Comparative evaluation of ropivacaine and levobupivacaine for postoperative analgesia after ultrasound-guided paravertebral block in patients undergoing percutaneous nephrolithotomy

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Abstract

**Background and Aims:** Percutaneous nephrolithotomy (PCNL), although a minimally invasive procedure, is associated with substantial postoperative pain that is often underestimated. The present study was undertaken to ascertain the relative analgesic efficacy of levobupivacaine (LB) and ropivacaine (RB) when administered in ultrasound-guided paravertebral block (PVB) in patients scheduled to undergo PCNL.

**Material and Methods:** After obtaining the Institutional Ethics Committee approval and written informed consent, 30 patients aged between 18 and 65 years of either sex, with American Society of Anesthesiologist status I/II and body mass index >18.5 to <25, scheduled to undergo PCNL were enrolled for the study. The patients were randomized to receive single shot of 20 ml of either ropivacaine (0.2%) or levobupivacaine (0.2%) in ultrasound-guided PVB using an in-plane technique.

**Results:** The demographic and the preoperative hemodynamic and respiratory parameters were comparable in both the groups. The postoperative hemodynamic variables, respiratory parameters, and pain scores were also comparable in both the groups. Although the time to first analgesic requirement was more in LB group (1.60 ± 3.64 h) as compared to RB group (0.33 ± 1.04 h), it was statistically nonsignificant. No complications attributable to either the procedure or usage of drugs were noted in any group during the entire postoperative period.

**Conclusions:** We conclude that single-shot ultrasound-guided ipsilateral PVB at the end of the surgical procedure provides adequate and effective analgesia in the postoperative period with either of the local anesthetic. Use of ultrasound provides real-time imaging of the anatomical structures and avoids potential complications of the block.

**Keywords:** Levobupivacaine, paravertebral block, percutaneous nephrolithotomy, ropivacaine, ultrasound-guided

Introduction

Percutaneous nephrolithotomy (PCNL) surgeries have by and large replaced open procedures owing to considerable advantages that include improved patient outcomes, reduced morbidity, and hospital stay. However, substantial postoperative pain, which usually arise as a result of insertion of nephrostomy tube and puncture as well as dilatation of the renal capsule, may be experienced in patients undergoing PCNL that is often underestimated. While provision of adequate and effective postoperative analgesia is a prerequisite for accelerated convalescence, it also leads to reduction in postoperative stress response and morbidity, thereby improving the surgical outcome as well as facilitating rehabilitation at the same time.

Paravertebral nerve block (PVB) has been used for providing postoperative analgesia in various surgical procedures, viz.,

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How to cite this article: Saroa R, Palta S, Puri S, Kaur R, Bhalla V, Goel A. Comparative evaluation of ropivacaine and levobupivacaine for postoperative analgesia after ultrasound-guided paravertebral block in patients undergoing percutaneous nephrolithotomy. J Anaesthesiol Clin Pharmacol 2018;34:347-51.
thoracic and abdominal surgeries, ventral hernia repair, breast augmentation and reductional mammoplasty, inguinal herniorrhaphy, laparoscopic cholecystectomy, thoracotomy, nephrectomy, myofascial chronic postoperative thoracic pain, and vascular surgeries.\(^{(3)}\) PVB provides effective analgesia subsequent to local anesthetic administration in the vicinity of spinal nerves emerging from the intervertebral foramina and traveling into the paravertebral space.\(^{(4)}\) Performance of this block under ultrasound guidance augments the ability to visualize the sliding pleura and anatomical structures around the paravertebral space and enables real-time conduct of the block while enhancing the safety and reducing the complications at the same time.

Various local anesthetics have been used in varying concentrations to provide effective postoperative analgesia when administered as single shot in paravertebral space after PCNL surgeries to ascertain the analgesic adequacy of the block.\(^{(5)}\) Ropivacaine (RB) and levobupivacaine (LB) are enantiomers of bupivacaine that have been compared extensively when administered in neuraxial blocks or other peripheral nerve blocks.\(^{(6-8)}\) The present study was undertaken to ascertain the relative anesthetic efficacy of these two local anesthetic agents in patients scheduled to undergo PCNL receiving ultrasound-guided PVB.

**Material and Methods**

After obtaining the Institutional Ethics Committee approval and written informed consent, 30 patients aged between 18 and 65 years of either sex, with American Society of Anesthesiologists physical status I/II and body mass index >18.5 to <25, scheduled to undergo PCNL were enrolled for the study. Patients with any history of drug allergy, psychiatric illness, substance abuse, severe comorbid conditions pertaining to cardiovascular, respiratory, neurological or metabolic system, pregnancy, sepsis, severe coagulopathy, complex stones with anticipated access points >2, receiving chronic opioid therapy, back or musculoskeletal deformity, and fibromyalgia were excluded from the study. The patients were randomized using coded sealed envelopes to receive single shot of 20 ml of either ropivacaine (0.2%) or levobupivacaine (0.2%) in PVB.

Sample size calculations were based on the mean time to first postoperative analgesic requirement. Considering a mean difference of 120 min with standard deviation (SD) of 70, the sample size was calculated to be 5 per group at a power of 90% with confidence interval of 95%. Total of 15 patients were enrolled in either group to compensate for any dropouts. After thorough preanesthetic checkup and relevant investigations, all patients were explained about linear visual analog score (VAS) for pain and categorical scoring system (CSS) for nausea in the preoperative period. Patients were kept fasting for 8 h and premedicated with tablet ranitidine (150 mg) and alprazolam (0.25 mg) a night prior to surgery and the morning of surgery. All the patients underwent intravenous cannulation for fluid administration and were connected to multichannel monitor (S/5\(^{TM}\) critical care monitor, Datex Ohmeda, Helsinki, Finland) in the operating room for electrocardiogram, noninvasive blood pressure, arterial oxygen saturation (SpO\(_2\)) respiratory rate, and end-tidal carbon dioxide (EtCO\(_2\)) monitoring. Standard general anesthetic technique was used in all patients and maintenance of anesthesia was achieved through administration of inhalational agent isoflurane with N\(_2\)O and O\(_2\) in 60:40 ratio. Because all PCNLs were performed in prone position, unilateral PVB on the side of surgery was performed at T10-11 level postoperatively before making patient supine for extubation. The anesthesiologist performing the block and subsequently the investigator assessing the block were blinded to the coded drug that was injected.

Ensuring complete asepsis, PVB was performed using 5–12 MHz linear array ultrasound transducer probe (Micromaxx\(^{TM}\) Sonosite, Inc., Bothell, WA 98021, USA) after identifying the wedge-shaped paravertebral space in transverse plane. Using an in-plane approach, 20 ml of the local anesthetic as per the group randomization was deposited after negative aspiration through 22 G × 100 mm cannula (Stim Sonoplex, Pajunk, Germany). Thereafter the patient was made supine, extubated after adequate reversal, and transferred to post anesthesia care unit (PACU).

The patients were observed in PACU for heart rate, hemodynamic parameters (systolic and diastolic blood pressure), SpO\(_2\), and respiratory rate at regular intervals of 10 min, 30 min, and 1 h. The patients were transferred to ward if there were no complaints of overt nausea, vomiting (CSS ≤1), and VAS was <4. The patients were assessed in ward at 4, 8, 12, and 24 h for all the parameters, including VAS and CSS. Rescue analgesia was administered to patients with intravenous paracetamol infusion over 30 min (1000 mg) if VAS exceeded 4. Patients experiencing nausea and vomiting (CSS >1) were administered intravenous ondansetron (0.1 mg/kg BW). Total dosages of the analgesics and antiemetics were recorded, calculated, and compared in both the groups at the end of 24 h. In addition, all the patients were monitored for the complications of either the procedure (pneumothorax, accidental epidural) or drugs (bradycardia, hypotension) during the entire postoperative period.
**Statistical analysis**

The statistical analysis was carried out by using Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, version 17.0 for Windows). All quantitative variables were estimated using measures of central location (mean, median) and measures of dispersion (standard deviation). Normality of data was assessed by using measures of Kolmogorov–Smirnov tests of normality. For normally distributed data, means were compared using Student’s t-test for two groups. Qualitative or categorical variables were described as frequencies and proportions. Proportions were compared using Chi-square test or Fisher’s exact test, whichever was applicable. One-way analysis of variance (ANOVA) was applied for within the groups comparison. VAS scores were compared using Mann–Whitney test; for time-related VAS scores Wilcoxon signed rank test was applied. All statistical tests were two-sided and performed at a significance level of $\alpha = 0.05$.

**Results**

All the patients enrolled in either group after the randomization were subject to the statistical analysis with no dropout from the study. The demographic and the preoperative hemodynamic and respiratory parameters were comparable in both the groups, as depicted in Tables 1 and 2. In addition, the postoperative hemodynamic variables, respiratory parameters, and pain scores were also comparable in both the groups. Although the time to first analgesic requirement was more in LB group (1.60 ± 3.64 h) as compared to RB group (0.33 ± 1.04 h), it was statistically nonsignificant ($P > 0.05$) as shown in Table 3. Rescue analgesic was administered in 2 out of 15 patients in RB group (13.33%) as compared to 3 in group LB (20%). The cumulative paracetamol consumption (in grams) was comparable in both groups and was found to be 0.13 ± 0.35 and 0.20 ± 0.41 (mean ± SD) in RB and LB groups, respectively. None of the patient required an antiemetic over 24 h.

No complications attributable to either the procedure (pneumothorax, accidental epidural) or usage of drugs whether intravenous or that used for performing PVB block (bradycardia, hypotension) were noted in any group during the entire postoperative period.

**Discussion**

The present study was undertaken to assess and ascertain the relative analgesic efficacy of ropivacaine and levobupivacaine when administered in PVB for providing postoperative analgesia in patients undergoing PCNL as the postoperative pain is substantial and often underestimated. While multiple modalities have been utilized to provide postoperative analgesia following PCNL, that includes oral or parenteral analgesics, peripheral nerve blocks, neuraxial blocks, intrathecal opioids, adjunctive techniques such as transcutaneous electrical nerve stimulation and physical therapy; all techniques have some inherent disadvantages. The use of PVB involves the deposition of LA around the spinal nerves when they emerge from the intervertebral foramina and has a unique character of eliminating the cortical responses to thoracic dermatomal stimulation even when compared to central neuraxial blocks.

PVB has been used for adequate postoperative analgesia in number of surgical procedures using different local anesthetics in varying concentrations. The effectiveness and advantages of PVB for urological procedures have been demonstrated with the use of local anesthetics in the perioperative and postoperative period. Also both ropivacaine and levobupivacaine have been compared for their analgesic effects in varying concentrations in different blocks, and the results with either of the local anesthetics have been found to be comparable in majority of the studies. Therefore, it was decided to utilize the similar concentration of both the local anesthetics in the present study and to determine whether the effect is different or the same with PVB in patients undergoing PCNL.

The results of this randomized double-blind controlled trial demonstrated that both the local anesthetics, i.e., ropivacaine and levobupivacaine are effective analgesics and comparable in terms of their onset and duration of analgesia when administered in PVB for PCNL.

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**Table 1: Demographic data**

| Parameter                  | Group RB   | Group LB   | $P$  |
|---------------------------|------------|------------|------|
| Age (years) (mean±SD)     | 44.33±11.77| 35.73±11.71| 0.05 |
| Sex (M/F)                 | 10/5       | 8/7        | 0.45 |
| Body weight (kg) (mean±SD)| 67.33±8.64 | 66.93±14.93| 0.92 |

P>0.05, nonsignificant

**Table 2: Preoperative hemodynamics and respiratory parameters**

| Parameter                  | Group RB   | Group LB   | $P$  |
|---------------------------|------------|------------|------|
| Pulse rate (per min)      | 74.47±9.50 | 76.33±5.88 | 0.52 |
| Systolic blood pressure (mmHg) | 122.80±4.39| 124.67±5.10| 0.29 |
| Diastolic blood pressure (mmHg) | 76.93±7.04 | 73.6±6.72  | 0.19 |
| Respiratory rate (breaths/min) | 13.67±1.04 | 14.27±0.79 | 0.08 |
| SpO$_2$ (%)               | 98.80±0.41 | 98.80±0.41 | 1.00 |

**Table 3: Comparison of time of first analgesic requirement**

| Groups       | Time to first analgesic requirement (h) | mean±SD |
|--------------|----------------------------------------|---------|
| Group RB     | 0.33±1.04                              |         |
| Group LB     | 1.60±3.64                              |         |

$P=0.20 (>0.05)$ nonsignificant
and levobupivacaine in the concentration of 0.2% were equally efficacious in providing postoperative pain relief with equivocal cumulative rescue analgesic consumption. Although the time to first analgesia requirement was more in group receiving LB, the overall analgesic consumption was similar in both the groups.

Baik et al. utilized 0.75% ropivacaine in ultrasound-guided PVB for provision of surgical anesthesia in patients undergoing nephrectomy and concluded that preoperative single-thoracic PVB contributes significantly to the reduction of postoperative pain scores and opioid consumption. Considering the fact that PCNL is an endoscopic procedure and relatively less invasive, the block administered at the end of the surgical procedure in the present study with either of the local anesthetic reinforced the utility of this block in patients undergoing PCNL.\[16]\]

The results of the present study are also consistent with that of Ak et al., where postoperative analgesia was provided with the use of levobupivacaine 0.5% in PVB that was administered at multiple levels under fluoroscopic guidance.\[22]\] In the present study, the use of ultrasound allowed the volume of the drug to be precisely deposited at single site rather than at multiple levels. As the PVB space is a continuous space, it has an inherent advantage of cephalad and caudal spread of the drug. It also has a theoretical advantage of lesser procedure-related complications by virtue of the fact that procedure is being performed at single site under direct visualization by the use of ultrasound that delineates the anatomical structures clearly.

The extended analgesic efficacy of the PVB has also been assessed by Borle et al. where the authors concluded that the use of continuous analgesia through PVB results in decreased opioid consumption and better perioperative analgesia as compared to patients receiving no analgesia through the PVB, and thus concluded that unilateral block can be used for the same.\[23]\]

Though we preferred to use intravenous paracetamol as sole rescue analgesic in the present study as compared to opioid analgesics, the overall cumulative analgesic consumption with either of the local anesthetic in both the groups was less and comparable to studies that have used opioids for postoperative analgesia by the use of these local anesthetics in other peripheral blocks.\[16,24,25]\] In addition, by using paracetamol as rescue analgesic, the unwarranted side effects of opioids were also avoided. The rescue analgesic was administered only if VAS exceeded 40. Considering the fact that only 2 patients in RB group and 3 patients in LB group demanded rescue analgesic, the efficacy of the block is self-explanatory. In addition, no episodes of nausea and vomiting or hemodynamic instability in the postoperative period in either group further reinforces the utility of the block.

Although neuraxial blocks are still a preferred mode of postoperative analgesia at many centers but the analgesic efficacy of PVB has been found to be comparable to them. Moreover, many of the studies recommend PVB in thoracic and inguinal surgeries as an alternative to epidural because of a better side effect profile and reduced pulmonary complications.\[5,26]\] Li et al. investigated the feasibility of thoracic PVB for PCNL and observed that thoracic PVB was as effective and safe as epidural blockade for provision of intraoperative as well as postoperative analgesia.\[27]\] In the present study, the block was administered as single shot at the end of the surgical procedure that provided effective analgesia through the postoperative period. Had the block been administered before the start of the procedure with a catheter in situ or the addition of an adjuvant to the local anesthetic been done, it could have probably reduced the analgesic consumption as well as prolonged the duration of analgesia in the perioperative period. However, because standard technique of general anesthesia was followed in both the groups, the intraoperative parameters and analgesic consumption was similar in both the groups.

In conclusion, we observed that in patients undergoing PCNL, single-shot ultrasound-guided ipsilateral PVB at the end of the surgical procedure provides adequate and effective analgesia in the postoperative period. Ultrasound guidance for the performance of PVB has dual advantage of clear delineation of the anatomical structures and deposition of drug precisely wherever it is intended for, while reducing the complication attributed to the block. Both ropivacaine and levobupivacaine are equivocal with respect to the analgesic efficacy, cumulative analgesic consumption, and side effect profile; thus either of the local anesthetic can be used in PVB in patients undergoing PCNL. However, to reflect the efficacy with respect to the duration of analgesia and the use of both local anesthetics needs future prospective studies with a larger sample size.

Limitations
That the pharmacokinetic characteristics of drug were not evaluated constitutes the limitation of this study. The dermatomal or segmental distribution of the spread of the local anesthetic when administered at a single level in PVB was not observed. Mean effective anesthetic volume was not ascertained and the probability of duplication of results with lower volume cannot be ruled out. Also because all the blocks were administered by a single experienced researcher, it is difficult to ascertain whether the results can be replicated by a less experienced person.
Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

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