Original Article
Özgün Araştırma

Endourol Bull. 2025;17(3):147-156. doi: 10.54233/endourolbull-1732746

Comparison of Spinal and General Anesthesia Outcomes in Geriatric Patients Undergoing Retrograde Intrarenal Surgery

Retrograd İntrarenal Cerrahi Yapılan Geriatrik Hastalarda Spinal ve Genel Anestezi Sonuçlarının Karşılaştırılması

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ABSTRACT

Objective: This study aims to investigate the feasibility of spinal anesthesia (SA) in retrograde intrarenal surgery (RIRS) among patients aged over 65 years, and to compare the effectiveness of spinal and general anesthesia (GA) techniques on postoperative pain.

Material and Methods: A retrospective analysis was conducted on 281 patients who underwent RIRS. Patients were divided into two groups: those who received SA (Group 1) and those who received GA (Group 2). Perioperative and postoperative outcomes of RIRS were compared between the groups. Additionally, postoperative pain levels in both the early and late periods were assessed using the Visual Analog Scale (VAS).

Results: Group 1, which received SA, consisted of 166 patients, while Group 2, which received GA, included 115 patients. There was no statistically significant difference between the two groups in the demographic data and stone characteristics. The complication rates, classified according to the modified Clavien-Dindo system, were comparable between the two anesthesia techniques. The mean early postoperative VAS score was 2.26 ± 0.99 in Group 1 and 3.58 ± 1.13 in Group 2, with the difference being statistically significant ($p < 0.001$). However, there was no statistically significant difference in late postoperative VAS scores between the groups ($p = 0.362$). Postoperative analgesic requirement was observed in 10.24% of patients in Group 1, compared to 27.82% in Group 2, and this difference was statistically significant ($p < 0.001$).

Conclusion: SA may be a viable alternative to GA in geriatric patients undergoing RIRS, as it provides favorable outcomes in postoperative pain control and may protect patients from certain potential morbidities associated with GA.

Keywords: general anesthesia, post operative pain, regional anesthesia, spinal anesthesia

Cite As: *Demir DO, Burlukkara S, Kacan T, Yildiz AK, Gokkurt Y, Erbay OF, Karakan T. Comparison of Spinal and General Anesthesia Outcomes in Geriatric Patients Undergoing Retrograde Intrarenal Surgery. Endourol Bull. 2025;17(3):147-156.* https://doi.org/10.54233/endourolbull-1732746

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Received : July 2, 2025 ***Accepted*** : September 27, 2025

ÖZET

Amaç: Bu çalışma 65 yaş üstü hastalarda spinal anestezinin (SA) retrograd intrarenal cerrahi' de (RIRS) uygulanabilirliğini araştırmayı ve ayrıca spinal ve genel anestezi (GA) tekniklerinin postoperatif ağrı üzerine etkinliğini karşılaştırmayı amaçlamaktadır.

Gereç ve Yöntemler: RIRS uygulanan 281 hastanın retrospektif incelemesi yapıldı. Hastalar SA uygulanan (Grup 1) ve GA uygulananlar (Grup 2) olmak üzere 2 gruba ayrıldı. Grupların perioperatif ve postoperatif RIRS sonuçları ve komplikasyon oranları karşılaştırıldı. Ayrıca Vizüel Analog Scale (VAS) kullanılarak postoperatif erken ve geç dönem ağrı düzeyleri karşılaştırıldı.

Bulgular: SA uygulanan Grup 1 166 hastadan, GA uygulanan Grup 2 115 hastadan oluşuyordu. Grupların demografik verileri ve taş özellikleri benzer olarak bulundu. Her 2 anestezi tekniğinde modifiye Clavien-Dindo komplikasyon oranları benzerdi. Gruplar arasında operasyon süresi ($p = 0,344$) ve hastanede yatış süresi ($p = 0,876$) açısından fark gözlenmedi. Grup 1' de erken dönem ortalama VAS skoru 2,26 ± 0,99 iken Grup 2' de 3,58 ± 1,13 olarak bulundu ve aradaki fark istatistiksel olarak anlamlıydı ($p < 0,001$). Geç dönem VAS skorları arasında istatistiksel anlamlı fark gözlenmedi ($p = 0,362$). Grup 1' deki hastaların %10,24' ünde postoperatif analjezi ihtiyacı olurken, Grup 2' deki hastaların %27,82 'sinin postoperatif analjezi ihtiyacı olmuştur ve aradaki fark istatistiksel olarak anlamlıydı ($p < 0,001$).

Sonuç: Spinal anestezi postoperatif ağrı kontrolünde olumlu sonuçlar vermesi ve hastaları genel anestezinin olası bazı morbidetelerinden koruması nedeniyle RIRS yapılacak geriatrik hastalarda genel anesteziye alternatif bir teknik olabilir.

Anahtar Kelimeler: genel anestezi, postoperatif ağrı, rejyonel anestezi, spinal anestezi

INTRODUCTION

The global prevalence of kidney stones ranges from 1% to 15%, with a recurrence rate of approximately 50% within 10 years of diagnosis (1,2). While most prevalent between ages 30–55, kidney stone incidence can reach 10–20% in those over 65 (3,4). Considering that the incidence of comorbidities also increases in individuals over the age of 65, the management of kidney stone treatment and associated complications becomes increasingly important.

The European Association of Urology (EAU) urolithiasis guideline recommends retrograde intrarenal surgery (RIRS) and shock wave lithotripsy (ESWL) for the treatment of kidney stones smaller than 2 cm (5). Advancements in flexible devices, laser lithotripters, and optical systems have progressively increased the use of RIRS in the surgical treatment of kidney stones. RIRS, a minimally invasive procedure with high stone-free and low complication rates, is traditionally performed under general anesthesia (GA). However, its use under regional anesthesia is increasingly common (6).

As life expectancy continues to rise, the demand for both medical and surgical treatment services for elderly patients is progressively increasing. Chronological age is not the sole factor determining patients' frailty, and it cannot be expected to provide objective information about their overall health status on its own. Additionally, the overall health status across age groups varies from country to country. However, in many academic studies, the population aged 65 and above is considered elderly, as per the classification of the World Health Organization (WHO) (7,8). Urinary system stone disease is a significant problem in patients over 65 years of age. This means that urologists encounter many stone patients with one or more chronic diseases in their daily practice. In this context, in addition to stone disease, complications that may arise from treatment in patients with higher frailty further challenge both the urologist and the patient.

RIRS is widely used in urolithiasis treatment and is considered safe and effective, with major complications being rare (9). While some studies assess RIRS outcomes in the elderly, data on how anesthesia methods affect its safety and efficacy in this group remain limited. Although RIRS, which has traditionally been performed under GA for many years, has recently been increasingly performed under regional anesthesia, there is insufficient data in the literature regarding the elderly population. Regional anesthesia is preferred over GA in many different surgeries due to safety and comfort considerations for both the anesthesiologist and the patient. This study aims to investigate the impact of anesthesia methods on the efficacy and safety of surgical procedures in the elderly population.

MATERIAL AND METHODS

We retrospectively analyzed data from 290 patients aged 65 years and older who underwent RIRS treatment for proximal ureteral or renal stones between January 2019 and January 2024. Approval was obtained from the Karabük University Clinical Research Ethics Committee (01.04.2024/1718) prior to the start of the study. Patients under the age of 65, those with congenital urinary anomalies, and individuals with non-sterile urine cultures were excluded from the study. The patients' ages, genders, body mass indices (BMI), American Society of Anesthesiologists (ASA) scores, Charlson Comorbidity Index (CCI), presence of congenital urinary anomalies, and preoperative JJ stent status were recorded. All patients were evaluated with preoperative non-contrast computed tomography (CT). Data related to the stone, including its size (maximum length of the stone, total of maximum lengths for multiple stones), number, side (right/left), location (proximal ureter, renal pelvis, upper/middle/lower calyx, and multiple calyceal), and density (Hounsfield unit), were recorded. In the postoperative period, the anesthesia method (general/spinal anesthesia), operation duration, fluoroscopy time, complications according to the Modified Clavien-Dindo Complication Classification (MCDCC), stone-free rates (SFR) (stones smaller than 2 mm were considered clinically insignificant), and hospitalization duration were recorded.

Spinal anesthesia was administered in the lateral decubitus position at the L3-L4 interspace. Before central blockade, all patients underwent skin infiltration with 3 ml of 2% lidocaine at the intervention site. Following skin infiltration, 3.5 ml (17.5 mg) of 0.5% hyperbaric bupivacaine was administered at the L3-L4 interspace using a 25-gauge Quincke spinal needle.

All surgeries were performed in the standard lithotomy position by three urologists experienced in RIRS (with a minimum of 100 cases). As a routine, diagnostic ureterorenoscopy was performed by advancing a semi-rigid ureterorenoscope to the renal pelvis in all procedures. A guidewire was left in the kidney, and a ureteral access sheath (Flexor 9.5/11.5 Fr, Cook Medical, Bloomington, IL, USA) was placed over it into the ureter. If the access sheath could not be placed into the ureter due to ureteral orifice stenosis or ureteral stricture, a JJ stent was inserted into the ureter for passive dilation, and the procedure was postponed for 2-3 weeks. A non-digital flexible ureterorenoscope (Flex X2™, Karl Storz, Tutlingen, Germany) was used in all cases. Irrigation rate was kept below 25 ml/min. When image quality deteriorated, irrigation pressure was manually increased from the irrigation pump. Lower pole stones that were difficult to reach were intervened on by moving them to the pelvis or midpole with a basket catheter. The operative time was defined as the duration from the urethral meatal entry of the ureterorenoscope to the placement of the urethral catheter. A JJ stent was placed in all cases, and if no further surgery or ESWL was indicated, the JJ stent was removed 1-2 weeks later. Three surgeons opted for a fluoroscopy-free protocol in their surgeries whenever possible. Postoperative pain was assessed using the Visual Analog Scale (VAS) 30 minutes after the end of the operation in the recovery room or in the patient room in the ward. On postoperative day 1, the VAS score was reassessed (late VAS score). Patients requiring analgesia were recorded, and nonsteroidal anti-inflammatory drugs (NSAIDs) (deksketoprofen trometamol 50 mg-2 ml intravenous)) were administered for pain management. Metoclopramide hydrochloride 10 mg/2 ml was administered intravenously as an antiemetic.

Postoperative day 1 imaging was performed using kidney-ureter-bladder radiography for opaque stones and ultrasound for non-opaque stones. Follow-up of the patients was conducted with a non-contrast CT scan three months postoperatively.

The patients were divided into two groups: those who underwent surgery under spinal anesthesia (SA) (Group 1) and those who received GA (Group 2). The data of the groups were compared to investigate the impact of anesthesia type on the effectiveness and safety of RIRS.

Visual Analog Scale (VAS)

The VAS is a 10 cm long scale drawn either horizontally or vertically, ranging from "No pain" at one end to "Unbearable pain" at the other. The patient is asked to mark a point on the scale that corresponds to the intensity of their pain, which intersects with the scale above.

Modified Clavien-Dindo Complication Classification (7)

The Clavien-Dindo classification system was established for the identification and grading of postoperative adverse events.

1. Normal postoperative changes that do not require pharmacological treatment, surgery, endoscopic, or radiological intervention. Medications such as diuretics, antipyretics, analgesics, antiemetics, and electrolytes are acceptable. Wound infection opened and treated at the bedside.

2. Conditions treated with medications other than those permitted for use in Grade 1 complications.

3. Conditions treated with surgical, endoscopic, or radiological interventions.

3a. Conditions not requiring general anesthesia.

3b. Procedures requiring general anesthesia.

4. Life-threatening conditions requiring treatment in the intensive care unit.

4a. Single organ dysfunction (including dialysis).

4b. Multiple organ dysfunction.

5. Patient death.

Statistical Analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 23.0 (IBM Corp., Chicago, Illinois, USA) software programme. The normal distribution of the data was examined using the Shapiro-Wilk test. Normally distributed and non-normally distributed numerical variables were presented as mean and standard deviation (SD) values or maximum, median, and minimum values, respectively. The differences between the groups for numerical variables were tested using the Student's t-test for data following a normal distribution, and the Mann-Whitney U test for data not following a normal distribution. The Pearson chi-square test was employed to compare the categorical variables. A p-value < 0.05 was considered significant.

RESULTS

The data of 290 patients who underwent RIRS were analyzed. Five patients were excluded from the study because early and late VAS results were not available, and four patients did not come for the 3rd month follow-up. The mean age of the patients was 71.63±4.85. 161 (57.29%) of the patients were male and 120 (42.71%) were female. Of the 281 patients included in the study, 166 (59.07%) were operated under SA (Group 1) and 115 (40.93%) were operated under GA (Group 2). No statistically significant difference was found between the groups regarding age, gender, BMI, CCI scores, urinary anomaly, and ASA scores. Demographic data of the patients are summarized in Table 1.

When stone-related data were analyzed, no statistically significant difference was found between the groups. Comparison of perioperative and postoperative data showed no significant differences between the groups in surgery time, fluoroscopy time, or hospitalization duration. Postoperative 1st day and 3rd month SFR of all patients were found to be 86.12% and 87.18%, respectively. When the SFR on postoperative day 1 and at 3 months were compared, no significant difference was found between the groups (p=0.129 and p=0.095, respectively).

In our study, the total complication rate was found to be 8.89% (25 patients). The number of patients with MCDCC grade 1 or 2 complications in Group 1 was 15 (9.03%), while in Group 2 it was 8 (6.95%) (p=0.366). In Group 1, hematuria was observed in 6 patients, postoperative fever in 4 patients, headache in 3 patients, and nausea in 2 patients. In Group 2, renal colic was observed in 3 patients, fever in 2 patients, hematuria in 2 patients, and vomiting in 1 patient. No MCDCC grade 3 or 4 complications were observed in Group 1, while in Group 2, 1 patient experienced a MCDCC grade 3 complication (steinstrasse) and one patient required intensive care unit admission due to urosepsis. The total complication rate in Group 2 was found to be 8.69%. No statistically significant difference was observed between the groups in terms of complications. Complication relationship data are summarized in Table 2 and 3.

A statistically significant difference between the groups was found only in the postoperative early-period VAS score and analgesic usage. The mean early VAS score was 2.26±0.99 in Group 1 and 3.58±1.13 in Group 2 (p<0.001). Late-term VAS scores of the groups were statistically similar. When postoperative analgesic requirements were analyzed, 10.24% of patients in Group 1 required postoperative analgesics, while 27.82% of patients in Group 2 required analgesics, and this difference was statistically significant (p<0.001). On the first postoperative day, one patient in Group 1 had a headache, while no patient in Group 2 had a headache.

Table 1. Demographic, clinical and preoperative data.

	Group 1 n:166	Group 2 n:115	p value
Gender			
Female/Male	70(42.16%)/96(57.84%)	50(43.47%)/65(56.53)	0.828[a]
Age (years) (mean ± SD)	71.93 ± 5.27	71.20 ± 4.17	0.516[b]
BMI (kg/m^2) (mean ± SD)	27.41 ± 4.55	28.18 ± 4.38	0.17[b]
CCI (mean ± SD)	5.11 ± 0.46	4.98 ± 0.39	0.488[b]
ASA Score 1/2/3/4 N	2/36/117/11	2/34/68/11	0.339[a]
Urinary anomaly No/Yes N(%)	139(83.73%)/27(16.27%)	105(91.30%)/10(8.70%)	0.066[a]
Preoperative JJ stent No/Yes N(%)	116(69.87%)/50(30.13%)	78(67.82%)/37(32.18%)	0.715[a]
Side (right/left) N(%)	66(39.75%)/100(60.25%)	52(45.21%)/63(54.79%)	0.363[a]
Location N(%)			
Pelvis	32 (19.27%)	23(20%)	
Upper calyx	41(24.69%)	32(27.82%)	
Middle calyx	29(17.46%)	22(19.13%)	0.538[a]
Lower calyx	20(12.04%)	12(10.43%)	
Ureter	39(23.49%)	22(19.13%)	
Multiple calyx	5(3.01%)	4(3.47%)	
Stone size (mm), median (Q1-Q3)	11 (10-15)	13 (8-22)	0.082[a]
Density (HU), median (Q1-Q3)	809.5(691-956)	798(616-985)	0.819[a]

BMI: Body Mass Index. CCI: Charlson Comorbidity Index. ASA: American Society of Anesthesiologist HU: Hounsfield Unit

[a]Mann- Whitney U Test

[b]Student's t-test

Table 2. Complication of RIRS classified according to MCDCC

Grade	Complications	Group 1 (n:15)	Group 2 (n:10)
Grade 1-2			
	Hematuria	6	2
	Fever	4	2
	Headache	3	
	Nausea	2	
	Renal colic		3
	Vomiting		1
Grade 3-4			
	Steinstrasse		1
	Urosepsis		1

Table 3. Peroperative and postoperative data

	Group 1(n:166)	Group 2 (n:115)	p value
Operation time (min) mean±SD (min-max)	35.55±15.59(5-90)	38.62±21.32(5-120)	0.344[a]
[x]Fluoroscopy time (sec) median (Q1-Q3)	0 (0-12)	0 (0-22)	0.310[a]
Hospitalization time (day) median(Q1-Q3)	1(1-1)	1(1-1)	0.876[a]
Postoperative 1. day stone- free N (%)	145 (87.34%)	97(84.34%)	0.129[a]
Postoperative 3 months stone- free N (%)	147(88.55)	98(85.21)	0.095[a]
MCDCC 1-2 complication N(%)	15 (9.03%)	8 (6.95%)	0.366[a]
MCDCC 3 complication N(%)	0	1 (0.86%)	0.230[a]
MCDCC 4 complication N(%)	0	1 (0.86%)	0.230[a]
Early VAS score (mean± SD)	2.26±0.99	3.58±1.13	<0.001[1,b]
Late VAS score (mean± SD)	1.50±0.85	1.47±0.61	0.362[b]
Postoperative analgesic use N(%)	17 (10.24%)	32 (27.82%)	<0.001[1,a]

[1]Significant at p<0.05. MCDCC: Modified Clavien-Dindo Complication Classification. VAS: Visual Analog Scale

[x]0 second: fluoroscopy-free protocol

[a]Mann- Whitney U Test

[b]Student's t-test

DISCUSSION

Nowadays, life expectancy and average age are steadily increasing (10). Consequently, the number of patients receiving treatment for urolithiasis in the geriatric population is also rising (11). This patient group, with high frailty, faces not only comorbid conditions but also the morbidity associated with anesthesia (12). While comorbidities are the main factor contributing to frailty, the prevalence of chronic diseases also increases with age. In the ICD-11 version, the WHO has defined 'advanced age' not as a part of the normal life cycle, but as a pathological process (7). By 2050, over 20% of the global population will be aged 60 or older, with life expectancy in developed countries surpassing 80 years (13).

Along with the increased incidence of stones in the geriatric population, the number of complications related to stones and their treatment is also rising (3,4,7). Therefore, it would be prudent for urologists to take various measures to reduce morbidity in the surgical treatment of urolithiasis in the geriatric population. RIRS has long been used as a minimally invasive procedure for the surgical treatment of kidney and proximal ureter stones. Although traditionally performed under GA, recent applications under regional anesthesia are becoming increasingly common (14). Advancements have been made not only in RIRS technology but also in anesthesia techniques. Although there are limited studies in the literature regarding the efficacy and safety of RIRS under GA and SA in the general population, to the best of our knowledge, no studies have been conducted on anesthesia methods in geriatric patients. There is no consensus regarding the ideal anesthesia method for elderly patients undergoing RIRS. In the present study, we evaluated the outcomes of RIRS performed under GA and SA in the geriatric patient group.

In our study, the SFR was 86.12% in a single procedure, consistent with RIRS outcomes in the general population (15-17). The anesthesia method does not affect the SFR of the procedure, and the SFR for both anesthesia techniques is consistent with those in the literature. In one of the rare studies in the literature examining RIRS outcomes in elderly patients, Berardinelli et al. reported that patient age did not affect the operation, fluoroscopy, or hospital stay duration (18). In the present study, perioperative outcomes such as operation and fluoroscopy time, as well as length of hospital stay, were not influenced by the type of anesthesia. However, there are studies in the literature reporting that SA shortens the duration of surgery compared to GA (14). Moreover, several studies have reported that, in medical specialties other than urology, the use of SA is associated with shorter hospital stays and reduced

intensive care unit durations compared to GA (19). Although average costs vary by country, evidence suggests no significant cost difference between GA and SA (14). However, reports of longer intensive care unit stays with GA indicate a potential for increased costs.

In the urology literature, major complications related to RIRS have been reported as rare. According to the MCDCC, complication rates ranging from 7% to 14% have been reported in the elderly population (7,18,20). The overall complication rate in this study was 8.89%, with similar rates observed in both groups. Anesthesia type had no impact, and the results were consistent with the literature.

In our study, procedures performed under SA were found to be associated with lower VAS scores compared to those performed under GA. Although VAS scores were similar between the two anesthesia techniques on postoperative day 1, more effective analgesia was achieved in the early postoperative period on the day of surgery in the SA group compared to the GA group. Moreover, the postoperative analgesic requirement was lower in the SA group compared to the GA group. This can be considered an objective indicator of improved patient comfort in the early postoperative period. In addition, patients are also protected from the potential side effects of NSAIDs and narcotic analgesics. Numerous studies have demonstrated that NSAIDs may cause gastrointestinal, cardiovascular, renal, hepatic, cerebral, and pulmonary adverse effects (21). Although these side effects are not commonly observed, they are clinically significant, and limiting the use of these medications may help prevent potentially serious complications. However, patients undergoing SA have a higher risk of developing postoperative headaches due to dural perforation compared to those receiving GA (22). In the present study, postoperative headache was observed in 3 patients in the SA group, whereas no patients in the GA group reported such a complaint. The occurrence of a headache may trigger the need for NSAID administration. To avoid this disadvantage of spinal anesthesia, Çakıcı et al. have suggested that combined spinal-epidural anesthesia, another regional anesthesia technique, could be a preferable alternative (22). Numerous studies in the literature have reported that spinal anesthesia is superior to general anesthesia in terms of postoperative pain control (14,18,19,22). Effective postoperative pain management is particularly important in patients with chronic kidney disease, as it helps to minimize exposure to the nephrotoxic effects of NSAIDs.

Anesthesia techniques exhibit distinct advantages and disadvantages; thus, the selection of the appropriate technique should be determined on an individual case basis. Providing the patient with detailed information about the techniques and understanding their expectations can facilitate the decision-making process, allowing for a collaborative choice of anesthesia method. It is recommended that the benefits and risks of anesthesia techniques be discussed with the patient, allowing them the opportunity to make an informed choice (23). For a patient experiencing surgical stress, GA may be preferred to forget the intraoperative period, while SA would be the natural choice for those with anxiety about general anesthesia. Additionally, in patients with bleeding disorders, general anesthesia may be preferred due to the risk of spinal cord compression following spinal hematoma caused by spinal hemorrhage (22). Aside from patient preference and contraindications, anesthesia techniques should be reviewed based on the patient's overall health status. The incidence of chronic diseases increases in geriatric patients. For example, patients with chronic obstructive pulmonary disease are at risk for pulmonary infections. In these patients, spinal anesthesia may be preferred over general anesthesia, as it allows for physiological respiration and does not require the use of an endotracheal tube or laryngeal mask (22,23). In our study, no postoperative pulmonary infections were observed. The anesthesiologist's choice of regional anesthesia for high-risk patients may have contributed to the absence of complications. A meta-analysis demonstrated an association between GA and increased incidence of postoperative pneumonia, deep vein thrombosis, and surgical site infections (24). Although increased risks of cardiac, cerebrovascular, and renal events were noted, wide confidence intervals limited statistical robustness. The same meta-analysis found reduced intraoperative bleeding with neuraxial blockade, possibly due to lower intraoperative arterial blood pressure.

In the context of RIRS procedures, the prevailing preference for GA has been attributed to respiratory-induced diaphragmatic excursions, which may lead to renal mobility and subsequently compromise surgical access to the stone (25,26). Furthermore, such renal movement may result in unintended laser contact with the urothelial mucosa,

increasing the risk of mucosal injury. The ability to control respiratory rate and tidal volume with mechanical ventilation is an advantage of GA. However, in elderly patients, the cessation of respiration may not be as tolerable as in younger individuals. Prolonged apnea may lead to hypercapnia, trigger cardiovascular events, and cause hyperkalemia (27). In the present study, the operation duration, SFR, and complication rates were found to be similar for both anesthesia techniques. Similarly, studies comparing anesthesia techniques in the literature also report comparable SFR and complication rates between the two methods, with no significant difference in operation duration, even in patients undergoing GA (14,25).

Our study had some limitations. First, the retrospective nature of our study was a key limitation. The absence of stone analysis was the second limitation; however, the Hounsfield units of the groups were similar, which may suggest that the stone structures were comparable. Despite these limitations, our study is one of the few to investigate anesthesia technique selection in geriatric patients undergoing RIRS, and it may serve as a foundation for future randomized controlled trials.

CONCLUSION

The RIRS procedure performed under SA and GA shows similarities in terms of SFR, complications, operation time, and length of hospital stay. SA may be preferred as it not only provides effective pain control in the early postoperative period, but also offers the potential for a more comfortable surgical experience, especially in the geriatric patient group with multiple comorbidities, likely resulting in lower morbidity and mortality. Considering its advantages, SA could serve as an alternative technique to GA in geriatric patients undergoing RIRS, and with the increasing number of randomized controlled trials, it may become the preferred anesthetic method.

Funding: There is no specific funding related to this research.

Competing interests: The authors declare that they have no competing interests.

Ethics Committee Report: Approved by the Karabük University Clinical Research Ethics Committee. Date: 1/4/2024 Decision No: 2024/1718.

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