Comparison of Anesthesia Methods in Treatment of Staghorn Kidney Stones with Percutaneous Nephrolithotomy

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Purpose: To compare the efficacy and safety of percutaneous nephrolithotomy (PNL) in the treatment of staghorn calculi (SC) under spinal anesthesia (SA) versus general anesthesia (GA).

Materials and Methods: Patients with SC who treated with PNL from 2011 to 2014 were retrospectively reviewed. In total, 100 patients were divided into 2 groups according to anesthesia type: SA (group 1, n = 47) and GA (group 2, n = 53). Demographics, perioperative parameters, and postoperative analgesic requirements were compared between the two groups.

Results: There was no significant difference in terms of age, sex, American Society of Anesthesiologists score, body mass index, or stone size between the two groups (P = .40, .30, .18, .20, and .50, respectively). The mean procedure times were 84.7 and 87.5 min in the SA and GA groups, respectively (P = .68). The complication rates were similar in the SA and GA groups (19.1% vs. 13.2%, respectively; P = .421). The stone-free rates were also similar in the SA and GA groups (61.7% vs. 52.8%, respectively; P = .374). No statistically significant difference was found in analgesic requirements.

Conclusion: SA is a safe method without the risks of GA and may be used for conditions in which GA is contraindicated or in patients with concerns about GA. Our outcomes indicated that SC can be treated safely and effectively under SA.

Keywords: kidney calculi; surgery; nephrostomy; percutaneous; adverse effects; complications; treatment outcome; anesthesia; methods.

INTRODUCTION

Staghorn calculi (SC) are branched kidney stones that fill part or all of the pelvicaliceal system and account for 27.7% of all cases of kidney stones.[1,2] Because SC can cause urinary infections, they may be responsible for kidney damage and the development of life-threatening sepsis.[3,4] For many years, percutaneous nephrolithotomy (PNL) was the first option for treatment of large and staghorn kidney stones.[1] However, PNL may be difficult due to a number of factors, such as a prolonged operation time and hospitalization, requirement for more than one access route, an increased rates of intercostal access, and hemorrhage.[5-8]

PNL can be performed with either spinal anesthesia (SA) or general anesthesia (GA). Several studies have evaluated the advantages and disadvantages of SA versus GA.[9-14] These studies suggested that treatment of SC with standard PNL might be problematic under SA because of the prolonged operation time. Due to a lack of previous clinical studies regarding this issue, we compared the efficacy and safety of PNL in the treatment of SC under SA versus GA.

MATERIALS AND METHODS

Patients with SC who underwent standard PNL by experienced urologists (A.T., O.I.) in two referral centers from 2011 to 2014 were retrospectively reviewed. We excluded patients 1) under the age of 18 years, 2) with a solitary kidney, 3) with bilateral kidney stones, and 4) undergoing additional surgical interventions for conditions other than kidney stones. In total, 100 patients were included in the study, and they were divided into 2 groups according to the type of anesthesia: SA (group 1) and GA (group 2). In a standard fashion, the patients

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Table 1. Demographic characteristics of study patients.

Variables	Group 1	Group 2	*P* Value
Patient number, no.	47	53	.435
Mean age, years	48.5 ± 13.8 (19-78)	46.1 ± 16.6 (19-69)	.3
Sex, Male/Female	33/14	42/11	.215
Mean BMI, kg/m²	28.7 ± 5.6 (18-46.1)	27.1 ± 6.6 (18-42.3)	
Mean ASA score	1.4	1.2	.188
Mean stone size, mm	52.9 ± 15.4 (35-125)	50.6 ± 24.6 (36-184)	.58

Abbreviations: BMI, Body Mass Index; ASA, American Society of Anesthesiologists score.

of the first center underwent the PNL procedures under SA (group 1), while PNL procedures were performed under GA in center 2 (group 2). Demographic data, American Society of Anesthesiologists (ASA) score, stone size and location, perioperative parameters (operation time, hemoglobin drop, stone-free and complication rates, mean access number, access location), and postoperative analgesic requirements were compared between the groups.

All patients underwent routine urinalysis, urine culture, and blood chemistry as well as a physical examination. Patients with positive urine cultures were also treated with appropriate antibiotics preoperatively. Antibiotic drugs, including ciprofloxacin 200 mg and cefuroxime sodium 750 mg, were administered as prophylactic regimens intravenously for 24 h, and oral ciprofloxacin 500 mg (twice per day) was maintained until the patient was discharged. Radiological evaluation was performed with kidney-ureter-bladder (KUB) plain images, urinary ultrasonography, intravenous urography, and/or computed tomography (CT) scan for all patients. The largest diameter of the stone was determined using imaging (in mm), and in the presence of multiple stones, the sum of the largest diameters of all stones was calculated.

Spinal Anesthesia Technique

All patients received 1000 mL of intravenous normal saline 20 to 30 min before surgery. Following administration of midazolam (2 mg) for sedation, anesthesia was achieved with administration of 15 to 20 mg of bupivacaine (adjusted according to body mass index [BMI]) through intervertebral gap L3–L4 into the subarachnoid space with a 25-gauge needle. Hypotension was controlled by ephedrine (5–10 mg) administration. Anesthesia was provided up to the T4 dermatome level (up to the level of the nipple).

General Anesthesia Technique

Initially, 2 mg/kg of propofol and 1 mg/kg of fentanyl were administered intravenously in the general anesthesia group. Following these medications, oxygen containing 0.8% to 1.2% isoflurane and 50% N_2O was applied. The ventilation rate was adjusted using an anesthesia machine ventilator with a tidal volume of 10 to 12 breaths/min (8–10 mL/kg). Neuromuscular block was eliminated by applying 0.5 mg of atropine and 1 mg of neostigmine at the end of surgery.

Surgical Technique

The procedure was started with the insertion of a 6 French (F) open-ended ureteral catheter in the lithotomy position. The patient was then turned to the prone position. Next, access to the desired calyx was performed under C-arm fluoroscopy. The tract was dilated up to 30 F using Amplatz dilators over a guidewire, and a 30 F Amplatz sheath was placed into the collecting system. Stone disintegration was achieved using a pneumatic lithotripter through a 26 F nephroscope. Stone fragments were removed with graspers. After assessment of stone clearance using fluoroscopy and endoscopy, a nephrostomy tube was inserted into the collecting system. The operation time was defined as the duration between the beginning of the PNL procedure after changing the position and inserting the nephrostomy tube.

All patients were evaluated with KUB and biochemical tests postoperatively. Patients were discharged in the absence of any complications after removal of the nephrostomy tube on postoperative days 1 to 3. Complications were classified according to the Clavien classification system.[15] The success of the procedure was assessed with CT scan 4 weeks after surgery.

Statistical Analysis

Data analysis was performed using Statistical Package for the Social Science (SPSS Inc, Chicago, Illinois, USA) version 20. Patient- and operation-related parameters were compared between the groups using the Mann–Whitney *U* test for numerical variables and the χ^2 test for categorical variables. A *P* value of < .05 for the Mann–Whitney *U* test was considered statistically significant.

RESULTS

Demographic characteristics of patients are summarized in **Table 1**. In total, 100 patients (75 males and 25 females) were included in the study. The numbers of patients were 47 and 53 in groups 1 and 2, respectively. The mean age, BMI, ASA score, and stone size were 48.5 and 46.1 years, 28.7 and 27.1 kg/m^2, 1.4 and 1.2, and 52.9 and 50.6 mm in groups 1 and 2, respectively. There was no statistically significant difference in terms of age, sex, ASA score, BMI, or stone size between the groups (P = .40, .30, .18, .20, and .50, respectively).

The postoperative outcomes of the patients are summarized in **Table 2**. The mean operation time was 84.7 (range, 55–200) min in group 1 and 87.5 (range, 40–210) min in group 2 (P = .68). The mean access numbers were 1.19 and 1.21, the rates of intercostal access were 4.2% and 13.2%, and the mean hospitalization times were 2.3 and 2.7 days, respectively. These differences were not statistically significant. The stone-free rates were similar in both groups (61.7% vs. 52.8%, respectively; P = .374). No statistically significant difference was found regarding analgesic requirements. The mean opioid usage was 43.2 and 53.2 mg in groups 1 and 2, respectively. The mean doses of paracetamol were 2303 and 2604 mg, respectively (P = .201).

The complication rates were similar in groups 1 and 2 (19.1% vs. 13.2%, respectively; P = .421). In total, nine patients in the SA group showed complications: hemorrhage requiring blood transfusion (Clavien II; n = 2), double-J ureteral catheter insertion due to prolonged urine drainage (Clavien IIIA; n = 2), atelectasis (Clavien II; n = 1), urinary tract infection (Clavien II; n = 1), perioperative hypotension (n = 1), and postoperative headache (Clavien I; n = 2). The complications seen in the GA group were hemorrhage requiring blood transfusion (Clavien II; n = 2), urinary tract infection (Clavien II; n = 2), urosepsis (Clavien IIIA; n = 1), double-J ureteral catheter insertion due to prolonged urine drainage (Clavien IIIA; n = 1), and pneumothorax (Clavien IIIA; n = 1).

Two patients experienced pain toward the end of the PNL procedure in the SA group, but the procedures were completed successfully after injection of 1 mg of midazolam and 1 µg/kg of fentanyl citrate. No patient in the SA group required conversion to GA.

DISCUSSION

Treatment of SC remains a problem for urologists despite recent technological refinements. PNL is recommended as the first option for the treatment of SC. All acute complications, such as transfusion requirement and death, are more common in cases of SC than oth-

Table 2. The operative outcomes of patients are presented.

Variables	Group 1	Group 2	*P* Value
Mean perative time (range), min	84.7 ± 28.6 (55-200)	87.5 ± 37.2 (40-210)	.684
Mean access number	1.19	1.21	.86
Intercostal access, no. (%)	2 (4.2)	7 (13.2)	.12
Mean hemoglobin drop, mg/dL	2.4 ± 1.5	1.9 ± 2.1	.283
Complication, no. (%)	9 (19.1)	7 (13.2)	.421
Hemorrhage	2 (4.2)	2 (3.8)	
Prolonged urine drainage	2 (4.2)	1 (1.9)	
Pneumothorax	0	1 (1.9)	
Atelectasis	1 (2.1)	0	
Urinary tract infection	1 (2.1)	2 (3.8)	
Postoperative headache	2 (4.2)	0	
Perioperative hypotension	1 (2.1)	0	
Urosepsis	0	1 (1.9)	
Mean analgesic requirement, doses/patient	4.2 ± 2.6	4.4 ± 2.0	.765
Mean hospital stay, day	2.3 ± 1.3	2.7 ± 2.5	.432
Outcome, no. (%)			
Stone free	29 (61.7)	28 (52.8)	.374
Fragments < 4 mm	7 (14.9)	9 (17.0)	.777
Rest	11 (23.4)	16 (30.2)	.448

er types of kidney stones.[1] In a study by the Clinical Research Office of Endourological Society (CROES) group, the rates of postoperative fever, hemorrhage, perforation of the collection system, blood transfusion, and both operative and hospitalization times were higher, while the stone-free rate was lower in the SC group than in cases of non-SC.[2]

Many urologists prefer GA in the treatment of SC with PNL. Despite its advantages, such as the ability to control the patient's breathing and increased comfort for the surgeon, GA has several disadvantages for the patient, including an increased incidence of anaphylaxis due to multiple drug administration; pulmonary, vascular, and neurological complications; and the risk of problems related to endotracheal tubes while turning the patient to the prone position from the lithotomy position.[11,16] Several studies have demonstrated that regional anesthesia can be performed safely and effectively in patients undergoing PNL for the treatment of kidney stones.[9-14] However, the efficacy of PNL under SA has not been investigated. To our knowledge, this is the first reported study comparing anesthesia methods for PNL of SC.

In a randomized clinical study, Nouralizadeh and colleagues[9] reported that both anesthesia methods had similar efficacy and complication rates. Kuzgunbay and colleagues[10] found no significant difference with respect to operative time, amount of irrigation, fluoroscopy time, hemoglobin changes, hospitalization, or stone-free rates between combined epidural SA and GA. In another study, Karacalar and colleagues[11] reported that patient satisfaction was higher and pain scores were lower in the spinal epidural block group than in the GA group. However, in a randomized controlled study comparing SA and GA in terms of efficacy and complication rates in PNL, Mehrabi and colleagues[12] found no statistically significant difference in success rate or patient satisfaction. They reported that intraoperative hypotension, postoperative headache, and backache were more common with SA. Moreover, they noted that SA was less costly while narcotic analgesia requirements were higher in GA on postoperative day 1.[12] Cicek and colleagues[13] reported similar success rates but shorter durations of hospitalization, operation, and fluoroscopy in SA than GA in PNL. They also found significantly higher postoperative narcotic analgesia requirements and blood transfusion rates in the GA group.[13] In contrast, we found similar outcomes in the SA and GA groups with regard to complications (19.1% vs. 13.2%, respectively), stone-free rates (61.7% vs. 52.8%, respectively), and mean hemoglobin change (2.4 vs. 1.9 mg/dL, respectively).

As mentioned in many previous studies, the most common side effects of SA are intraoperative hypotension and postoperative headache and backache due to the blockage of central venous pressure and vasodilatation. All of these conditions can be managed with intraoperative ephedrine injection, rest, and postoperative use of analgesic drugs.[12]

Intercostal access rates were higher in PNL surgery of patients with SC versus those with non-SC.[2] In one study, investigators evaluated patients undergoing supracostal access in SA and GA groups. They found similar complication and success rates, and no patients converted to GA. The average sensorial and motor block times were 120 ± 20 and 110 ± 40 min, respectively.[17] We found no significant difference with regard to the number of intercostal interventions (4.2% vs. 13.2%, respectively). In the SA group, two patients experienced pain and prolonged operation times of > 150 min, and they were managed by perioperative analgesic supplementation.

The main limitations of this study are its retrospective nature and the lack of visual analog scale scores and perioperative blood pressure measurements. There may also be a need to convert to open surgery in cases of massive hemorrhage. There might also be wasted time in turning the patient to the lateral decubitus position following the insertion of an endotracheal tube. Thus, it can be recommended to perform PNL under SA only with an experienced urologist and anesthesiologist. The outcomes reported here contribute to the literature in terms of the safety and efficacy of performing PNL under SA for the treatment of SC.

CONCLUSIONS

SA is a safe method without the risks of GA and may be used for conditions in which GA is contraindicated or in patients with concerns about GA. The outcomes reported here indicated that staghorn kidney stones can be treated safely and effectively under SA.

CONFLICT OF INTEREST

None declared.

REFERENCES

1. Preminger GM, Assimos DG, Lingeman JE, Nakada SY, Pearle MS, Wolf JS Jr. AUA Nephrolithiasis Guideline Panel. Chapter 1: AUA guideline on management of staghorn calculi: Diagnosis and treatment recommendations. J Urol. 2005;173:1991-2000.

2. Desai M, De Lisa A, Turna B, et al. The clinical research office of the endourological society percutaneous nephrolithotomy global study: staghorn versus nonstaghorn stones. J Endourol. 2011;25:1263-8.
3. Koga S, Arakaki Y, Matsuoka M, Ohyama C. Staghorn calculi--long-term results of management. Br J Urol. 1991;68:122-4.
4. Soucy F, Ko R, Duvdevani M, Nott L, Denstedt JD, Razvi H. Percutaneous nephrolithotomy for staghorn calculi: A single center's experience over 15 years. J Endourol. 2009;23:1669-73.
5. Turna B, Nazli O, Demiryoguran S, Mammadov R, Cal C. Percutaneous nephrolithotomy: Variables that influence hemorrhage. Urology. 2007;69:603-7.
6. Preminger GM. High burden and complex renal calculi: Aggressive percutaneous nephrolithotomy versus multimodal approaches. Arch It Urol Androl. 2010;82:37-40.
7. Akman T, Sari E, Binbay M, et al. Comparison of outcomes after percutaneous nephrolithotomy of staghorn calculi in those with single and multiple accesses. J Endourol. 2010;24:955-60.
8. Ganpule AP, Mishra S, Desai MR. Multiperc versus single perc with flexible instrumentation for staghorn calculi. J Endourol. 2009;23:1675-8.
9. Nouralizadeh A, Ziaee SA, Hosseini Sharifi SH, et al. Comparison of percutaneous nephrolithotomy under spinal versus general anesthesia: a randomized clinical trial. J Endourol. 2013;27:974-8.
10. Kuzgunbay B, Turunc T, Akin S, Ergenoglu P, Aribogan A, Ozkardes H. Percutaneous nephrolithotomy under general versus combined spinal-epidural anesthesia. J Endourol. 2009;23:1835-8.
11. Karacalar S, Bilen CY, Sarihasan B, Sarikaya S. Spinal-epidural anesthesia versus general anesthesia in the management of percutaneous nephrolithotripsy. J Endourol. 2009;23:1591-7.
12. Mehrabi S, Mousavi Zadeh A, Akbartabar Toori M, Mehrabi F. General versus spinal anesthesia in percutaneous nephrolithotomy. Urol J. 2013;10:756-61.
13. Cicek T, Gonulalan U, Dogan R, et al. Spinal anesthesia is an efficient and safe anesthetic method for percutaneous nephrolithotomy. Urology. 2014;83:50-5.
14. Singh V, Sinha RJ, Sankhwar SN, Malik A. A prospective randomized study comparing percutaneous nephrolithotomy under combined spinal-epidural anesthesia with percutaneous nephrolithotomy under general anesthesia. Urol Int. 2011;87:293-8.
15. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg. 2004;240:205-13.
16. Barak M, Putilov V, Meretyk S, Halachmi S. ETView tracheoscopic ventilation tube for surveillance after tube position in patients undergoing percutaneous nephrolithotomy. Br J Anaesth. 2010;104:501-4.
17. Moslemi MK, Mousavi-Bahar SH, Abedinzadeh M. The feasibility of regional anesthesia in the percutaneous nephrolithotomy with supracostal approach and its comparison with general anesthesia. Urolithiasis. 2013;41:53-7.