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Comparison of the efficacy of spinal and general anesthesia in retrograde intrarenal surgery

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ABSTRACT

This study aimed to compare spinal anesthesia (SA) and general anesthesia (GA) in terms of success rate, efficacy, reliability, and cost among patients diagnosed with renal stones and undergoing retrograde intrarenal surgery (RIRS).

Between January 2018 and June 2021, 76 patients diagnosed with kidney stones and undergoing RIRS in our clinic were retrospectively evaluated. The groups were compared in terms of operative time, stone fragmentation time, intraoperative double-J stent requirement, length of hospital stay, requirement of additional procedures, stone-free rate, incidence of complications, and cost of anesthesia.

When the groups were compared, the mean age and American Society of Anesthesiologists stage of the patients were statistically higher in the SA group than in the GA group ($P = 0.009$, $P = 0.024$). No statistically significant difference was found between the groups in terms of operative time, stone fragmentation time, intraoperative double-J stent requirement, length of hospital stay, requirement of additional procedures, and stone-free rate ($P > 0.05$). The cost of anesthesia was significantly lower in the SA group ($P < 0.001$). No statistically significant difference was observed between the groups in terms of the incidence of complications ($P > 0.05$).

RIRS coupled with SA is a viable and effective option for treating renal stones. The success, stone-free, and complication rates are comparable to those observed in GA-administered RIRS. We prefer SA in patients with comorbidities and consider that it can be performed safely and successfully with both lower morbidity rates and much lower cost than GA.

Keywords: General anesthesia, renal stone, retrograde intrarenal surgery, spinal anesthesia

INTRODUCTION

Minimally invasive methods for treating renal stones are increasingly preferred. Retrograde intrarenal surgery (RIRS) is a minimally invasive procedure used for renal stones smaller than 20 mm, which is currently preferred by some surgeons for patients with a larger stone burden (1). RIRS is favored over percutaneous nephrolithotomy (PNL) due to lower morbidity, less postoperative pain, and shorter hospital stay, and over extracorporeal shock wave therapy (ESWL) due to higher stone-free rates (2).

RIRS is usually performed with general anesthesia (GA) to reduce respiratory-induced kidney movements. However, applying GA results in increased morbidity in patients with cardiac and pulmonary comorbidities. Thus, patients and surgeons may have reservations about using even minimally invasive procedures, such as RIRS, due to the requirement of GA. The quality of a minimally invasive surgical procedure can be improved using a minimally invasive anesthesia method.

A regional anesthesia approach is more reliable in elderly patients with high comorbidities and is therefore preferred by anesthesiologists and patients. Among these applications, spinal anesthesia (SA) is more frequently used due to its low postoperative pain, short hospital stay, and less anesthetic use (3). Another advantage of SA is that it costs much less than GA. Our experience in ureterorenoscopy using SA has led us to consider that successful operations using flexible instruments can be undertaken efficiently and reliably using RIRS in cases of proximal ureteral stone migration into the kidney.

This study aimed to compare SA and GA applications in terms of their success rate, efficacy, reliability, and cost in patients undergoing RIRS for renal stones.

MATERIAL AND METHODS

Between January 2018 and June 2021, 76 patients diagnosed with renal stones and undergoing RIRS in our clinic were retrospectively evaluated. Included in the study were patients with renal stones measuring less than 20 mm (up to 30 mm in selected patients), those who had not responded to previous ESWL, and those with residual stones measuring less than 20 mm after PNL.

The patients were divided into two groups based on the method of anesthesia used during the surgery without standardizing the size and number of stones. The patients with an American Society of Anesthesiologists (ASA) score greater than 3 were excluded from the study.

Before the surgery, the patients were evaluated by anamnesis, physical examination, routine blood tests, urinalysis and culture, plain films (KUB radiography), renal ultrasonography (USG), intravenous pyelography, and/or noncontrast computed tomography (CT). The stone size was determined by measuring the longest axis in preoperative radiological examination. The sum of the largest dimensions of each stone was calculated in cases of multiple renal stones. The ASA scores and comorbidities, namely chronic obstructive pulmonary disease, coronary artery disease, and diabetes mellitus (DM), were recorded. As a pre-anesthetic, prophylactic antibiotherapy (intravenous cefazolin) was applied at a dose of 25–50 mg/kg for pediatric cases and 1 g for adults. Surgery was performed on patients with positive urine cultures only after their urine became sterile following treatment with culture-specific antibiotics.

After written informed consent was obtained from all patients, all surgeries were performed using 7.95-F Olympus URF-P6 and 8.5-F Karl Storz Flex-X [c] flexible ureteroscopes. In addition, 9.5–11.5 F, 20- and 28-cm Cook medical ureteral access sheaths were used for children and 11-13/12-14/13-15 F, 28/36/48-cm Navigator HD Boston Scientific access sheaths for adults. Dornier Medilas H30 16 MPS 50/60 Hz was used as the Holmium:YAG laser.

The duration of the surgery was measured, and the time to reach the stone and the amount of time to achieve appropriate fragmentation were recorded.

Management of anesthesia

Both groups underwent routine noninvasive blood pressure measurement, pulse oximetry, and 3-lead ECG monitoring. Subsequently, all patients received 0.03 mg/kg midazolam as premedication.

In the first group, SA was injected into the subarachnoid space between the L3–L4 or L4–L5 vertebrae using a 25-gauche Quincke spinal needle in the sitting position. Once the free flow of the cerebrospinal fluid was established, 12.5 mg of 0.5% bupivacaine mixed with 25 mcg of fentanyl was administered into the subarachnoid space, and 3 mL of the anesthetic was given. Subsequently, the patients were placed supine, and the surgery began when their sensory block reached the thoracic 8 level.

In the second group, GA was applied using 0.03 mg/kg midazolam premedication, followed by 3 mg/kg propofol, and then 1 mcg/kg fentanyl for analgesia. After losing verbal contact with the patient, induction was started with 0.6 mg/kg rocuronium (relaxant), and tracheal intubation was performed by laryngoscopy. Sevoflurane gas infusion and remifentanil infusion were used for maintaining GA.

RIRS technique

All patients underwent cystoscopy in the lithotomy position. A guide wire with a hydrophilic tip was advanced to the ureter. Control ureteroscopy was performed over this guide wire using semirigid ureterorenoscopy (9.5-F Karl Storz endoscopy) to exclude ureteral pathologies and stones and for dilation. The access sheath was then advanced over the guide wire to the proximal ureter under C-arm fluoroscopy. The renal pelvis was reached over the guide wire in patients with an access sheath and by flexible ureterorenoscopy in those without an access sheath. The stones were fragmented with the Holmium: YAG laser. If it was not possible to reach the kidney due to stenosis, a double-J (DJ) stent was placed in the ureter, and the procedure was repeated 4 weeks later. The stones were fragmented until they could pass spontaneously. At the end of the procedure, a 4.8-F DJ ureteral stent was placed if necessary.

The stone-free rates in all patients were evaluated by x-ray and USG in the first month postoperatively. In addition, the patients with nonopaque residual stones were evaluated using noncontrast CT. The success was

determined based on the achievement of a stone-free status or residual fragments smaller than 3 mm. Recurrent RIRS, URS, PNL, and ESWL were used as additional therapy in patients with residual stones.

Stone localization was grouped as lower, middle, upper calyx, and pelvis. The operative time was defined as the time passed from the insertion of a rigid ureteroscope to the completion of stent placement. Postoperative hospital stay was defined as the number of days between surgery and discharge.

Statistical analysis

Data were analyzed using IBM SPSS Statistics software version 17.0 (IBM Corporation, NY, USA). The normal distribution of continuous variables was determined using the Kolmogorov–Smirnov test. The Levene test was used for evaluating the homogeneity of variances. Where appropriate, descriptive statistics for continuous variables were shown as mean ± SD or median (min-max). The number and percentages of cases were used for categorical data. The mean differences between the groups were compared using the Student t test, and the Mann–Whitney U test was applied for comparing variables when the parametric test assumptions were not met. Where applicable, the categorical data were analyzed using the continuity-corrected chi-square or Fisher's exact test. A P value less than 0.05 indicated a statistically significant difference.

RESULTS

Table 1 compares the patients in terms of demographic and clinical characteristics, showing that the

Table 1 Demographic data and preoperative clinical characteristics of the patients

	GA (*n* = 35)	SA (*n* = 41)	*P* value
Age (year)	42.4 ± 10.1	50.6 ± 16.3	**0.009**[a]
Male/Female (*n*)	12/23	22/19	0.144[b]
BMI (kg/m²)	25.3 ± 2.76	26.2 ± 3.37	0.224[a]
Stone side (right/left), (*n*)	18/17	19/22	0.832[b]
ASA status, *n* (%)			**0.024**[c]
I	22 (62.9)	15 (36.6)	
II	11 (31.4)	21 (51.2)	
III	2 (5.7)	5 (12.2)	
Stone size (mm)	15 (8–30)	13 (5–30)	0.186[c]
Stone location, *n* (%)			
Lower pole	4 (11.4)	2 (4.9)	0.405[d]
Mid pole	1 (2.9)	0 (0.0)	–
Pelvis	29 (82.9)	39 (95.1)	0.133[d]
Upper pole	1 (2.9)	0 (0.0)	–
Hounsfield unit (HU) values of stones	893.8 ± 283.72	897.4 ± 281.55	0.956[a]
Comorbidities, *n* (%)	2 (5.7)	10 (24.4)	0.056[b]
CAD	1 (2.9)	7 (17.1)	0.063[d]
DM	1 (2.9)	3 (7.3)	0.620[d]
Preoperative DJ stent, *n* (%)	9 (25.7)	9 (22.0)	0.909[b]
Preoperative hydronephrosis, *n* (%)			0.157[c]
0	7 (20.0)	15 (36.6)	
1	4 (11.4)	5 (12.2)	
2	19 (54.3)	16 (39.0)	
3	5 (14.3)	4 (9.8)	
4	0 (0.0)	1 (2.4)	

[a]Student *t* test, [b]Continuity-corrected chi-square test, [c]Mann–Whitney *U* test,[d] Fisher's exact test.

mean age and ASA stage of the patients were statistically higher in the SA group compared with the GA group ($P = 0.009$ and $P = 0.024$, respectively). No statistically significant difference was observed between the groups in terms of sex distribution; body mass index; stone side, size, localization, and density (Hounsfield unit, HU); comorbidities; preoperative DJ stent requirement; and preoperative hydronephrosis degree ($P > 0.05$).

The comparison of clinical outcomes by groups is presented in Table 2. No statistically significant difference was observed between the groups in terms of operative time, stone fragmentation time, intraoperative DJ stent requirement, length of hospital stay, requirement of additional procedures, and stone-free rate ($P > 0.05$). The cost of anesthesia in the SA group was statistically lower ($P < 0.001$) (Fig. 1).

Table 3 compares the incidence of complications between the SA and GA groups. No statistically significant difference was found between the groups in terms of the incidence of complications ($P > 0.05$).

Table 2 Comparison of clinical outcomes between the two anesthesia groups

	GA (*n* = 35)	SA (*n* = 41)	*P* value
Operative time (min)	65 (35–110)	65 (30–115)	0.962[a]
Stone fragmentation time (min)	45 (25–95)	48 (15–105)	0.726[a]
Intraoperative double-J stent, *n* (%)	34 (97.1)	39 (95.1)	>0.999[b]
Postoperative hospitalization (day)	1 (1-3)	1 (1-3)	0.468[a]
Additional procedure, *n* (%)	9 (25.7)	14 (34.1)	0.584[c]
Follow-up	2 (5.7)	3 (7.3)	>0.999[b]
PNL	0 (0.0)	1 (2.4)	–
RIRS	0 (0.0)	3 (7.3)	0.245[b]
ESWL	1 (2.9)	2 (4.9)	>0.999[b]
URS	6 (17.1)	5 (12.2)	0.776[c]
Anesthetic cost ($)	25.2 (16.4–35.2)	4.5 (3.75–6.5)	**<0.001**[a]
Stone-free status, *n* (%)			0.995[c]
No	11 (31.4)	14 (34.1)	
Yes	24 (68.6)	27 (65.9)	

[a]Mann–Whitney *U* test, [b]Fisher's exact test, [c]continuity-corrected chi-square test.

Table 3 Comparison of complications between the spinal anesthesia (SA) and general anesthesia (GA) groups according to the modified Clavien classification

	GA (*n* = 35)	SA (*n* = 41)	*P* value
Total number of complications	5 (14.3%)	6 (14.6%)	>0.999[a]
Grade I			
Fever	1 (2.9%)	0 (0.0%)	–
Flank pain	2 (5.7%)	1 (2.4%)	0.592[b]
Mild hematuria	1 (2.9%)	3 (7.3%)	0.620[b]
Minimal mucosal injury	1 (2.9%)	1 (2.4%)	–
Grade II			
Double-J stent migration	0 (0.0%)	1 (2.4%)	–

[a] Continuity-corrected chi-square test, [b] Fisher's exact test.

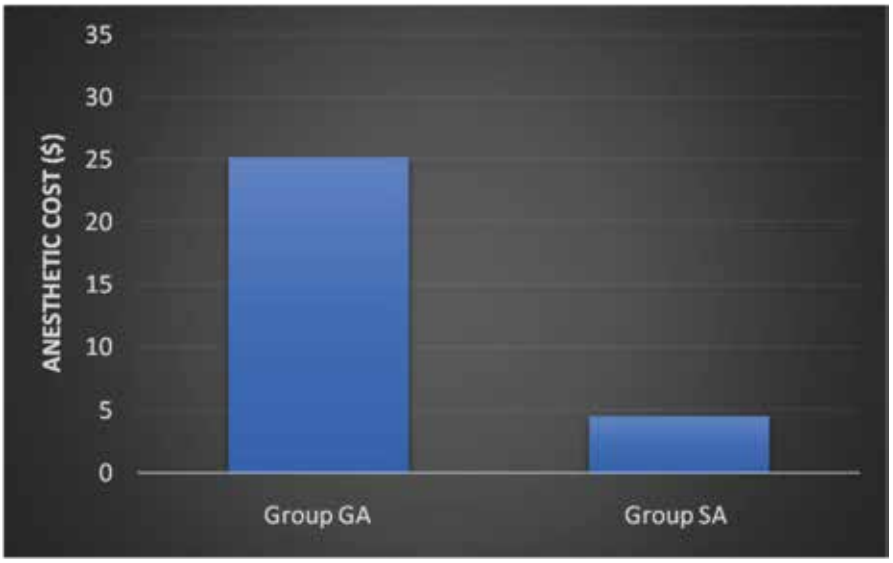

Figure 1 Comparison of cost between the general anesthesia and spinal anesthesia groups.

DISCUSSION

With the advances in technology, miniaturized endoscopic devices have been developed and laser technology has been more widely accepted, increasing the applicability and effectiveness of minimally invasive surgical treatments. In general, studies have been conducted to evaluate the stone-free and complication rates so as to increase the success rate of RIRS (4,5). Another factor that increases the safety and success of RIRC is the choice of anesthesia. Increased renal movement in the surgery makes it difficult to reach the stone and increases damage to the renal mucosa during the fragmentation of the stone with the Holmium laser, which raises the concern of associated hematuria development, leading to surgeries using GA. Therefore, RIRS is generally performed under GA (5-7).

Studies comparing GA and SA in PNL revealed no difference except for postoperative pain, supporting the feasibility of RIRS with SA, which is a less painful procedure than PNL (8-10).

The application of GA has increased morbidity in patients with comorbidities, resulting in both surgeons and patients having reservations about the use of GA. The idea of combining a minimally invasive surgical procedure with minimally invasive anesthesia was first proposed by Zeng *et al.,* who demonstrated that RIRS could be successfully coupled with combined spinal epidural anesthesia (CSEA) in a safe and reliable manner, as in GA. In the same study, the duration of surgery, early postoperative pain, stone-free rates, and complication rates of CSEA were found to be similar to those of GA; however, the anesthesia cost was lower. The pain score was also lower in the CSEA group, albeit not statistically significant (11).

In the proximal ureteral stone operations performed with SA in our clinic, the successful procedures using flexible endoscopic instruments in cases of the pushback of the stone into the kidney led us to consider that we could safely perform RIRS with SA.

In a prospective, double-blind, randomized-controlled trial, Mohamed et al. found that RIRS with SA was a safe and feasible method with shorter hospital stay and less cost burden (12). In another study, Bosio et al. reported that the results of RIRS with SA did not significantly differ from those of RIRS with GA applied during the same period in terms of stone-free rates (13).

In the present study, no significant difference was found between the SA and GA groups in terms of the operative time, stone fragmentation time, intraoperative DJ stent requirement, postoperative length of hospital stay, additional procedure requirement, SFR rates, and incidence of complications. In addition, the cost of anesthesia was significantly lower in the SA group.

The results obtained in the SA group were similar

to those in the GA group. The fact that none of the cases in the SA group required conversion to GA showed that SA during RIRS could be performed as safely as GA. In addition, the cost of SA was much lower than that of GA. Considering that RIRS procedures are adequately safe and have an extremely low morbidity rate, we prefer and recommend performing RIRS under SA in any patient under similar clinical and economic conditions, if the general health state permits. The limitations of this study included the retrospective nature and the absence of an evaluation of the pain status.

CONCLUSIONS

RIRS with SA is a viable and effective option for treating renal stones. The success, stone-free, and complication rates are similar to those of GA-administered RIRS. We prefer SA for patients with comorbidities, and we consider that it can be performed safely and successfully with both lower morbidity rates and much lower costs.

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