DISCUSSION

The endoscopic stone treatment is used in the treatment of urinary system stones. These methods can be used in anomalous kidney stones and secondary kidney stones.[11] URS is a minimally invasive method that urologists use safely and efficiently. It is often used in the treatment of urinary tract stones. Moreover, in the diagnosis of abnormal lesions reported in imaging methods (intravenous pyelography, magnetic resonance, CT, etc.), it can be applied in ureteral stricture, diagnosis, and treatment to investigate the source in positive urine culture and cytology[12-14]. In the URS procedure, anesthesiologists prefer RA methods to avoid complications due to GA and to provide patient turnover and postoperative care easiness in the operating room. In contrast, surgeons prefer the GA method mostly to avoid ureteral trauma by providing more controlled case management [15]. In the literature, it has been emphasized that the URS procedure can be performed safely with anesthesia methods such as intravenous sedation, sacral block, local anesthesia, and spinal anesthesia[15-20].

Access to ureteral orifice and access to stone is one of the important stages of the URS procedure. At this stage, the applied force and manipulations may cause complications and decrease ureteral access and surgical success. In the distal part of the ureter, the □-adrenergic receptors are at higher densities than the middle and proximal regions[21]. The presence of more intense adrenergic receptors in the distal ureters in patients who have had RA may lead to inadequate relaxation and excessive manipulation. In a study measuring the force exerted during primary urethral entry and ureteral access sheath placement in patients undergoing retrograde intrarenal surgery procedure under GA, the control group and the group had given α-blocker before the operation were compared. In the group using □-blocker, it has been concluded that the ureteral access force is significantly lower. Smaller diameter access or pre-stenting has been proposed to avoid ureteral damage by reducing this insertion force[5]. Parikh et al. have stated that extra anesthesic drug administration during ureteral catheterization has been required in 5 patients, in a study comparing segmental EA and GA in patients undergoing percutaneous nephrolithotomy (PCNL). It has been emphasized that EA does not block proprioception, which may cause discomfort to patients despite adequate sensory blockage. Furthermore, in these patients, propofol and the complementary GA are required, and the segmental GA is not sufficient.[23,24] Basiri et al. conducted that SA did not provide enough analgesia for the patient in a limited frequency of PCNL operations. In our study, we evaluated the success of the ureteral entry in terms of dilatation and the access time to stone. These durations were statistically significantly longer in SA and EA group compared to the GA group, suggesting that sufficient ureteral relaxation could not be achieved in RA and more manipulation was required, in the GA group, this duration was short, suggesting better ureteral relaxation.

Kizilay et al. analyzed 638 patients with proximal ureteral stones by dividing them into two groups as URS under SA and GA. Although there was no difference between the groups in terms of operation time and complication rates, SFR was found to be better in the SA group (p = .041). However, in this study, stone density and area have been found significantly lower in the SA group. Also, the push-back ratio has been found significantly higher in the SA group, and it has been thought that ureteric stones may be more mobile if adequate relaxation is not provided as much as it is expected in GA.[16] Conversely, according to the results of our study, we think that ureteral relaxation is better under GA. Shaikh et al. have compared SA and GA methods in their series of 60 diseases URS. No difference has been found between the two groups in terms of SFR and complications. Although the stone size was significantly smaller in the GA group, the operation time was lower in the SA group[19]. In our study, there was no statistically significant difference between the groups in terms of stone size, density, and location, operation time, and SFR.

Pain after URS is a common postoperative complication.[24,25] There are studies showing that RA methods are advantageous in terms of postoperative pain in URS and other surgical procedures.[19,22,26] In our study, when the VAS scores in 8th and 24th hours were compared, they were higher in the GA group. In the spinal and epi-

dural anesthesia groups, the provided pre-emptive analgesia may also lead to a lower VAS score[27]. This result is seen as important data for postoperative comfort in the URS procedure under RA.

In general, studies conducted in the literature showed no effect of anesthesia methods on complications in terms of URS and other surgical procedures.[15,16,19,20,28,29] The overall complication rate is 9-25% after URS. Most complications are minor complications that do not require additional treatment[7]. In our study, sepsis developed in one patient in the GA group. Minor complications were recorded as infection, mucosal injury, hematuria without blood transfusion necessity, although they were lower in the GA group, there was no statistically significant difference between the groups. In addition, there was a significant difference in ASA scores between the groups in our study. In the literature, it is reported that major complications were increased by 58% and minor complications were increased by 49% for patients with ASA > grade 3.[30] Therefore we included ASA I and II patients who did not have a serious systemic disease in order to standardize the data and not to affect the results of our study.

We planned this study based on the observation that the URS procedure we performed under RA required more manipulation, especially during the ureteral entrance and the access to the stone. Although this is not a ureteral pressure measurement study, shorter entry time in the GA group suggests that ureteral relaxation might be better in the GA group. In surgeries performed under GA, muscle relaxant agents may contribute to ureteral relaxation.

CONCLUSIONS

RA methods may be preferred to reduce the risk of complications related to GA and for the postoperative low pain score. However, under the GA, the primary URS procedure provides a better relaxation of the ureter, allowing the surgeon to enter the ureter in a shorter time with less manipulation and to reach the stone more easily. Therefore, in patients who are planned with primary URS procedure due to the stone, it can be suggested to treat with GA if there are no contraindications.

CONFLICT OF INTEREST

The authors report no conflict of interest.

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