DOI: 10.4081/aiua.2022.2.195

ORIGINAL PAPER

Spinal versus general anesthesia in retrograde intrarenal surgery

Mehmet Yoldas [1], Tuba Kuvvet Yoldas [2]

[1] Tepecik Training and Research Hospital Urology Clinic, Izmir, Turkey;
[2] Ege University Faculty of Medicine Anesthesiology and Reanimation Department, Izmir, Turkey.

Summary ***Aim: The indications for retrograde intrarenal surgery (RIRS) have greatly increased, however, there is still no consensus on the use of spinal anesthesia (SA) during this procedure. The aim of this study was to evaluate the comparability of surgical outcomes of RIRS performed under SA versus general GA for renal stones.***
Materials and methods: This was a retrospective, observational study in patients scheduled for RIRS in a single teaching hospital in Turkey. Inclusion criteria were age > 18 years and the presence of single or multiple renal stones. We recorded information concerning the site of lithiasis, the number of calculi, total stone burden, and the presence of concomitant ureteral stones or hydronephrosis. Results were evaluated in terms of surgical outcome, intraoperative and postoperative complications. Patients were followed-up until day 90 from discharge.
Results: The data of 502 patients, 252 in GA group and 250 in SA group, were evaluated. The stone-free rate was 81% in the GA group and 85% in the SA group (p = 0.12). No cases of conversion from SA to GA were recorded. Complication rates were similar in the 2 groups (19% vs 14.5%, p = 0.15).
Conclusions: In our cohort, RIRS performed under SA and GA was equivalent in terms of surgical results and complications.

KEY WORDS: *Spinal Anesthesia; Retrograde intra-renal surgery; Urolithiasis.*

Submitted 21 April 2022; Accepted 20 May 2022

INTRODUCTION

With the evolution of instruments and techniques, *retrograde intrarenal surgery* (RIRS) gained an established role as a minimally invasive procedure with fast recovery, short hospitalization, and low rates of complications (1-3).
However, high-grade complications are still possible (4-5), and linked to the use of *general anesthesia* (GA).
In this scenario, the use of *spinal anesthesia* (SA) could move toward the reduction of invasiveness, costs, and hospitalization (6-7).
Endoscopic procedure of renal stones has increased in the last decade in accordance with minimally invasive principles. Ureteral stone treatment has been described and widely accepted under SA (8-9), however, GA is usually offered during RIRS because it has some advantages: in case of a large stone burden the lithotripsy is easier with reduced renal movement caused by respiration, the comfort for the patient is expected to be better, and there is no risk for the anesthesia duration to be exceeded.
SA also has advantages: it avoids some GA related complications, allows an early mobilization, and is cost effective. Few studies compared different anesthesia modality during RIRS for renal stones and the only randomized controlled trial (9) compared RIRS performed under combined spinal-epidural anesthesia with GA (10).
The aim of this study was to compare surgical results, intraoperative and postoperative complications, and analgesia demand of RIRS performed under SA *versus* GA.

MATERIALS AND METHODS

The data of the patient who underwent RIRS due to kidney stones between January 2013 and January 2022 were reviewed retrospectively.
Those with missing data, bilateral RIRS, additional procedure with RIRS (percutaneous nephrolithotomy, rigid ureterorenoscopy, etc.), urinary system anomaly (double collecting system, horseshoe kidney, pelvic kidney, urinary diversion, etc.), previous stone surgery, *extracorporeal shock wave lithotripsy* (ESWL) history, patients with nephrostomy or double J stent were excluded from the study.
A total of 502 patients were evaluated after exclusion criteria. The ethics committee of the study was obtained from the local Tepecik training and research hospital local ethics committee. Informed consent was obtained from all patients.
Stones and urinary systems of all patients were evaluated with *computed tomography* (CT) in the preoperative low-dose stone protocol, urinalysis and urine culture, and biochemistry including urea, creatinine, and hemogram. All patients underwent the procedure with a clean urine culture or under antibiotic. All patients received preoperative antibiotic prophylaxis. Stone protocol CT was performed for stone-free rate assessment at 4 week post operative in all patients, and patients with residual stone less than 4 mm were considered as stone-free.
We divided the patients in 2 groups, according to the anesthesia regimen chosen by the anesthesiologist: SA and GA.
Patients in both groups were compared in terms of demographic data such as age and gender, stone size, stone side, stone localization, number of stones, and stone density as *Hounsfield Unit*. The complications that developed within both groups were grouped according to the modified Clavien-Dindo classification and compared one by one.

No conflict of interest declared.

RIRS procedure

Under spinal or general anesthesia, ureter and renal pelvis were evaluated under direct vision with a 7 F semi rigid ureteroscope. The distance between the ureteropelvic junction and the external meatus was marked on the rigid scope and a 0.038 inch guide wire was placed in the collecting system, 9.5 F ureteral access sheet was placed in the collecting system on the guide as long as the measured distance. After the guide was taken out, a 7-8 F flexible scope was entered. The stone was broken with a 272 or 360 micron laser probe. At the end of the procedure, the ureter was evaluated with a semi-rigid scope. When necessary, a double J stent stent was placed in the ureter.

Anesthesia

In all patients, a peripheral vein was cannulated and a single dose of antibiotic prophylaxis was administered and normothermia maintained with warm air devices. Perioperative heart rate, peripheral oxygen saturation, and blood pressure values were monitored until transfer to the urological ward, when the Aldrete score was ≥ 8.
In the SA group, anesthesia was administered using a 25 gauge atraumatic Sprotte type needle with 10-20 mg hyperbaric 1% or 0.05% bupivacaine at L2-3 level to provide a sensitive block up to T8-10. We administered an intranasal oxygen supply only if SpO2 was below 92%. Additional sedation was based on 2 mg midazolam boluses or low-dose propofol infusion according to the Schneider model effect-site target-controlled infusion 1 mg/mL, plus additional low-dose remifentanil (Minto model effectsite target-controlled infusion 0.5-2 ng/mL) if analgesia was inadequate. Target controlled infusion was titrated based on the clinical response in the SA group.
In the GA group, anesthesia was induced with propofol 2 mg/kg and fentanyl 1 mg/kg and maintained with either propofol Schneider model effect-site target-controlled infusion, sevoflurane or desflurane plus remifentanil with the Minto model effect-site target-controlled infusion according to the anesthesiologist's choice.
In all cases in the GA group, anesthesia depth was monitored with the entropy index, targeting values between 40 and 60. After induction, a laryngeal mask was placed avoiding the use of neuromuscular blockade when clinically feasible. We administered ranitidine plus ondansetron intraoperatively as prevention of postoperative nausea and vomiting. An opioid-free postoperative analgesia regimen was preferred, based on acetaminophen 1000 mg plus ketorolac 30 mg. Rescue doses were administered if the pain numeric rating scale was above 4.

Statistical analysis

Continuous variables are reported as a mean ± SD and compared with the Student's t-test. Categorical variables are presented as the absolute frequency (percentage) and compared with the chisquare or Fisher's test, as appropriate. All the statistical analyses were performed using SPSS v.23 (*IBM Corp., Armonk, NY*), and significance considered for two-tailed $p < 0.05$.

Results

The data of 502 patients, 252 in GA group and 250 in SA group, were evaluated retrospectively.
The mean age of GA group was 47.31(16-83) years and the mean age of SA group was 46.16 (20-75) years; GA group included 156 (62%) men and 96 (38%) women, SA group 176 (71%) males and 74 (29%) females.
The mean stone size was 13.57(+-2,6) mm^2 in GA group and 12.43(+-2,8) mm2 in SA group. There was no statistically significant difference between the two groups for stone size (p = 0.21).
In GA group, 124 patients had a stone in the right side and 128 in the left side, in SA group 128 patients had a stone in the right side and 122 patients in the left side (p = 0.25).
In GA group the stone was in the lower calyx, which was the most difficult to reach, in 71 (28.4%) patients, whereas in SA it was in the lower calyx in 71 (28.7%) patients (p = 0.13).
The demographic and stone data of the patients are shown in Table 1 and intraoperative and post-operative data of the patients in Table 2.
The operation time of the patients in GA group was 57.65 (+-11.56) min, in SA group 54.3 (+-12.1) min. The duration of scopy in the GA group was 24.29 (+-2.3) sec, in the SA group. 26.32 (+-3.2) sec. Operation time and duration of scopy was equal between the two groups (p = 0.29 and p = 0.35, respectively).
Mean hospital stay was 1.06 (+-0.25) days in GA group, and 1.37 (+-0.22) days in SA group. Although in SA group hospital stay was longer, there was no statistically significant difference between groups (p = 0.12).
Complications developed in 48 (19%) patients in the GA group and in 36 (14.5%) patients in SA group. No difference was observed for grade 1 (p = 0.18) and grade 2 (p = 0.11) complication rate between the two groups.
None of our patients needed blood transfusion.
Due to stenosis in the distal ureter in 3 of our patients in GA group, access to the renal pelvis was achieved by using baloon dilatation.
High post-operative fever was detected in 20 patients of GA group: two of them received parenteral antibiotic in hospital, 2 of them were treated with oral antibiotic as outpatients, 16 patients were treated with antipiretic as outpatients; 16 patients in SA group developed fever and were treated with antipiretic as outpatients; 5 were treated with oral antibiotic as outpatients.

Table 1.
The demographic and stone data of the patients.

		GA group (252)	SA group (250)	P-value
Age		47.31+-3.5	46.16+-3.8	0.39
Stono size cm^2		13.57(+-2.6)	12.43(+-2.8)	0.25
Gender	F	96(38%)	74 (29%)	0.22
	M	156 (62%)	176 (71%)	
Laterality	Right	124	128	0.52
	Left	128	122	
Localization				0.19
	Lower calix	71 (28.4%)	71 (28.3%)	0.16
	Middle calix	11 (4.4%)	21 (8.3%)	0.08
	Upper calix	9 (3.7%)	5 (2%)	0.08
	Pelvis	118 (46.4%)	117 (46.2%)	0.15
	More than one calix	43 (16.9%)	36 (14.5%)	0.15

Table 2.
Intraoperative and post-operative data of the patients.

		GA group	SA group	P-value
Operation time (min)		57.65 (+/-11.56)	54.3 (+/-12.1)	0.29
Scopy time (sc)		24.29 (+/-2.3)	26.32 (+/-3.2)	0.35
Postoperative hospitalization (days)		1.06 (+-0.25)	1.37 (+/- 0.22)	0.12
Complications		48 (19%)	36 (14.5%)	0.15
Degree 1	Use of antiemetics, antipyretics, analgesics etc.	16 (6.2%)	11 (4.4%)	0.18
Degree 1	Headache (cerebrospinal fluid leak after spinal anesthesia)		4 (1.6%)	
Degree 2	Fever requiring antibiotics	4 (1.7%)	5 (2%)	0.11
Degree 3a	Hematoma, urinoma	1 (0.4%)	1 (0.4%)	0.25
Degree 3a	Low grade ureteral injury	4 (1.7%)	5 (2%)	0.09
Degree 3a	Nephrostomy insertion	3 (1.3%)	5 (2%)	0.08
Degree 3a	Installing post op djs	2 (0.1%)	0	1.00
Degree 3b	Urs again (due to ureteral stone)	8 (1.7%)	0	1.00
Degree 3b	Foreign body in the ureter (djs guide wire basket ureteral sheed etc.)	3 (1.3%)	0	1.00
Degree 4	Intensive care follow-up due to sepsis	6 (1.2%)	5 (2%)	0.19
Degree 5	Ex	1 (0.2%)	0	1.00
Stone free rate (SFR)		202 (81%)	214 (85%)	0.12

Subcapsular hematoma and then urinoma developed in GA group in 2 patients who were treated with double J stent and percutaneous drainage.
Low-grade ureteral injury occurred in 8 patients in GA group and 1 patient in SA group, and they were followed up with double J stent. No avulsion occurred in any of our patients.
Nephrostomy or double J stents were placed in 8 patients in GA group and 1 patient in SA group due to renal colic and hydronephrosis. Stents were removed 2 weeks later due to regression of hydronephrosis and colic.
Re-URS was performed in 8 of our patients in GA group because of the steinstrasse; this complication was not observed in any of our patients in SA group.
In GA group, the laser probe tip or the hydrophilic tip of the Sensor guide remained in the renal pelvis in 3 patients as a result of a fracture of the device.
Six patients in GA group and one patient in SA group were followed up in the post-operative intensive care unit.
In GA group, one patient died due to post-operative multi-organ failure and sepsis.

Discussion

The first treatment choice for intrarenal stones < 2 cm in size and hard stones is RIRS (11).
In this study, we report similar SFR, intraoperative and postoperative outcomes and complications in patients treated with RIRS under GA *versus* SA. Our results concord with the previous published studies and added value to the use of SA for RIRS, particularly when a fast recovery and a short hospitalization are intended to be achieved. Kidney stone surgeries are developing towards to non-invasive methods. Endoscope miniaturization, improved deflection mechanism, improved optical quality, and advancement in laser technology have led to the increased use of URS for kidney and ureteral stones (12).
The 2022 *EAU Urolithiasis Guidelines* states that for retrograde stone removal both local and SA is feasible, however, the majority of patient still undergo GA (13). SA reduces anesthesiologic costs and hospital stay when compared with GA. Generally, the anesthesiologist for rapid endoscopic procedures proposes SA because it has lower risks of anaphylaxis, vascular, pulmonary, and neurological complications and compared with GA it does not present the risk of intubation-related problems (14).
The overall complication rate was found to be 3.5% in a series of 11.885 prospectively studied RIRS published by CROES. According to the modified Clavien classification, 2.8% of these complications are grade 1 and 2 (15).
In our study, general complications were 48 (19%) in GA group, 36 (14.5%) in SA group; grade 1-2 complications 20 (7.9%) in GA group and 20 (8%) in SA group.
This may have been caused by the high density of difficult cases (lower pole, more than 1 stone and large stone size) because we are a third-level hospital.
For grade 1-2 complications, no significant difference was found between the two groups.
Urinoma and hematoma have been reported in the literature to be more likely in patients over 70 years of age, using anticoagulants and having chronic kidney disease; the probability of this complication is less than 1%.
In our study, 2 (0.4%) patients in GA group had supcapsular hematoma cured with nephrostomy and double J stent insertion. Bleeding is seen at a rate of 0.3-2.1% after URS, due to the introduction of the scope, stone breakage procedure or damage caused by the guide wire in the calyceal structures. Bleeding often stops spontaneously, but the hematoma caused by it may cause colic pain and hydronephrosis in the postoperative period. Six patients in GA group, and one patient in SA group had nephrostomy due to clot hydronephrosis and renal colic. Two patients in GA group had double J stent for the same reasons and the catheters were removed 2 weeks later in their follow-up.
Stone tract (Clavien 3b), which is an important complication, was seen in 9 (0.6%) patients in a study conducted with 1571 patients (16). This complication is the only that was found associated to stone size. In fact, SFR after RIRS was found significantly correlated with the stone size (17).
In our study, *Steinstrasse* was observed in 8 (1.7%) patients in GA group who had stones larger than 3 cm according with the literature. The fragments were endoscopically extracted and the stones cured. This complication was not observed in any patient in SA group.
Loss of the integrity of the stents is also an important problem. *Zisman et al.* (18) evaluated ureteral stents with spontaneous multiple fragmentations observing that the fracture resistance was decreased dramatically. Fractured stents were removed after 4 weeks. Due to cost problems, some materials were used longer than the recommended time. We may have encountered this complication due to the high stone load in our cases and the long duration of the cases.
In the prospective study of CROES, it was reported death in 5 cases due to sepsis, pulmonary embolism, multiple organ dysfunction, and cardiac causes (15).

In our series, 6 patients were followed up with post-operative sepsis: 2 with hydronephrosis due to ureteral stone, 1 with hemorrhage and clot-related hydronephrosis without stones, and 3 patients with sepsis without any stone or hydronephrosis. All the patients had pre-operative hydronephrosis. These results are comparable to most previous report of the literature.

One of our patients died due to post-operative sepsis and multiorgan failure in GA group. This 76-year-old patient had a stone size of 0.9 cm^2 and 2 stones in the lower calyx and pelvis. The urine culture was clean preoperatively but preoperative hydronephrosis was present. The stone size was small but the stone was difficult to reach and the operation time was long (108 min). Furthermore, *ureteral access sheath* (UAS) could not be used due to ureteral stenosis. In the literature, it is emphasized that sepsis is generally related with high intrapelvic pressure (15, 17). Consequently, UAS should be used during RIRS and high pressure should be avoided.

In the literature the success rate of RIRS is reported to be between 73.6% and 94.1%.

In the study of 207 patients conducted by *Reşorlu et al.* (19) in 2012, it was described a new scoring system (*Reşorlu-Ünsal Taş score*) that can help us predict postoperative stone-free rates (18).

In the study, the factors affecting success were examined and parameters such as age, gender, body mass index, stone size, stone side, location, composition, number of stones, lower pole infundibulopelvic angle, use of anticoagulant therapy, skeletal and renal anomalies were evaluated.

They reported that stone size, number, location, composition, renal malformations, and lower pole infundibulopelvic angle significantly affected success. In our cases, the success rate of 81% in GA group and 85% in SA group were lower than in the literature, because of high frequency of lower pole stones and multiple stones.

According to the literature, in our study we did not find any statistically significant differences in terms of intraoperative and postoperative complications, analgesia demand, and SFR in patients with single or multiple renal stones with a stone burden up to 30 mm treated with flexible ureteroscopy in GA versus SA (SFR rate p = 0.12).

References

1. Doizi S, Traxer O. Flexible ureteroscopy: technique, tips and tricks. Urolithiasis. 2018; 46:47.

2. Giusti G, Proietti S, Villa L, et al. Current standard technique for modern flexible ureteroscopy: tips and tricks. Eur Urol. 2016; 70:188.

3. Osther PJS. Risks of flexible ureterorenoscopy: pathophysiology and prevention. Urolithiasis. 2018; 46:59.

4. Reis Santos JM. Ureteroscopy from the recent past to the near future. Urolithiasis. 2018; 46:31.

5. Xu Y, Min Z, Wan SP, et al. Complications of retrograde intrarenal surgery classified by the modified Clavien grading system. Urolithiasis. 2018; 46:197.

6. Cindolo L, Castellan P, Scoffone CM, et al. Mortality and flexible ureteroscopy: analysis of six cases. World J Urol. 2016; 34:305.

7. Kamal M, Sharma P, Singariya G, Jain R. Feasibility and complications of spinal anaesthesia in percutaneous nephrolithotomy: our experience. J Clin Diagn Res. 2017; 11:UC08.

8. Cybulski PA, Joo H, Honey RJ. Ureteroscopy: anesthetic considerations. Urol Clin North Am. 2004; 31:43.

9. Zeng G, Zhao Z, Yang F, et al. Retrograde intrarenal surgery with combined spinal-epidural vs general anesthesia: a prospective randomized controlled trial. J Endourol. 2015; 29:401.

10. Bosio A, Dalmasso E, Alessandria E, et al. Retrograde intra-renal surgery under spinal anesthesia: the first large series. Minerva Urol Nefrol. 2018; 70:333.

11. Wendt-Nordahl G, et al. Do new generation flexible ureterorenoscopes offer a higher treatment success than their predecessors? Urol Res. 2011; 39:185.

12. Geraghty R, Abourmarzouk O, Rai B, et al. Evidence for ureterorenoscopy and laser fragmentation (URSL) for large renal stones in the modern era. Curr Urol Rep. 2015; 16:1-6.

13. Skolarikos A, Neisius A, Petřík A, et al. EAU Guidelines on Urolithiasis. Edn. presented at the EAU Annual Congress Amsterdam 2022.

14. Breen P, Park KW. General anesthesia versus regional anesthesia. Int Anesthesiol Clin. 2002; 40:61-71.

15. de la Rosette J, Denstedt J, Geavlete P, et al. CROES URS Study Group. The clinical Research Office of the Endourological Society

ureteroscopy global study: Indications, complications, and outcomes in 11885 patiens. J Endourol. 2014; 28:131-9.

16. Okan Baş, Can Tuygun, Onur Dede, et al. Factors affecting complication rates of retrograde flexible ureterorenoscopy: analysis of 1571 procedures-a single-center experience World J Urol. 2017; 35:819-826.

17. Maugeri O, Dalmasso E, Peretti D, et al. Stone free rate and clinical complications in patients submitted to retrograde intrarenal surgery (RIRS): Our experience in 571 consecutive cases.Arch Ital Urol Androl. 2021; 93:313-317.

18. Zisman A, Siegel YI, Siegmann A, Lindner A. Spontaneous ureteral stent fragmentation. J Urol. 1995; 153:718-21.

19. Resorlu B, Unsal A, Gulec H, et al. A new scoring system for predicting stonefree rate after retrograde intrarenal surgery: the "resorlu-unsal stone score". Urology. 2012; 80:512-518.

Correspondence

Mehmet Yoldas, MD (Corresponding Author)
yoldas_2297@hotmail.com
Tepecik Training and Research Hospital Urology Clinic, Izmir (Turkey)

Tuba Kuvvet Yoldas, MD
drtuba2004@hotmail.com
Ege University Faculty of Medicine, Anesthesiology and Reanimation Department, Izmir (Turkey)