**Original Research Article**

# General versus spinal anesthesia in percutaneous nephrolithotomy: A comparative study

**Monika Meena[1*], Kiwi Mantan[2], Madhu Saxena[3], Sonali Dhawan[4], Sangeeta Sethia[5], Anju Meena[6]**

[1]Senior Resident, [2]Assistant Professor, [3]Senior Professor, [4]Associate Professor, [5]Medical Officer, [6]Senior Resident
Department of Anaesthesiology, Sardar Patel Medical College and attached group of Hospitals, Bikaner, Rajasthan, India
[*]Corresponding author email:**dr.87monika@gmail.com**

International Archives of Integrated Medicine, Vol. 4, Issue 9, September, 2017.

**Available online at http://iaimjournal.com/**
**ISSN: 2394-0026 (P)ISSN: 2394-0034 (O)**
**Received on:** 03-06-2017 **Accepted on:** 29-06-2017
**Source of support:** Nil **Conflict of interest:** None declared.
**How to cite this article:** Meena M, Mantan K, Saxena M, Dhawan S, Sethia S, Meena A. General versus spinal anesthesia in percutaneous nephrolithotomy: A comparative study. IAIM, 2017; 4(9): 59-66.

## Abstract

**Background:** Percutaneous nephrolithotomy (PCNL) is usually done under general anesthesia (GA). However, it can be done under spinal anesthesia (SA) which can have advantages like less bleeding, less postoperative pain, low dose analgesic requirement and less drug intake.

**Aim:** In our study, we had compared the efficacy and safety of general versus Spinal Anaesthesia in PCNL.

**Materials and methods:** In prospective randomized study, 100 patients undergoing PCNL were randomly assigned into two groups; group A (n = 50) underwent PCNL under GA, by injecting thiopentone, succinylcholine and vecuronium and group B (n = 50) received SA, by injecting bupivacaine and fentanyl in spinal space L4 in sitting position. Thereafter, a urethral catheter was placed in lithotomy position, head of the table was tilted down for 5 to 10 minutes, and the level of anesthesia was checked. Then, PCNL was done by standard technique.

**Results:** Hemodynamic stability was more in SA group. Heart rate and mean arterial pressure intraoperatively at 5, 10, 15 mins and at 60 mins and postoperatively at 0, 2 and 6 hours was significantly less in SA group ($P < 0.05$) as compared to GA group. The VAS score was 5.29±0.62 in GA group and 0.98±0.89 in SA group at 0 hour, 5.58±0.49 in GA group and 1.88±0.84 in SA group at 2 hours and 4.26±1.30 in GA group and 2.10±1.02 in SA group at 6 hours which was significantly

lower in SA group in comparison with GA group ($P < 0.05$). Mean analgesic requirement within 24 hours was lower in SA group (76±36.05) than GA group (140±28.57) and it was statistically highly significant (p<0.001). Postoperative nausea and vomiting was more in GA group than SA group.
**Conclusion:** Spinal anaesthesia is a safe alternative to GA for PCNL with better pain relief, less analgesic requirement, less side effects.

## Key words

Percutaneous Nephrolithotomy, Spinal Anesthesia, General Anesthesia.

## Introduction

PCNL is a minimally invasive therapy for treatment of upper ureteral and renal stones [1-3]. It is the treatment of choice for kidney stones larger than 20 to 30 mms, staghorn stones and stones that are multiple or resistant to ESWL [4].

In most cases PCNL is performed under GA. The particular advantages of GA in PCNL procedure include its feasibility to control tidal volume, secure patient airway especially in prone position, and extensibility of anaesthesia time. The feasibility to control tidal volume minimizes renal mobility secondary to respiration while extensibility of anaesthesia time allow surgeon to create multiple punctures with subsequent increased efficacy of the procedure especially in cases with large stones burden. Moreover, GA is more comfortable for the patients and the ability to carry out prolonged operation in prone position without limitation of airway is another advantage [5, 6].

Complications of GA occur especially when patients position is changed from supine to prone. The most common complications are injury to lung, brachial plexus, tongue, displacement of endotracheal tube and occasionally the spinal cord injury [1, 4]. It may also be associated with atelectasis, drug reactions, nausea and vomiting [7, 8]. In recent years, RA is preferred over GA due to its advantages including less postoperative pain, low dose analgesic requirement and less drug intake, low cost shortened surgery as well as anaesthesia time, prevention from multiple drug allergies or side effects resulting from GA, complications and costs of GA are higher than SA [7].

Due to high cost and rate of complications in patients undergoing PCNL under GA it is planned to compare them with those undergoing the same procedure under SA.

## Materials and methods

After taking permission from institutional ethical committee, the study was conducted as hospital based Controlled, Prospective, Randomized Study.

The patients (n=100) of either gender between the age group of 20 to 60 years belonging to ASA grade grade I and II undergoing elective PCNL procedure were randomly selected and allocated into two groups of 50 patients each by CHIT IN BOX method. Patient with known allergy to the drugs used in the study, with significant cardiac, respiratory, hepatic or renal dysfunction, with anticipated difficult airway, with spinal deformity, local infection at injection site and with renal anomalies were excluded.

Pre-anesthetic checkup was performed on the day before the surgery and included a complete history of the patient, any known drug allergy, general and systemic examination and local examination of the lumbar spine area. Pulse rate, non-invasive blood pressure (NIBP), respiratory rate and SPO2 were recorded. Routine investigations were carried out in all the patients. Written informed consent was obtained from all the patients after proper explanation about the study protocol and the procedure. The visual analog scale (VAS) was explained to the patients.

All patients were kept nil per orally 8 hour before surgery.

Patients shifted to the operating room and an intravenous line was secured and Ringer's lactate was started @10-20 ml/kg. Multipara monitor was connected and baseline heart rate, blood pressure and oxygen saturation were recorded and monitored throughout the procedure.

**In SA Group** patients received Spinal Anaesthesia by injecting 3-4ml of heavy bupivacaine 0.5% with 25µgm fentanyl at $L_3$-$L_4$ intervertebral space in sitting position using 25 gauge spinal needle. Head of the bed was tilted down for 5-10 min while checking the level of anaesthesia. Sensory blockade was evaluated by a pointed cotton wisp (for heat perception) or a needle (for touch sensation) every 15-20 seconds; then motor blockade was assessed by Bromage scale.

**In GA Group** patients received General Anaesthesia. All patients were pre-medicated with Inj. glycopyrolate 0.2 mg i.v. + Inj. Fentanyl 1µg/kg i.v., 15 minutes before induction of anaesthesia.All patients were pre oxygenated with 100% oxygen for 3 minutes. Patients were induced with Inj. Thiopentone 3-5 mg/kg followed by Inj. Succinylcholine 1-1.5 mg/kg. Patient ventilated with bains circuit and intubation was performed with appropriate sized endotracheal tube

After completion of surgical procedure reversal of neuromuscular blockade was achieved with Inj. Neostigmine (40 µg/kg) and Inj. Glycopyrolate (4µg/kg) and extubation was done when full motor power as shown by sustained head lift for 5 seconds, regular spontaneous respiration and cough reflex was present.

Following induction of anesthesia, patients were placed in the lithotomy position. A ureteral catheter (5–6 F) was inserted into the renal pelvis by the urologist, and the patients were subsequently changed to the prone position.

All patients in both the groups were monitored with non-invasive multiparameter monitor in terms of heart rate, MAP, oxygen saturation intraoperatively, every five minutes for first thirty minutes, every fifteen minutes for the next thirty minutes and every thirty minutes thereafter.

Patients were observed for 24 hrs in PACU(post anaesthesia care unit) for pain with VAS scoring which is a 10 cm horizontal line labeled as “No pain” at one end (0) and “Worst pain” imaginable on the other end (10). Patients were asked to mark on the line where the pain lies. 100 mg of tramadol was intravenously administered when patients had a VAS score more than 4.

Patients were also observed for any postoperative complications like nausea, vomiting, hypotension, bradycardia, back pain and postural headache. The complications were treated with appropriate measures.

**Statistical analysis**

All the data obtained were analysed using student t test and SPSS version 10 software used.

## Results

The present study was conducted on ASA I-II patients undergoing PCNL to see for the efficacy of performing the same under Spinal anaesthesia. 100 patients were randomly allocated into two groups: Group GA and Group SA.

The two groups were comparable with respect to age, weight, ASA grade.

There were no statistically significant differences in SpO2 at different time periods between the two groups.

Above table shows that at 5, 10, 15 and 60 minutes interval the mean pulse rate in GA group statistically significant from SA group (p value<0.05) whereas at 20, 25, 30 and 45 minutes, no statistically significant difference were observed between two groups (p value>0.05) as per **Table - 1**.

There was statistically significant difference in pulse rate at baseline, 2 hours and 6 hours post operatively ($p<0.05$) but later on the statistical association was observed to be insignificant (**Table – 2**).

When MAP was compared between the two groups, statistically significant differences were observed ($p<0.05$) at 5, 10, 15, and then at 60 minutes respectively, whereas at 20, 25, 30 and 45 minutes, no statistically significant difference was observed (p value>0.05) as per **Table - 3**.

**Table – 1:**Comparison of intraoperative pulse rate in group GA and SA.

| Time Intervals (min) | Group GA | | Group SA | | T | P |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | | |
| 0 | 88.08 | 10.92 | 88.10 | 6.71 | 0.011 | 0.991 |
| 5 | 100.40 | 9.12 | 90.20 | 6.17 | 6.547 | <0.001 |
| 10 | 88.48 | 4.99 | 92.24 | 5.80 | 3.469 | 0.001 |
| 15 | 86.72 | 4.69 | 90.26 | 6.47 | 4.897 | <0.001 |
| 20 | 86.24 | 6.12 | 84.16 | 7.49 | 1.519 | 0.132 |
| 25 | 84.34 | 5.06 | 83.94 | 9.94 | 0.253 | 0.800 |
| 30 | 87.30 | 7.95 | 85.26 | 9.13 | 1.160 | 0.249 |
| 45 | 90.22 | 12.62 | 87.17 | 9.29 | 1.273 | 0.206 |
| 60 | 94.47 | 4.37 | 86.45 | 6.89 | 5.521 | <0.001 |

**Table - 2:** Comparison of postoperative pulse rate in group GA and SA.

| Time Intervals (Hours) | Group GA | | Group SA | | T | P |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | | |
| 0 | 96.92 | 8.81 | 84.62 | 7.89 | 7.351 | <0.001 |
| 2 | 93.68 | 11.47 | 87.66 | 6.98 | 3.168 | 0.002 |
| 6 | 88.68 | 3.75 | 86.26 | 5.13 | 2.603 | 0.011 |
| 12 | 90.54 | 3.82 | 88.54 | 6.12 | 1.959 | 0.053 |
| 18 | 90.72 | 5.03 | 88.16 | 9.06 | 1.745 | 0.084 |
| 24 | 90.54 | 4.12 | 88.00 | 8.34 | 1.929 | 0.057 |

**Table – 3:** Comparison of intraoperative mean arterial pressure.

| Time Intervals (min) | Group GA | | Group SA | | T | P |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | | |
| 0 | 100.27 | 5.97 | 99.62 | 9.49 | 0.388 | 0.699 |
| 5 | 104.34 | 10.71 | 92.27 | 7.64 | 6.313 | <0.001 |
| 10 | 100.52 | 5.79 | 88.02 | 6.43 | 9.879 | <0.001 |
| 15 | 99.60 | 5.40 | 87.54 | 7.61 | 8.829 | <0.001 |
| 20 | 92.36 | 8.01 | 89.92 | 4.94 | 1.831 | 0.070 |
| 25 | 94.12 | 4.31 | 92.66 | 4.95 | 1.550 | 0.124 |
| 30 | 93.32 | 3.40 | 92.24 | 6.27 | 1.052 | 0.295 |
| 45 | 95.20 | 7.74 | 92.52 | 7.36 | 1.663 | 0.100 |
| 60 | 109.97 | 7.01 | 93.00 | 6.16 | 8.964 | <0.001 |

MAP levels differ significantly at baseline, 2 hours and 6 hours post operatively ($p<0.05$) but later on the statistical difference was observed to be insignificant ($p>0.05$) as per **Table – 4**.

**Table – 4:** Comparison of postoperative mean arterial pressure.

| Time Intervals (Hours) | Group GA | | Group SA | | T | P |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | | |
| 0 | 100.06 | 4.37 | 91.28 | 7.00 | 7.517 | <0.001 |
| 2 | 100.02 | 4.30 | 88.68 | 4.93 | 12.249 | <0.001 |
| 6 | 100.78 | 3.95 | 92.16 | 6.90 | 7.662 | <0.001 |
| 12 | 94.40 | 5.06 | 93.78 | 4.12 | 0.671 | 0.504 |
| 18 | 93.54 | 4.55 | 92.56 | 4.47 | 1.086 | 0.280 |
| 24 | 94.44 | 4.55 | 93.36 | 4.47 | 1.195 | 0.235 |

**Table – 5:** Comparison of post-operative VAS score between patients undergoing PCNL under GA vs SA.

| Time Intervals (Hours) | Group GA | | Group SA | | T | P |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | | |
| 0 | 5.29 | 0.62 | 0.98 | 0.89 | 24.362 | <0.001 |
| 2 | 5.58 | 0.49 | 1.88 | 0.84 | 22.900 | <0.001 |
| 6 | 4.26 | 1.30 | 2.10 | 1.02 | 0.605 | 0.027 |
| 12 | 4.88 | 1.00 | 4.48 | 0.93 | 1.880 | 0.064 |
| 18 | 3.32 | 0.97 | 3.02 | 1.07 | 1.315 | 0.192 |
| 24 | 3.91 | 1.11 | 3.68 | 1.01 | 0.986 | 0.327 |

**Table – 6:** Comparison of post-operative analgesic demand among GA and SA group.

| Analgesia DemandUp to 24 hour (mg) | Group GA | | Group SA | | Total | |
|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % |
| ≤100 | 14 | 28 | 43 | 96 | 57 | 57 |
| >100 | 36 | 72 | 7 | 14 | 43 | 43 |
| Total | 50 | 100 | 50 | 100 | 100 | 100 |
| Mean | 140.00 | | 76.00 | | | |
| SD | 28.57 | | 36.05 | | | |
| T | 9.837 | | | | | |
| P | <0.001 | | | | | |

**Table – 7:**Distribution of cases according to complications in both groups.

| Complications | Group 1 (GA) | | Group 1 (SA) | | Total | | $\chi^2$ | P |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | | |
| Nausea | 13 | 26 | 4 | 10 | 17 | 17 | 5.740 | <0.05 |
| Vomiting | 10 | 20 | 3 | 6 | 13 | 13 | 4.332 | <0.05 |
| Hypotension | 3 | 6 | 7 | 14 | 10 | 10 | 1.777 | >0.05 |
| Bradycardia | 2 | 4 | 4 | 8 | 6 | 6 | 0.709 | >0.05 |
| Low Back Pain | 0 | - | 1 | 2 | 1 | 1 | 1.010 | >0.05 |
| Postural Headache, | 0 | - | 1 | 2 | 1 | 1 | 1.010 | >0.05 |

Difference between the mean VAS score in two groups at baseline, 2 hours and 6 hours post operatively was found to be statistically significant to highly significant ($p<0.05$ to $p<0.001$) as per **Table - 5**.

There was highly significant difference in analgesic requirement between both groups which was less in Group SA as compared to Group GA (p value <0.001) as per **Table - 6**.

There was statistical significant difference (p<0.05) in occurrence of nausea and vomiting between 2 groups and difference between occurrence of hypotension, bradycardia, low back pain, postural headache was found to be statistically insignificant (p>0.05) as per **Table - 7**.

## Discussion

PCNL is a minimally invasive surgery which is an accepted treatment for large renal and upper ureteric calculi. The method of anaesthesia was reported to affect morbidity during PCNL. In most cases, PCNL is usually performed under GA in prone position. Although GA is preferred in many centers, it can be a challenge in some situations, such as patients with COPD. Because of possibilities of fluid absorption and electrolyte imbalance, especially in staghorn stones and morbidly obese patients, RA may be a good alternative to GA in such patients.

Recently PCNL under SA has gained ground overt GA owing to longer, postoperative pain relief, lower dose requirement for analgesic drugs, and avoidance of side-effects from multiple medications during GA and better postoperative quality of life due to earlier recovery.

This study was carried out in 100 adult patients undergoing PCNL, fifty in each group. The main aim of our study was to compare hemodynamic changes, postoperative analgesia & analgesic requirement and side effects in patients undergoing PCNL under GA and SA.

Demographic details of the patients between the two groups were comparable.

Hemodynamic changes during PCNL can be due to various factors such as type of anaesthesia (GA/CSE), positioning, fluid absorption, co-morbidity of the patient and blood loss.

In our study, while comparing effect of anaesthesia mode on Pulse Rate, SBP, DBP, and MAP intraoperatively at 5, 10, 15, and then at 60 minutes respectively and postoperatively at baseline, 2 hrs & 6hrs postoperatively statistically significant differences were observed between mean values of GA and SA groups (p<0.05). Intraoperative and Postoperative mean value Spo2 was found to be statistically insignificant (p value>0.05).

Similar to our results Elbealy, et al. [9] also found that the MAP was significantly lower in the RA group compared with GA group from 15 to 90 min after anaesthesia (p < 0.05)

Moawad and Hefnawy [10] also reported that intra-operative HR and MAP, had less mean values in spinal group as compared to GA group till 1.5 hour after beginning of the procedure.

Contrary to our results Movasseghi, et al. [11] found no significant differences in SBP, DBP, MAP, and heart rate (HR) during surgery and recovery, between the spinal anaesthesia (SA) and GA groups, but reported that patients in SA group had more stable hemodynamics.

**Visual Analogue score**

Lower VAS value in Spinal group is due to residual analgesic effect of local anesthetic and fentanyl in subarachnoid space and decrease in discomfort due to absence of a tracheal tube and avoidance of problems associated with general anesthesia. In our study the VAS score had lower mean values in SA group when compared with GA group, also the differences between the mean VAS score in two groups postoperatively at 0 hour (GA group 5.29±0.62 and SA group 0.98±0.89), 2 hours (GA group 5.58±0.49 and SA group 1.88±0.84) and 6 hours (GA group 4.26±1.30 and SA group2.10±1.02) was found to be statistically significant to highly significant (p<0.05 to p<0.001).

Similar to our studyKarasu, et al. [12] assessed postoperative analgesic requirement using the Visual Analog Score (VAS) and found that patients with VAS >3 were given 75 mg diclofenac sodium for analgesia. When the number of patients who needed analgesic within the 1st postoperative hour was considered, it was significantly higher in Group G (n=43) compared to Group R (n=12) ($p<0.05$).

Singh, et al. [13] while comparing CSEA with GA in patients undergoing PCNL, also observed that the mean VAS score and analgesic use were significantly less in the CSEA group. The length of hospitalization was also significantly less in the CSEA group.

Tanuj Kumawat [14] also observed in their study thatin group EA, a statistically significant reduced VAS score was found at 1, 3 and 6 hours postoperatively compared with group GA.

**Postoperative analgesic demand**

In our study mean analgesic requirement within 24 hrs was lower in SA group (76±36.05) than GA group (140± 28.57) and it was statistically highly significant ($p<0.001$).

Similar to our study Similar to our study Cicek, et al. [15] also reported that postoperative narcotic analgesics were administered to 61.3% of patients in GA group and 39.7% of patients in SA group, and the difference between the groups was statistically significant ($p<0.05$).

Mehrabi, et al. [16] also found that less narcotic and analgesic drugs were needed on the day of surgery in SA group compared with the GA group and the difference was clinically and statistically significant.

Tangpaitoon, et al. [17] also found that postoperative tramadol consumption was statistically significantly lower in the EA group (53.8 mg) as compared to the GA group (111.5 mg) .

**Intraoperative and postoperative complications**

In our study we observed that there was a statistically significant difference in postoperative nausea and vomiting in both groups, which was less in SA group than GA group.

Similar to our study Tangpaitoon, et al. [17]; Karacalar Serap, et al. [18] also found increase in incidence of PONV in GA group as compared to RA.

Movasseghi, et al. [12] also reported that PCNL surgery under SA results in lower blood loss, and lesser side effects (such as nausea, vomiting, and post-op pain).

## Conclusion

From our study, we can conclude that spinal anesthesia is adequate, safe, equally effective alternative to GA during PCNL with reduced morbidity in terms of less postoperative pain, less analgesic requirements, less nausea/ vomiting, early postoperative recovery and overall higher patient satisfaction.

## References

1. Mehrabi S, Karimzadeh Shirazi K. Results and complications of spinal anesthesia in percutaneous nephrolithotomy. Urol J., 2010; 7: 22-25.
2. Stoller ML, Wolf JS Jr, St Lezin MA. Estimated blood loss and transfusion rates associated with percutaneous nephrolithotomy. J Urol., 1994; 152: 1977-81.
3. Trivedi NS, Robalino J, Shevde K. Interpleural block: a new technique for regional anaesthesia during percutaneous nephrostomy and nephrolithotomy. Can J Anaesth., 1990; 37: 479-81.
4. Aravantinos E, Karatzas A, Gravas S, Tzortzis V, Melekos M. Feasibility of percutaneosu nephrolithotomy under assisted local anaesthesia: a prospective study on selected patients with upper

urinary tract obstruction. Eur Urol., 2007; 51: 224-7.

5. Prakash R, Kushwaha BB, Shashibhushan, Bhatia VK. Chandra G, Singh BP. A comparative study of bupivacaine 0.25% alone and with fentanyl or dexmetomidine for percutaneous nephrolithotomy (PCNL) under epidural anaesthesia. Ind J Sci res., 2014; 5(1): 39-46.
6. Attari MA, Mirhosseini SA, Honarmand A, Safavi MR. Spinal anesthesia versus general anaesthesia for elective lumbar spinal surgery: a randomized clinical trial. J res Med Sci., 2011; 16(4): 524-9.
7. Kuzgunbay B, Turunc T, Akin S, Ergenoglu P, Aribogan A, Ozkardes H. percutaneous nephrolithotomy under general versus compblind spinal epidural anesthesia. J Endourol., 2009; 23(11); 1835-8.
8. Karacalar S, Bilen CY, Sarihasan B, Sarikaya S. Spinal epidural anesthesia versus general anaesthesia in the management of percutaneous nephrolithotripsy. J Endourol., 2009; 23(10): 1591-7.
9. Elbealy ME, Rashwan MD, Kasim MS, Abbas MS. A comparison of the effects of epidural anaesthesia, lumbar paravartebral block and general anaesthesia in percutaneous nephrolithotomy. J Med Sci., 2008; 8(2): 170-6. 11.
10. Moawad HE, El Hefnaxy AS. Spinal vs general anaesthesia for percutaneous nephrolithotomy: A prospective randomized trial Egyptian J Anaesth., 2015; 31: 71-75.
11. .Movasseghi G, Hassani V, Mohabgegh MR. Comparison between Spinal and General Anesthesia in Percutaneous Nephrolithotomy. Anesth Pain Med., 2013; 3(3): e13871.
12. Karasu D, Yilmaz C, Oner S, Karaduman I, Ozgunay SE et al., Retrospective analysis of two different anesthetic methods in percutaneous nephrolithotripsy. J Urol Res., 2015; 2(2): 1026.
13. 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. Urologia Internationalis, 2011; 87(3): 293–298.
14. Kumawat T, Kothari V, Priyadarshi S, Mistry T, Morwal S. A randomized study comparing the efficacy and safety of epidural anesthesia versus general anesthesia in patients undergoing percutaneous nephrolithotomy. Ain-Shams J Anaesthesiology, 2016; 9: 353-357.
15. Cicek T, Gonulalan U, Dogan R, Kosan M, Istanbulluoglu O, Gonen M, Ozturk B, Ozkardes H. Spinal anesthesia is an efficient and safe anesthetic method for percutaneous nephrolithotomy. Urology, 2014; 83(1): 50-55.
16. Mehrabi S, Zadeh AM, Toori MA, Mehrabi F. General versus spinal anesthesia in eprcutaneous nephrolithotomy. Endourology Stone Disease, 2012; 756-761.
17. Tangpaitoon T, Nisoog C, Lojanapiwat B. Efficacy and safety of percutaneous nephrolithotomy (PCNL): a prospective and randomized study comparing regional epidural anesthesia with general anesthesia. International Brazilian Journal of Urology, 2012; 38(4): 504–511.
18. Karacalar S, Bilen CY, Sarihasan B, Sarikaya S. Spinal epidural anesthesia versus general anaesthesia in the management of percutaneous nephrolithotripsy. J Endourol., 2009; 23(10): 1591-7.