Comparison of Two Different Anesthesia Methods in Patients Undergoing Percutaneous Nephrolithotomy.

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Purpose: The study aims to compare the effectiveness, safety and costs of two different anesthesia methods in percutaneous nephrolithotomy (PCNL) operations.

Material and Method: In our study, data was retrospectively examined of 1657 patients who underwent PCNL due to renal calculi between 2009 and 2017. Patients were separated into two groups according to the type of anesthesia; as those who underwent PCNL by general anesthesia (GA) (n = 572) and those under spinal anesthesia(SA) (n = 1085). Standard PCNL technique was used in both groups. Gender, age, operation duration, period of hospitalization, stone-free ratio, post-operative narcotic analgesic need and complications were compared between these two groups.

Results: A total of 1657 patients consisting of 1064 (64.2%) male patients and 593 (35.8%) female patients were included in the study. The average age of the all patients was 33.2 ± 12.4 (range 16-74) years. The two groups were similar in terms of mean age, gender, stone size, stone location and body mass index. Mean operation time was significantly shorter in the SA group than in the GA group (81.8 ± 33.9 minute vs. 118.2 ± -42.9 minute respectively, $P < .001$). Mean period of hospitalization was remarkable shorter in the SA group than in the GA group (30.0 ± 9.9 hours vs. 38.4 ± 11.2 hours respectively, $P < .001$). Post-operative narcotic analgesic need rate was significantly higher in the GA group than in the SA group (33.4% vs. 10.9%, respectively, $P < .001$). Anesthesia cost was found significantly lower in the SA group than in the GA group (USD 21.3±2.8 vs. USD 83.6 ± 9.5, respectively, $P < .001$). Significant difference was not observed between both groups in terms of stone-free ratio, amount of bleeding, fluoroscopy time, pre-operative and post-operative complications.

Conclusion: Compared to those performed with GA, PCNL performed with SA is a safe, effective and low-cost method.

Keywords: cost; percutaneous nephrolithotomy; spinal anesthesia

INTRODUCTION

Percutaneous nephrolithotomy (PCNL) was defined in the treatment of renal calculi for the first time in 1976 by Fernström and Johansson.[1] A breakthrough in the surgical treatment of renal calculi, this development, together with the technological developments in Endourology, became a method preferred against open surgery in the treatment of renal calculi as a minimal invasive method. In time, depending on the miniaturization of the equipment used, PCNL started being implemented on patients in almost all age groups by leading to less complication and less bleeding. PCNL is a treatment method preferred in renal calculi larger than 2 cm, in many renal calculi and staghorn renal calculi.[2] General anesthesia (GA) is the most widely used anesthesia method in PCNL operations.[3] However, there are risks of encountering pulmonary (atelectasia), vascular and neurological complications in GA. Especially, under GA, there is the risk of brachial plexus and spinal trauma when giving operative position to the patient.[4] It is obvious that this risk will increase especially in elder and obese patients. In addition, compared to those receiving spinal anesthesia (SA), patients receiving GA have the risk of staying immobile post-operatively and hence the risk of extended ileus and deep vein thrombosis. However, in PCNL operations performed with SA, as the patient is awake under the first access, risk is minimized for damage that may occur in extremities or nerves during positioning. Morever, early mobilization can be achieved in the post-operative period.[4,5]
In the examination we conducted on the large retrospective patient series, we evaluated different parameters such as effectiveness, safety, cost and complications in PCNL conducted with GA and SA.

MATERIALS AND METHODS

Study population and design

A number of 1657 patients undergoing PCNL between March 2009 and April 2017 were included in our study. Patients included in the study were those who were

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Received December 2017 & Accepted February 2018

Table 1. Pre-operative attributes of the patients

Variables1	Spinal anesthesia	General anesthesia	*P*
Gender (M/F)	723/362	341/231	.134
Age, (median/y)	34.3 ± 11.1	32.7 ± 13.1	.645
Average calculi size,mm2	635.2 ± 304.1	644.5 ± 301.8	.456
Stone location			0.76
Upper calyx	163 (15%)	98 (17.1%)	
Pelvis and caliyx	507 (46.7%)	237 (41.5%)	
Lower calyx	305 (28.2%)	171 (29.9%)	
Proximal ureter	38 (3.5%)	23 (4%)	
Staghorn	72 (6.6%)	43 (7.5%)	
Stone laterality(left/right)	500/585	354/218	
ASA2			.92
I	514 (47%)	231 (40%)	
II	443 (41%)	235 (41%)	
III	128 (12%)	106 (19%)	
BMI3 kg/m2	25.1 ± 4.6	24.2 ± 3.5	.127
Previous stone intervention	117 (10.7)	58 (10.1)	.83
Open	66 (%6)	31(%5.4)	
PCNL	51(%4.7)	27(%5)	

[1]Data are presented as mean ± SD or number (percent)
Abbreviations: ASA, American Society of Anesthesia; BMI, Body mass index

planned to undergo PNL due to stone disease and had no anesthetic concerns. The patients with the following characteristics were excluded from the study: Patients younger than 16 years old, patients with renal anomaly, patients with solitary kidney, with irreversible coagulopathy, with vertebral and/or skeletal anomaly, with severe cardiac-pulmonary failure.

The operations were performed by similar teams and by implementing the same procedure. Parameters such as gender, age, body-mass index, operation duration, hospitalization period, pre-operative ASA (American Society of Anesthesia) evaluation, post-operative narcotic analgesia need, stone burden, pre-operative and post-operative hemoglobin, post-operative complication, pre-operative tension tracking, anesthesia cost and fluoroscopy duration were compared between the two groups. (**Table1 & 2**)

All patients were administered intravenous prophylactic antibiotic (ceftriaxone 1 gram) treatment. Calculi of size 4 mm and smaller were considered as insignificant residue. Pre-operative 20mg/kg ringer lactate solution was given to each patient in the SA group in order to prevent hypotension. Then, 20 mg 0.5% bupivacaine was given to the subarachnoid cavity in the decubitus position using 27-gauge injection, by entering intervertebral between L2-L3. Midazolam (2 mg) was given as intravenous for sedation. Midazolam (2 mg) was given as pre-medication to all the patients in the GA group. Then 2mg/kg propofol, 1 mg/kg fentanyl and 0.5 mg/kg rocuronium bromide was given for induction. 1-2% isoflurane and 40% nitrous oxide was given with oxygen. Then intubation was conducted.

Surgical technique

5F or 6F ureteral catheter was used for retrograde catheterization in both groups. After the catheter was mounted, the patient was taken to prone position. The kidney was entered with 19 gauge percutaneous injection accompanied with fluoroscopy. Amplatz dilators were used for dilation. 30F sheat was placed and 26F nephroscope was used. Standard PCNL procedures were implemented. Intravenous tenoxicam 20 mg was used for post-operative pain. Tramadol or morphine sulphate was used in severe pain cases. Erythrocythe suspension was given to patients with hemoglobin values below 10g/dL and who were symptomatic.

Statistical analysis

Statistical analyses were performed using SPSS software version 15. The variables were investigated using visual (histograms, probability plots) and analytical methods (Kolmogorov-Simirnov/Shapiro-Wilk's test) to determine whether or not they are normally distributed. As the patient numbers did not show normal distribution, analyses of the groups were compared using the Wilcoxon test and Mann-Whitney U test. The Chi-square test, where appropriate, was used to compare

Table 2. Intra-operative and post-operative attributes in both groups.

Variable1	General anesthesia	Spinal anesthesia	*P*
Operation time (min)	118.2 ± -42.9	81.8 ± 33.9	< .001
Hospitalization period (hours)	38.4 ± 11.2	30.0 ± 9.9	< .001
Fluoroscopy duration (s)	61.2 ± 21.2	63.4 ± 23.4	.86
Stone free rate	477(83.4%)	923(85.1%)	.48
Bleeding amount (ml)	179.2 ± 94.3	166.3 ± 83.4	.32
Narcotic analgesia need	191(33.4%)	118(10.9%)	< .001
Blood transfusion(1 or 2 Ü erythrocyte susp.)	24(4.2%)	45(4.1%)	.92
Drug and consumables cost	USD[2] 83.6 ± 9.5	USD 21.3 ± 2.8	< .001

[1] Data are presented as mean ± SD or number (percent)
Abbreviations: USD: American Dollar

Table 3. Comparison of post-operative complications according to modified clavien classification.

Modified Clavien Classification	GROUP GA (n=572)	GROUP SA (n=1085)
No complication	436(76.2%)	820(75.5%)
Grade 1	40(6.9%)	114(10.5%)
Fever	28(4.9%)	52(4.8%)
Hedache	12(2%)	62(5.7%)
Grade 2	55(9.6%)	89(8.2%)
Blood transfusion	24(4.2%)	45(4.2%)
Atelectasi	8(1.4%)	0(%)
Urinary tract infection	15(2.6%)	28(2.6%)
Hematuria> 48 h	8(1.4%)	16(1.4%)
Grade 3a	24(4.2%)	31(2.9%)
Pneumothrax	0(%)	0(%)
Hemothorax	0(%)	0(%)
Prolonged drainage	19(3.3%)	28(2.6%)
Urinoma	5(0.9%)	3(0.3%)
Grade 3b	14(2.4%)	26(2.4%)
Arteriovenous fistula	3(0.5%)	6(0.5%)
Perirenal Haematoma	4(0.7%)	8(0.7%)
Calculi in the ureter or bladder	7(1.2%)	12(1.2%)
Perinephric abscess	0(%)	0(%)
Grade 4a	0(%)	0(%)
Heart attack	0(%)	0(%)
Pulmonary embolism	0(%)	0(%)
Grade 4b	3(0.5%)	5(0.5%)
Urosepsis	3(0.5%)	5(0.5%)
Grade 5	0(%)	0(%)
Death	0(%)	0(%)
Total	572(100%)	1085(100%)

proportions in different groups. A p-value of less than 0.05 was considered to show a statistically significant result.

RESULTS

A total of 1657 patients consisting of 1064 (64.2%) male patients and 593 (35.8%) female patients were included in the study. Demographic attributes of the patients are provided in **Table 1**. Statistically significant differences were not observed between the two groups in age, gender, body-mass index, average calculi size, calculi localization, anesthesia risk assessment (ASA), and previous stone intervention. ($P = .645$, $P = .134$, $P = .127$, $P = .456$, $P = .76$, $P = .92$, $P = .83$ respectively). Operation results, intra-operative and post-operative situations are given in **Table 2.** Operation duration, hospitalization period, post-operative narcotic analgesic need and anesthesia drug-consumables cost was determined to be higher in the GA group ($P < .001$). Post-operative complications were classified according to Modified Clevian and provided in **Table 3**. Complications of spinal anesthesia were observed in 265 (24%) patients during operation. Hypotension, nausea and vomiting were the most frequently observed complications. They were taken under control with ephedrine and metoclopramide. Serious hypotension developed in 2 patients. The patients were taken to supine position and the operation was continued after blood pressure was corrected with ephedrine and volume expander and colloid fluid. One unit of blood was given to 45 patients due to hypotension and bleeding. Anesthesia related complications were observed in 136 (23%) patients in the GA group. Hypertension, nausea and vomiting during extubation was observed most frequently. Major vascular injury, neurological and visceral organ injury was not observed in both groups. Intraoperative hypotension was determined to be higher in the SA group. Atelectasia developed in 8 (1.4%) patients in the GA group. They were corrected with breathing exercises.

The success of the operation was assessed with abdominal ultrasonography and radiography taken after the surgery in both groups. Residual calculi burden was observed to be similar in both groups ($p = .48$). Narcotic analgesia requirement was observed to be higher in the GA group. Average drug and material cost used in spinal and general anesthesia was determined as USD 21.3±2.8 and USD 83.6 ± 9.5 respectively ($P < .001$). The operation duration and the hospitalization period were determined to be significantly lower in the SA group ($P < .001$).

DISCUSSION

In this large series study that we conducted, we showed that compared to GA, PCNL conducted with SA had many advantages such as short operation duration, short hospitalization period and low cost. PCNL is an effective method applied usually under GA on large, multiple and complex calculi in the upper urinary system.[2] The number of publications on PCNL performed with regional anesthesia is increasing. However, the number of patients has usually remained low in these publications.[4,6,7] The current study aimed to compare PCNL performed with SA and GA in terms of safety and effectiveness in the wide series patient group. Although GA is the first preference in many centers, applying GA may be inconvenient in many cases such as chronic obstructive pulmonary disease and cardiovascular diseases.[4,6-10]

Moreover, GA has disadvantages such as, anaphylaxis development risk and probability of the endotracheal tube getting displaced when going from the lithotomy to prone position.[4] Due to high probable complications in morbid obese patients, SA may be a better alternative for these patients.(4,5) Stone-free ratios in different studies conducted with different methods were reported as 53.8% and 97%.[4,6,7,11] In our study, stone-free rate

was found as 83.4% in the GA group and 85.1% in the SA group and the difference between the two groups was found to be statistically insignificant.

In the studies performed, hospitalization period and operation duration were determined to be different in PCNL performed with SA and GA. In some studies, the hospitalization period was found to be related to the anesthesia technique. Shorter hospitalization period was reported in patients to whom regional anesthesia was applied. In these studies, no difference was detected in terms of the type of anesthesia applied and operation and fluoroscopy duration.[6,7,11] In our study, the operation duration and the hospitalization period was determined to be significantly shorter in the SA group. We determined that the operation time was longer in the GA group, specifically, for longer durations of the stages of process of preparation for GA, the period in intubation, giving supine position to the patient in a longer time, extubation time and post-operative waking. Also, we observed that early mobilization of patients and starting to eat earlier shortened the hospitalization periods.

Conducted as prospective randomized, in the study with PCNL performed with spinal and general anesthesia, visual analog pain score and early post-operative analgesia need were found to be significantly lower in the SA group.[7,11,12] In our study, the post-operative narcotic analgesic need was determined as 33.4% in the GA group 10.9% in the SA group and was found to be statistically significant.

In the systematic compilation and meta-analysis comparing regional anesthesia and GA in PCNL, it was shown that regional anesthesia offered many advantages such as surgery time, hospitalization period, fluoroscopy duration, blood transfusion, post-operative pain and analgesic requirements. However, it was reported that the anesthesia method implemented had no significant effect on the stone-free and complication ratios.[13] There is a different application for classifying the complications of PCNL. The most frequently used method is the Modified Clavien Classification.[14,15] We used MCC (Modified Clavien Classification) to evaluate the complications in both groups in our own study. Headache was the most frequently observed post-operative complication in patients with SA.[16] Headache incidence was between 0% and 25% in SA performed with 25-gauge injection.[17] 27–gauge injection was used for SA in our patients. According to MCC, headache was the most frequently observed group 1 complication in the SA group (5.7%). In the study by Karaka□ et al. it was shown that pre-operative complication risk was higher in patients with high ASA score.[18] In our study, it was shown that potential pre-operative problems could be minimized with SA in such patients. Basiri et al. stated that intraoperative pain was excessive in patients with SA. Although the duration of operation is short in this study, the presence of pain may be related to the anesthesia block made.[19] Because with spinal anesthesia you are doing a complete nerve block. We have not encountered such a situation in our own work. 54 (4,9%) patients were very uncomfortable with this position. But they did not feel pain.

In our study, we observed that SA cost was lower compared to GA. Comparing the costs of the drugs and consumables used for anesthesia, the mean cost in the SA group was determined as USD 21.3 while the mean cost in the GA group was determined as USD 83.6 ($P < .001$). This cost difference was determined to be even greater in patients with long operation times. Adding to this cost the shorter hospitalization duration and the fact that post-operative drugs are less in amount, we can easily say that PCNL performed with SA is very effective in terms of cost.

There is a certain operation duration in operations performed with SA. This duration is between 2-6 hours, depending on the drug dosage. Therefore, if SA is to be performed in patients with extreme calculi burden or potential prolongation of the operation duration, then epidural catheter should be mounted concomitantly. Therefore, patients to use this method should be assessed well and GA method should be preferred in unsuitable patients. Of course, the experience of the surgeon and the anesthesia team performing the operation is very important.[20] This experience has great impact on the operation duration. Hypotension and pre-operative medication are the issues to pay attention most during SA.

CONCLUSIONS

In this study we found that the stone-free rates were similar in operations performed in both anesthesia groups. However, operation duration, hospitalization period, post-operative narcotic analgesic need and cost were found to be significantly lower in the SA group. In the light of this data, it was shown that PNL can be performed more effectively, safely and with lower cost using SA.

CONFLICT OF INTEREST

The authors report no conflict of interest.

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