General Versus Spinal Anesthesia in Percutaneous Nephrolithotomy

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Purpose: To compare efficacy and complications of spinal anesthesia versus general anesthesia in percutaneous nephrolithotomy (PCNL).

Materials and Methods: In a prospective randomized study, 110 patients were randomly assigned into two groups for PCNL; group 1 (n = 52) underwent general anesthesia and group 2 (n = 58) received spinal anesthesia. In group 1, PCNL was performed using standard technique under general anesthesia. In group 2, spinal anesthesia was done by injecting bupivacaine and fentanyl in spinal space L4 in sitting position. Thereafter, a urethral catheter was placed in lithotomy position, head of the bed was tilted down for 5 to 10 minutes, and the level of anesthesia was checked. Then, PCNL was done by standard technique. Complications were recorded and analyzed by SPSS software using Chi-Square and Student's *t* tests.

Results: Mean stone size in groups 1 and 2 was 34.2 ± 9.8 mm and 31.3 ± 7.9 mm, respectively. Intra-operative hypotension and postoperative headache and low back pain were more in spinal group than the general group with a significant difference ($P < .05$). No neurologic complication was observed in both groups. Need to narcotic medications on the day of operation in groups 1 and 2 was 12.4 ± 3.1 mg and 7.8 ± 2.3 mg of morphine sulfate, respectively ($P = .03$). The cost of anesthetic drugs was 23 ± 3.7 US $ and 4.5 ± 1.3 US $ in groups 1 and 2, respectively ($P = .001$).

Conclusion: Spinal anesthesia with combined bupivacaine and fentanyl is a safe, effective, and cost-effective method for performing PCNL in adult patients.

Keywords: percutaneous nephrolithotomy, anesthesia, complications

INTRODUCTION

Urinary tract stone disease is a major health-care problem, and after urinary tract infections and prostate pathology, is the third in rank among the diseases of the urinary system.[1,2] Although there are no specific prevention and medical treatment for the management of these patients, with the advance in endourology techniques, such as extracorporeal shockwave lithotripsy (ESWL), transurethral lithotripsy (TUL), and percutaneous nephrolithotomy (PCNL) during the last three decades, diagnostic and treatment methods for this kind of disease have been changed remarkably.[2]

Percutaneous nephrolithotomy is a minimally-invasive therapy for treatment of upper ureteral and renal stones.[2-4] It is the treatment of choice for kidney stones larger than 20 to 30 mm in size, staghorn stones, and stones that are multiple or resistant to ESWL.[5] In most cases, PCNL is performed under general anesthesia, whereas complications and the costs of general anesthesia are higher than spinal anesthesia.[6]

Complications occur especially when patient's position is changed from supine to prone. The most common complications are the lung, brachial plexus, tongue, and occasionally the spinal cord injury when the position of patient is changed as well as neurological complications and side effects related to displacement of tracheal tube.[2,5]

Some scientific evidence shows that in certain cases, such as patients who are at high risk for surgery, we can use either spinal, epidural, or intrapleural anesthesia.[1,4,6] Due to high rate of complications and cost in general anesthesia compared with spinal anesthesia, we aimed to compare the efficacy and complications of general and spinal anesthesia in adult patients who were candidate for PCNL.

MATERIALS AND METHODS

This study was a randomized clinical trial with registered number: IRCT138707201323N1, which was carried out from March 2008 to November 2010 on 110 patients older than 18 years with ureteral stones larger than 15 mm in the beginning of the upper ureter, renal stones larger than 20 mm, staghorn stones, multiple renal stones, and stones resistant to ESWL. They have been referred to our urology department for performing PCNL.

A written informed consent was obtained from patients. Then, they were randomly assigned in two groups, spinal anesthesia (n= 58) and general anesthesia (n = 52), according to Zelen randomization method. History and physical examination were obtained from all the patients.

Pre-operative laboratory tests, such as sodium, potassium, complete blood count (CBC), coagulation tests, renal function tests (urea and creatinine), urinalysis, and urine culture, were checked for all the patients. The size and location of stones were checked by intravenous pyelography (IVP). In nonopaque stones, noncontrast spiral computed scan was done for better decision.

Patients with renal anomalies (horseshoe or ectopic kidneys), cardiovascular disease (ASA class 3 or 4), severe pulmonary, or coagulation disorders, or who were banned having general or spinal anesthesia, or who had any contraindication for spinal anesthesia, such as skin infection over lumbar spine, elevated intracranial pressure, or severe kyphoscoliosis, and failure of spinal anesthesia (inability to enter intrathecal space) were excluded from the study.

In general anesthesia, after inserting a 5-6F urethral catheter in lithotomy position, patients were rotated gently to prone position with caution and assistance of anesthesiologists. Thereafter, operation was performed by standard procedure under general anesthesia with intravenous injection of midazolam, thiopental, and atracorium, and inhalation of isoflurane for induction and maintenance of anesthesia. Access to system and dilatation were done by one-shot technique using an Amplatz dilator, holding a 28F to 30F Amplatz sheath, and the use of a 24F nephroscope according to the standard method of access under guidance of fluoroscopy. Lithotripsy was done by LithoClast Master. In absence of pulmonary, visceral, and vascular complications, a nephrostomy tube was inserted and within maximum 3 hours, the procedure was terminated.

In spinal anesthesia, operation was carried out by injection of 2 to 2.5 mL bupivacaine (0.5%) and 0.5 mL fentanyl (25 µg) in the L4 and L5 intervertebral space by spinal needle sized 25 to 27 gauge. Thereafter, the patient lied in supine position and the bed changed to Trendelenburg position with a gradient of 30 degree for 5 to 10 minutes. The anes-

Table 1. Comparison of demographics and stone characteristics in two groups before operation.*

Variable	General anesthesia	Spinal anesthesia	*P*
Gender			.07
Male, n (%)	35 (67.3)	31 (53.4)	
Female, n (%)	17 (32.7)	27 (46.6)	
Stone location			.11
Pelvic + staghorn, n (%)	29 (55.8)	37 (64.9)	
Others, n (%)	23 (44.2)	20 (35.1)	
Mean age ± SD, y	43.7 ± 8.2	47.4 ± 7.6	.17
Mean stone size ± SD, mm	30.9 ± 10.6	32.8 ± 9.6	.06
Mean body mass index ± SD, kg/m^2	24.1 ± 5.6	24.1 ± 7.2	.07

*SD indicates standard deviation.

thesia level was checked by the anesthesiologist to reach the lower sternum appendage, the xiphoid (T6 to T7). Then, a 5-6F urethral catheter was inserted in lithotomy position by the urologist, and the patient was changed to prone position gently and by assistance of anesthesiologists in the operating room. Percutaneous nephrolithotripsy with fluoroscopy guidance was performed by standard methods. If there was any failure of anesthesia or return of pain, pain relief was obtained using hypnotic and narcoleptic drugs, such as ketamine for maximum 3 hours. If no pulmonary, visceral, or vascular complication was developed, a nephrostomy tube was inserted, and the operation was terminated, the same as the first group. In case of any adverse vascular, visceral, pulmonary, or cardiac complications, the procedure was terminated and the patient was given standard treatment.

The costs of drugs and consumables material used were recorded from the beginning of the anesthesia procedure in both groups. In both groups, patients were hospitalized for two days and rechecked for CBC, urea, and creatinine. Amounts of narcotic drugs used for pain control were recorded. Patient's satisfaction and severity of pain were checked by 7-point verbal test and visual analogue scale (VAS), respectively.

On the 2nd postoperative day, if there was no complication, the nephrostomy tube would be clamped, and provided that the patients did not have fever, leakage of urine, or flank pain after 3 hours, the nephrostomy tube would be removed and the patient would be discharged from the hospital. After one week, the patient was visited again and followed up with kidney, ureter, and bladder x-ray and ultrasonography. Furthermore, the efficacy of operation, including the ability to remove kidney stones completely or residuals stone less than 4 mm, was recorded.[2,3] If there were significant residual stones, standard treatment was done.

Data were analyzed using the SPSS software (the Statistical Package for the Social Sciences, Version 15.0, SPSS Inc, Chicago, Illinois, USA) and analytic tests of Chi-Square and *t* test.

RESULTS

Demographic characteristics and baseline variables in two groups are shown in Table 1. There were no significant differences between two groups regarding age, gender, body mass index, mean stone size, stone location, and operation time ($P > .05$). Only 2 patients in general group and 1 in spinal group required supracostal access, and others were operated via lower calyx access.

Intra-operative and postoperative complications in two groups are shown in Table 2. Complications of spinal anesthesia during surgery were seen in 13 patients. Most common complications related to anesthesia were hypotension (11 patients) and nausea and vomiting (2 patients) that were controlled by ephedrine and metoclopramide. The complication not related to anesthesia was intra-operative bleeding (2 patients) that one of them required 2 units of packed cell.

In general anesthesia group, 10 patients experienced complications related to anesthesia, such as hypotension (2 patients), nausea and vomiting during extubation (3 patients) that were controlled by ephedrine and metoclopramide, and tachycardia (2 patients). The complication not related to an-

Table 2. Comparison of two groups based on intra-operative and postoperative variables.

Variable	General anesthesia	Spinal anesthesia	*p*
Mean operation time ± SD, min	92.3 ± 10.1	82.2 ± 9.8	.09
Patient satisfaction, n (%)	40 (80)	38 (77.2)	.2
Postoperative headache, n	0	3	.02
Low back pain, n	0	2	.02
Hypotension, n	2	11	.01
Mean postoperative Hb, g/dL	12.35	11.52	.66

*SD indicates standard deviation.

esthesia was intra-operative bleeding (2 patients); one patient required one unit packed cell transfusion and another one required chest tube due to hemothorax. There was no major vascular, neurologic, or visceral complication in two groups. Results showed no significant difference between type of anesthesia and intra-operative complications (P = 0.1), but there was a significant difference between two groups regarding intra-operative hypotension (P = .02).

Postoperative complications in spinal anesthesia group were seen in 9 patients. Blood transfusion was required in 4 patients, and 5 patients complained from moderate headache and low back pain, which improved with bed rest and oral analgesic drugs. In general anesthesia, 6 patients experienced complications, of whom 4 needed blood transfusion, and postoperative fever due to atelectasia occurred in 2 patients that improved with chest physiotherapy. There was a significant difference between type of anesthesia and postoperative minor complications (P = .2). Except 3 patients in 2 groups that had urine leak, others were discharged on the second postoperative day, and there was no significant difference regarding hospital stay.

Successfulness of operation in general and spinal groups according to radiography and ultrasonography results after surgery (complete clearance of system from stone or residual stone less than 4 mm) was 80% and 77.8%, respectively. There were no significant differences between type of anesthesia and result of radiography and renal ultrasonography after surgery (P = .2). Significant residual stone (>4 mm) was observed in 10 (20%) patients in general anesthesia and in 12 (22.2%) patients in spinal anesthetic group (P = .3). Two patients in the first group and 4 patients in the second group were lost for follow-up visits.

Dosages of narcotic drugs which were needed after surgery for pain control in two groups are shown in Table 3. The average cost of drugs and materials used in spinal and general anesthesia was 5.4 ± 3.1 US $ and 23 ± 7.3 US $, respectively. Therefore, there was a significant difference in the cost of anesthetic drugs between two groups (P < .01).

DISCUSSION

Although general anesthesia is preferred in many centers for performing PCNL, but it can be a challenge in some situations, such as PCNL for staghorn calculi or patients with chronic obstructive pulmonary disease or cardiovascular disorders.[1-4,6,7] Because of the possibility of fluid absorption and electrolyte imbalance, especially in staghorn stones and also in morbid obese patients, regional or local anesthesia may be a good alternative for general anesthesia in these patients.[2,5]

In several studies, efficacy of spinal anesthesia in selected cases or critically ill patients who were candidate for PCNL has been addressed.[2,5,8] In a study by Kuzgunbay and colleagues, general versus combined spinal-epidural anesthesia was compared in patients that were candidate for PCNL. There was no significant difference between two groups regarding pre and postoperative variables, such as operation time, irrigation fluids, hemoglobin level, and hospital stay.[7] In this study, there were no significant differences between two groups regarding efficacy of operation and intra-operative complications, which is consistent with other studies.

Although efficacy of operation is not directly related to an-

Table 3. Need to opioid drugs (mg per day) after percutaneous nephrolithotomy in two groups.

Time	General anesthesia	Spinal anesthesia	*t* test	*P*
1st postoperative day	12.4 ± 3.1	7.8 ± 2.3	2.23	.03
2nd postoperative day	13.2 ± 2.1	11.1 ± 2.1	1.87	.06

esthesia, but if suitable anesthetic level can not be achieved in regional anesthesia or operation takes long time, efficacy and success decrease. Regarding postoperative hemoglobin and amount of hemoglobin reduction that is the reflection of bleeding, there was no significant difference between two groups, but minor complications were more in spinal group.

In another study, author and associates evaluated the efficacy and complications of spinal anesthesia in PCNL. The most common reported side effects were hypotension during operation, moderate pain, and headache (5% to 8%) postoperatively that improved with ephedrine injection during operation and postoperative rest and analgesics.[2] The results were similar to this study with respect to mean hospitalization, stone size, efficacy, and complications during and after the surgery. Furthermore, about 5% to 8% of patients had mild hemodynamic instability and hypotension, which is somewhat consistent with the results of the present study showing that 20% of patients developed hypotension during the operation and improved spontaneously or by injection of ephedrine and metoclopramide.

Saied and coworkers investigated efficacy of intrapleural bupivacaine injection combined with meperidine and diazepam in PCNL with spinal anesthesia. In their study, the bupivacaine analgesia had a quite painless course in the postoperative period, and a lower dose of analgesic medication was needed.[9]

In our study, the combination of bupivacaine and fentanyl was used for induction of spinal anesthesia in all the patients with appropriate established analgesia. Less narcotic and analgesic drugs were needed on the day of surgery compared with the group that was operated under general anesthesia, and the difference was clinically and statistically significant, but on the 2nd day, this difference was not significant.

Regarding dose of narcotic drugs after surgery and postoperative complications, this study is similar to Andreoni and colleagues' study that evaluated effect of single dose of subarachnoid morphine injection in 20 patients who were candidate for PCNL.[10] In the present study, need for opioid drug in spinal anesthesia was significantly less than the second group on the 1st postoperative day, which is similar to the first group of Andreoni's study. This finding may be due to the effects of analgesic and sedative drugs which were used in spinal anesthesia.

Regarding efficacy and safety of low dose fentanyl and bupivacaine, our results were similar to Singh and associates' study showing that regional anesthesia with low dose fentanyl and bupivacaine could be a good alternative for general anesthesia in PCNL.[11]

In another study, the cost of regional anesthesia was compared with general anesthesia in patients with orthopedic problems and trauma, and was found to be between 5% and 19% according to time of operation.[12] Gonano and associates found that cost of spinal anesthesia was about 40% less than general anesthesia in orthopedic surgeries.[13] Although our patients were different from these studies, our results were similar to them.

Despite general opinion that spinal anesthesia is not suitable for PCNL procedure of staghorn stones and stones in the upper pole of the kidney, our study results denote that this approach is efficient and tolerated well by patients, and also provides a good operation scope for access to all parts of the kidney. Furthermore, this approach was without any complications, such as pulmonary, neurologic, and vascular problems, which were accompanied by general anesthesia.

CONCLUSION

This study showed that success rate of PCNL and ability to remove the kidney stones in both spinal and general anesthesia were similar, but according to the cost of consumable materials for anesthesia, significant differences were seen between spinal and general anesthesia. Therefore, spinal anesthesia is a safe and low-risk technique with suitable efficacy and cost in comparison with general anesthesia for PCNL operation in adult patients with kidney and upper

ureteral stones.

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CONFLICT OF INTEREST

None declared.

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