Effect of Spinal and General Anesthesia on Postoperative Pain and Satisfaction in Ureteroscopic Lithotripsy (URSL)

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Purpose: To compare general anesthesia (GA) with spinal anesthesia (SA) regarding postoperative pain and satisfaction after ureteroscopic lithotripsy (URSL).

Materials and Methods: Two hundred twenty-nine patients were analyzed in the study. Patients were assigned to two groups—SA and GA. Demographic data, stone characteristics, operation time, and frequency of opioid analgesic use during the admission period were collected from hospital medical records. Visual analogue scale (VAS) scores at 6 hours and 24 hours after URSL were recorded. Complications according to the Clavien–Dindo classification and the experience of headaches after surgery (Yes/No) were documented after one month. Participants and surgeons were asked to rate their satisfaction on a scale of 1 to 10.

Results: Of 237 eligible patients, 229 completed the study. The incidence of headaches and VAS scores (at 6 h and 24 h) were significantly higher in the SA group ($P < 0.001$). Patient and surgeon satisfaction in the GA group were significantly higher ($P < 0.001$). Multivariate analysis showed that female sex was associated with lower opioid analgesic use during the admission period (odds ratio [OR] = 0.47), and surgery time correlated with frequency of opioid use and headache (OR = 1.12 and OR = 1.11, respectively).

Conclusion: GA was associated with better postoperative pain control after URSL and higher satisfaction levels for both surgeons and patients.

Keywords: lithotripsy; pain; satisfaction; ureteroscopic lithotripsy; ureteroscopy; urolithiasis

INTRODUCTION

Urolithiasis is defined as the presence of one or more stones in the urinary tract, which affects between 2% and 20% of the population, with a recurrence rate of 30% to 50% over 5 years.[1] Management has shifted from open surgery to minimally invasive techniques, including ureteroscopic lithotripsy (URSL), percutaneous nephrolithotomy (PCNL), and extracorporeal shock wave lithotripsy (ESWL). According to European guidelines, URSL and ESWL are preferred for ureteral stones, with URSL being particularly effective for stones larger than 10 mm in the middle and distal ureters, offering good stone-free rates and reduced morbidity.[2–7]

Spinal anesthesia (SA) is a common and safe technique for lower extremity and abdominal surgery.[8] It is also widely used for many urological surgeries, especially transurethral procedures.[9] SA has various advantages, such as reducing respiratory complications, blood loss, perioperative cardiac problems, hypoxic episodes, vascular thrombosis, and postoperative cognitive dysfunction.[10] Nevertheless, cauda equina syndrome, hypotension, bradycardia, headache, and back pain are some of the complications associated with SA.[11]

Despite the benefits of SA, there is uncertainty among surgeons about using this method in URSL due to the possibility of patient movement, restlessness, and lack of control over the procedure.[9] General anesthesia (GA) has also been deemed reasonable for urological procedures due to the emergence of supraglottic airway devices and short-acting general anesthetics. Overall satisfaction and the ability to perform prolonged operations without airway compromise are advantages of GA. However, GA can affect the central nervous and cardiorespiratory systems, resulting in cardiorespiratory failure and hypotension. It can also lead to aspiration pneumonia, failed intubation, and respiratory complications.[12–15]

Effective preoperative anesthesia is the foundation of a successful operation. One of the most important measures of high-quality anesthesia is patient satisfaction. Pain management is a crucial part of anesthesia and must be assessed to determine overall satisfaction.[16] Satisfaction is a multifactorial concept that relies on individual patient judgment. It is attributed to several factors such as the patient's emotional state, social circumstances, cultural background, past experiences, and future expectations. Patients often compare their expectations with their previous experiences as well as with actual outcomes.[17] Patient satisfaction can indicate the quality of healthcare provided. In the modern era, utilizing patient satisfaction as an indicator is more reasonable than morbidity and mortality for anesthet-

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Table 1. Comparison of demographics data

Variables	SA	GA	*P*-value
Sex (male), number (%)	78 (59.5 %)	65 (66.3 %)	0.335 (a)
Age (years), mean (SD)	47.8 (13.2)	45.63 (11.6)	0.294 (b)
BMI (Kg/m2), mean (SD)	24.4 (4.4)	23.9 (4.3)	0.395 (b)
Stone size (mm), mean (SD)	7.8 (2.6)	7.8 (2.5)	0.959 (b)
Stone laterality (right), number (%)	71 (54.2%)	52 (53.0%)	0.894 (a)
Surgery time (minute), mean (SD)	15.9 (6.3)	14.5 (4.5)	0.049 (b)
Stone-free rate, number (%)	95 (72.5)	70 (71.4)	0.882 (a)

Abbreviations: SA, spinal anesthesia; GA, general anesthesia; BMI, body mass index; SD, standard deviation
a: Chi-squared test; b: independent t-test.

ic care.[18] Safe and effective pain relief plays a major role in patient satisfaction; as more pain is relieved, satisfaction tends to be higher.[19] Postoperative pain is an unpleasant physical and emotional sensation that affects every aspect of life and can continue for hours to days, and rarely weeks to a month. Pain should be relieved immediately with analgesic agents to improve quality of life, allow rehabilitation, and prevent further complications.[20] Effective management of postoperative pain has always been a concern for both patients and surgeons due to the potential adverse effects of the physiological response to pain.[21] The primary objective of this study was to evaluate the effect of anesthesia type on patient and surgeon satisfaction. The secondary objectives included assessing patient pain and analgesic consumption during the admission period and after discharge between the two groups.

MATERIALS AND METHODS

Study Design and Participants

This prospective cohort study was carried out between June 2023 and September 2023. All patients provided written informed consent, as required by the Persian Registry for Stones of the Urinary System (PERSUS). The study protocol was approved by the ethics committee of the Tehran University of Medical Sciences (IR.TUMS.SINAHOSPITAL.REC.1403.062) and was performed in accordance with the Helsinki Declaration. Participants signed written informed consent before participation.

The inclusion criteria were: age greater than 18 years; distal ureteral stones confirmed by non-contrast-enhanced computed tomography (CT) planned for elective URSL; stone size less than 15 mm; and willingness to participate. The exclusion criteria included chronic pain diseases; history of opioid abuse; opioid consumption within the last 3 months; untreated psychological disorders; cardiovascular or respiratory diseases; pregnancy; previous double J stent placement; previous genitourinary system surgery; emergent setting caused by obstructed stone; any neurogenic disease; urethral and ureteric stenosis; kidney anomalies; renal failure; severe hydronephrosis; multiple stones; contraindications for regional anesthesia (RA); and unsuccessful ureteral access. American Society of Anesthesiologists (ASA) score was utilized to evaluate preoperative health. Patients with ASA score ≥ 3 were excluded.[22] Inserting a double J stent (in case of ureteral damage, risk of obstruction, and infective complication) may cause stent-related symptoms and confound both satisfaction and pain severity. Because most patients in our center undergo double J stenting, we excluded patients without double J stents to eliminate the confounding effect of stenting.^[23,24] The sample size was determined using G*Power (version 3.1), with type I error 0.05, type II error 0.10, anticipated effect size 0.5, and 20% loss to follow-up. Accordingly, a minimum of 101 participants per group was required. Recruitment continued until at least 101 participants per group were enrolled.

Anesthesia and URSL Procedure

A total of 237 patients were enrolled. The anesthesia method was chosen preoperatively by the anesthesiologist according to the patient's condition. All patients were informed about their anesthesia type. Participants were assigned to GA and SA groups. Demographic data (age, sex, body mass index [BMI], past medical history) and stone characteristics (size, location) were documented.

Patients in the GA group were anesthetized with fentanyl, propofol, and isoflurane in an air/oxygen mixture through a supraglottic airway device. The SA group received 0.5% heavy bupivacaine. Motor block was assessed by the modified Bromage scale, and after an adequate level of sensation, the operation began.[25] All patients were placed in lithotomy position. A 0.035 inch floppy-tip guidewire was inserted, and a second guidewire with a 10 Fr double lumen catheter was placed. URSL was performed using a semi rigid 8 Fr ureteroscope (Karl Storz SE, Germany) with a pneumatic lithotripter (without prior dilatation) by expert urologists ($\geq$ 5 years of experience). Intraluminal pressure was maintained by a ureteral access sheath to prevent complications such as ureteral perforation or mucosal avulsion. Proper irrigation was ensured to provide a clear surgical

Table 2. Comparing the measured variables between the SA and GA groups

Variables	SA	GA	*P*-value
VAS score (6h postoperative), mean (SD)	5.1 (0.99)	4.2 (1.00)	< 0.001 [a]
VAS score (24h postoperative), mean (SD)	3.8 (0.89)	1.4 (0.68)	< 0.001 [a]
Surgeon satisfaction, median (IQR)	7 (5-6)	8 (6-8)	< 0.001 [b]
Patient satisfaction, median (IQR)	5 (4-5)	9 (8-9)	< 0.001 [b]
Frequency of opioid analgesics use, median (IQR)	2 (1-3)	2 (1-2)	0.103 [b]
Headache (yes), number (%)	90 (68.7 %)	11 (11.2 %)	< 0.001 [c]

Abbreviations: SA, spinal anesthesia; GA, general anesthesia; VAS, visual analogue scale; SD, standard deviation; IQR, interquartile range
a: independent *t*-test; b: Mann-Whitney test; c: Chi-squared test.

Table3. Multivariate logistic regression models

Variables	OR (95% CI)	*P*-value	Variables	OR (95% CI)	*P*-value
VAS score (6h postoperative) | VAS score (24h postoperative)					
Anesthesia (spinal)	0.20 (0.10-0.40)	< 0.001	Anesthesia (spinal)	0.00 (-)	0.996
Sex (male)	0.60 (0.30-1.16)	0.132	Sex (male)	0.92 (0.43-1.96)	0.842
Age (year)	1.00 (0.97-1.03)	0.699	Age (year)	0.99 (0.96-1.02)	0.692
Surgery time (min)	0.97 (0.91-1.03)	0.331	Surgery time (min)	1.02 (0.96-1.08)	0.440
Stone size (mm)	0.92 (0.81-1.05)	0.261	Stone size (mm)	1.02 (0.88-1.18)	0.721
Patient satisfaction | Surgeon satisfaction					
Anesthesia (spinal)	53.59 (19.70-145.74)	<0.001	Anesthesia (spinal)	12.23 (4.95-30.16)	< 0.001
Sex (male)	1.77 (0.84-3.73)	0.130	Sex (male)	1.30 (0.66-2.56)	0.435
Age (year)	0.99 (0.96-1.02)	0.596	Age (year)	1.00 (0.97-1.02)	0.941
Surgery time (min)	1.00 (0.95-1.06)	0.819	Surgery time (min)	0.97 (0.92-1.03)	0.382
Stone size (mm)	0.99 (0.86-1.15)	0.965	Stone size (mm)	0.92 (0.81-1.05)	0.263
Frequency of opioid analgesics use | Headache					
Anesthesia (spinal)	0.69 (0.39-1.22)	0.203	Anesthesia (spinal)	0.04 (0.02-0.10)	< 0.001
Sex (male)	0.39 (0.21-0.71)	0.002	Sex (male)	0.42 (0.20-0.87)	0.020
Age (year)	0.99 (0.96-1.01)	0.461	Age (year)	0.98 (0.95-1.01)	0.231
Surgery time (min)	1.12 (1.06-1.18)	< 0.001	Surgery time (min)	1.11 (1.04-1.19)	< 0.001
Stone size (mm)	1.12 (1.00-1.25)	0.049	Stone size (mm)	0.99 (0.86-1.13)	0.900

Abbreviations: OR, odds ratio; CI, confidence interval; VAS, visual analogue scale

field while preventing excessive pressure build up.
After the procedure, all participants underwent stenting with polyurethane double J stents (GoharShafa, Lorestan, Iran) and were hospitalized for at least 24 hours. A kidney–ureter–bladder (KUB) radiograph was performed on postoperative day 1 to confirm stent placement. Residual stones were evaluated via KUB and/or ultrasonography. Pain intensity was measured using a visual analogue scale (VAS).[26] VAS scores were assessed 6 hours and 24 hours after the procedure. Operation time (from initiation to termination of anesthesia) and frequency of opioid analgesic use during admission were recorded from medical records. The stone free rate was calculated using pelvic CT scans. Non contrast CT is the modality of choice for postoperative imaging to detect residual stone fragments and assess the urinary tract for complications.[27] Other data, including complications according to the Clavien–Dindo classification and the experience of headaches after surgery (Yes/No), were documented at one month. To measure satisfaction, participants rated satisfaction on a 0–10 scale; surgeons also rated their satisfaction on the same scale. Scores of 0–2 were considered very poor, 3–5 poor, 6–8 moderate, and 9–10 good.

Statistical Analysis

Continuous variables were described using mean (standard deviation [SD]) or median (interquartile range [IQR]); independent t test or Mann–Whitney *U* test was used as appropriate. The Kolmogorov–Smirnov test assessed distribution normality. Discrete variables were reported as number (percentage), and the chi square test was performed; when assumptions were violated, Fisher's exact test was used. Multivariate logistic regression models were fitted after binarizing outcomes. All analyses were conducted using SPSS (version 26, IBM) with a significance level of 0.05.

RESULTS

In total, 237 patients were enrolled; two were excluded due to missing stone data, and six were lost to follow up. (Figure 1) demonstrates the study flow. Analysis was performed on 229 patients, of whom 86 (37.5%) were female and 143 (62.5%) were male. Ages ranged from 18 to 75 years. Demographic data are provided in (Table 1). The mean age (SD) of the SA group was 47.8 (13.2) years and of the GA group was 45.63 (11.6) years (P = 0.194). The two groups included 78 (59.5%) and 65 (66.3%) men, respectively ($P = 0.335$). Comorbidities did not differ significantly between groups ($P > 0.05$). Surgery time was longer in the SA group with borderline significance compared with the GA group ($P = 0.049$). Other characteristics showed no significant differences. Postoperative complications did not differ between groups according to the Clavien–Dindo classification (all grade 1 or 2). No differences were observed in age, sex, BMI, stone size, stone laterality, surgery time, or stone free rate (**Table 1**).
The variables of interest were compared in (Table 2). Patients in the GA group had significantly lower VAS scores at 6 hours and 24 hours after the procedure than the SA group ($P < 0.001$). Patient satisfaction was significantly higher in the GA group (9 [8–9]) compared with the SA group (5 [4–5]) ($P < 0.001$). Surgeon satisfaction was also higher in the GA group (P < 0.001). Among SA patients, 90 (68.7%) experienced headaches after the procedure, whereas 11 (11.2%) in the GA group reported headaches ($P < 0.001$). Opioid analgesic consumption during admission did not differ significantly between groups ($P = 0.103$).
Given the categorical nature of some responses, VAS scores (6 h and 24 h) were categorized (≤ 4 vs > 4) as no to moderate pain versus severe to worst pain.[26] Patient and surgeon satisfaction were categorized (< 6 vs ≥ 6) as very poor/poor versus moderate/good. Opioid analgesic use frequency was categorized (≤ 1 vs > 1) for multivariate logistic regression adjusted for confounders (**Table 3**). Multivariate analysis showed that VAS (6 h), patient satisfaction, surgeon satisfaction, and headache differed significantly between SA and GA (95% CI: 0.10–0.40, OR = 0.20, $P < 0.001$; 95% CI: 19.70–145.74, OR = 53.59, $P < 0.001$; 95% CI: 4.95–30.16, OR = 12.23, $P < 0.001$; 95% CI: 0.02–0.10, OR = 0.04, $P < 0.001$, respectively), similar to univariate findings. All GA patients (100%) had VAS (24 h) ≤ 4, while 46 (35.1%) patients in the SA group had scores > 4; however, the differences were not significant between groups ($P = 0.996$). Opioid use frequency remained non significant between groups; however, female patients used lower amounts of opioid analgesics

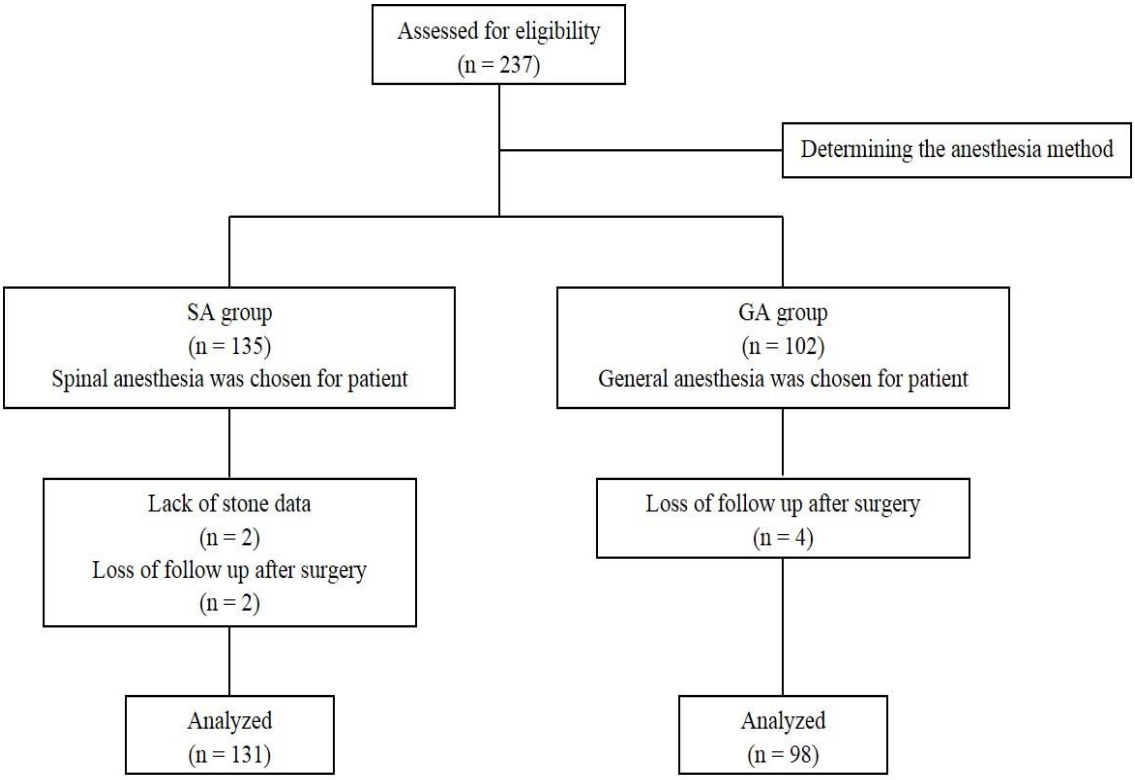

Figure 1. Flow diagram of the present trial

during admission (95% CI: 0.21–0.71, OR = 0.39, P = 0.002). Increased surgery time was significantly associated with higher opioid use and headache (95% CI: 1.06–1.18, OR = 1.12, $P < 0.001$; 95% CI: 1.04–1.19, OR = 1.11, $P < 0.001$, respectively). Larger stone size contributed to opioid use with borderline significance (95% CI: 1.00–1.25, OR = 1.12, $P = 0.049$).

DISCUSSION

According to the EAU guidelines, GA is a preferred method for ureterorenoscopic procedures, although spinal and local anesthesia are accepted alternatives.^[6,8,28] Anesthesiologists often recommend regional techniques to avoid GA related complications and to facilitate turnover and postoperative care, whereas urologists may prefer GA to prevent ureteral trauma from sudden patient movement. GA is associated with higher rates of nausea/vomiting, delayed mobilization, and longer hospital stay, while SA can entail greater pain, restlessness, and sudden movements during surgery.^[9,29,30]

Multiple studies have compared postoperative pain outcomes between GA and SA across surgical fields.[31–35] In our cohort, VAS at 6 hours and 24 hours and the frequency of opioid use were used as pain indicators. Both univariate and multivariate analyses showed significantly lower 6 hour VAS with GA. While univariate analysis showed lower 24 hour VAS with GA, multivariate analysis found 100% of GA patients had VAS < 4 versus 64.9% with SA, with no significant difference for the 24 hour binary outcome. Opioid use was lower with GA but not statistically significant. Satisfaction for both patients and surgeons favored GA. Prior studies variably support these findings, with some showing advantages for GA, others for SA, and many indicating early but not sustained differences, underscoring the influence of procedure type and perioperative analgesia regimens.[31–35]

Headache, particularly post dural puncture headache, is a recognized complication of SA and may be reduced by small gauge, rounded bevel needles.[36] Consistent with this, headaches were substantially more frequent with SA in our study ($P < 0.001$), aligning with prior reports.[37,38]

Age related differences in postoperative pain remain debated.^((39,40)) Our regression models adjusting for sex and age showed no differences except lower opioid use among female patients. Notably, longer surgery time correlated with greater opioid use and headache, consistent with literature linking operative duration to postoperative pain intensity.[41,42] Larger, procedure specific studies are needed to refine anesthesia selection and perioperative analgesic strategies.

Limitations include use of a single SA agent (bupivacaine) without assessing alternative neuraxial regimens, subjective VAS assessments, and potential confounding from non opioid analgesics. Future trials should compare GA with varied neuraxial techniques and standardized multimodal analgesia.

CONCLUSIONS

Both GA and SA are safe and effective options for URSL. In this cohort, GA provided better early postoperative pain control and higher satisfaction for patients and surgeons. These findings can aid clinicians in selecting optimal anesthesia for URSL, while recognizing that results may vary across surgical contexts and warrant further research.

SUMMARY

In patients undergoing ureteroscopic lithotripsy, general anesthesia led to less pain soon after surgery and higher satisfaction for both patients and surgeons compared with spinal anesthesia.

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The study protocol was approved by the ethics committee of the Tehran University of Medical Sciences (IR.TUMS.SINAHOSPITAL.REC.1403.062) and performed in accordance with the Helsinki Declaration. The authors thank the Persian Registry for Stones of the Urinary System (PERSUS) for providing patients and data.

CONFLICT OF INTEREST

All authors declare that they have no conflict of interests.

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