



Comparison of 0.5% Ropivacaine and 0.5% Levobupivacaine for Sciatic Nerve Block Using Labat Approach in Foot and Ankle Surgery

Ayak ve Ayak Bileği Cerrahisinde Labat Yaklaşımı Kullanılarak Yapılan Siyatik Sinir Bloğu İçin %0,5 Ropivakain ve %0,5 Levobupivakain Kullanımının Karşılaştırılması

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Objective: Compared to ropivacaine, levobupivacaine is more lipophilic and a more potent vasoconstrictor. The study was conducted to compare the effect of 0.5% ropivacaine and 0.5% levobupivacaine in sciatic nerve block using conventional Labat approach in foot and ankle surgery.

Methods: A prospective double-blind, randomised study was carried out in 100 patients of either sex, aged between 20 to 60 years, and American Society of Anesthesiologist (ASA) grades I and II. Patients were randomly allocated into groups R and L of 50 each with 0.5% ropivacaine and 0.5% levobupivacaine, respectively, for sciatic nerve block using the Labat approach. We assessed the onset and duration of sensory and motor block, duration of analgesia, consumption of analgesic, and any untoward effect over 24 hours.

Results: Both the groups were comparable with regard to demographic variables and onset of sensory and motor block ($p>0.05$). Group L compared to group R had significantly longer median (95% confidence interval) duration of sensory block (647.50 min [624.99-674.41] vs. 535 min [524.77-559.83], respectively; $p<0.0001$) as well as motor block (1065.0 min [1054.5-1068.90] and 945 min [947.13-1013.30], respectively; $p<0.0001$). Post-operative analgesia also lasted significantly longer in group L compared to group R (1320 min [1273.4-1321.8] vs. 840 min [759.23-812.77]; $p<0.0001$). Patients in group L had significantly better visual analogue scale (VAS) score and lesser consumption of analgesics ($p<0.0001$). None of the groups developed any adverse effect over the observation period.

Conclusion: Levobupivacaine provides prolonged postoperative analgesia in sciatic nerve block with reduction in postoperative analgesic consumption.

Keywords: Regional, sciatic and femoral nerve block, ropivacaine, levobupivacaine, foot and ankle surgery

Amaç: Ropivakain ile kıyaslandığında levobupivakain daha lipofilik ve daha etkili bir vazokonstriktördür. Bu çalışma, ayak ve ayak bileği cerrahisinde geleneksel Labat yaklaşımı kullanılarak yapılan siyatik sinir bloğu için %0,5 ropivakain ve %0,5 levobupivakain kullanımının etkilerini karşılaştırmak amacıyla yapılmıştır.

Yöntemler: Bu prospektif çift-kör randomize çalışma her iki cinsiyetteki 20-60 yaş aralığında ve ASA (American Society of Anesthesiologist) I-II sınıfı 100 hastada yapılmıştır. Hastalar, Labat yaklaşımı kullanarak siyatik sinir bloğu uygulaması için, hastalar her biri 50 kişiden oluşan R (%0,5 ropivakain) ve L (%0,5 levobupivakain) gruplarına rasgele seçildiler. Duyusal ve motor bloğun başlaması ve süresi, analjezi süresi, analjezik tüketimi ve 24 saat içerisinde ortaya çıkan herhangi istenmeyen etki varlığı değerlendirildi.

Bulgular: Her iki grup demografik değişkenler, duysal ve motor bloğun başlaması açısından benzer bulundu ($p>0,05$). Grup R ile kıyaslandığında Grup L'de medyan (%95 güven aralığı) duysal blok (sırasıyla 647,50 dk [624,99-674,41] ve 535 dk [524,77-559,83]; $p<0,0001$) ve motor blok (sırasıyla 1065,0 dk [1054,5-1068,90] ve 945 dk [947,13-1013,30]; $p<0,0001$) süreleri anlamlı ölçüde daha uzundu. Ayrıca, postoperatif analjezi süresi Grup L'de Grup R'ye göre anlamlı derecede daha uzundu (1320 dk [1273,4-1321,8] ve 840 dk [759,23-812,77]; $p<0,0001$). Grup L'deki hastalarda vizüel analog skala (VAS) skoru anlamlı ölçüde daha iyi saptandı ve daha az analjezik tüketimi gözlemlendi ($p<0,0001$). Hiçbir grupta gözlem süresince herhangi bir olumsuz etki gelişmedi.

Sonuç: Levobupivakain, postoperatif analjezik tüketiminde azalma sağlayarak siyatik sinir bloğunda uzun süreli postoperatif analjezi sağlamaktadır.

Anahtar sözcükler: Rejyonal, siyatik ve femoral sinir bloğu, ropivakain, levobupivakain, ayak ve ayak bileği cerrahisi

Introduction

Regional anaesthesia (RA) of peripheral nerve trunks and plexuses has become increasingly popular for lower limb procedures. It improves the quality of postoperative analgesia as well as patient outcome and decreases complications especially in high-risk and elderly patients (1, 2). This analgesia method is considered the safest with regard to the development of complications typical for endotracheal intubation and neuraxial block (3). Postoperative pain after foot and ankle surgery can be severe and difficult to control with oral analgesics. Femoral and sciatic nerve blocks with long-acting local anaesthetic (LA) agents provide postoperative analgesia for longer duration, particularly when a high tourniquet is used. Bupivacaine has been frequently used previously for this purpose; however, due to its potential cardio toxicity after accidental intravascular (IV) administration. Ropivacaine and levobupivacaine, the newer long-acting LA agents and S (-) isomers with a favourable safety profile, were introduced into clinical practice (4). It has been recently demonstrated that levobupivacaine contributes a different clinical profile because of its high lipophilic and vasoconstrictor properties compared to ropivacaine (5). Previous studies of peripheral nerve blocks (PNBs) with levobupivacaine have suggested that the duration of analgesia of levobupivacaine might be longer than that of an equivalent dose of bupivacaine or ropivacaine (6-11).

In this study, we compared the duration and quality of postoperative analgesia for foot and ankle surgery produced by equal concentration and volume of levobupivacaine and ropivacaine in combined sciatic and femoral nerve block.

Methods

This prospective, randomised, double-blind study was conducted at the Dr. S. N. Medical College, Jodhpur, India, after approval of institutional ethical committee (F.1/Acad/MC/JU/15-9355). One-hundred patients belonging to American Society of Anesthesiologist (ASA) grades I and II, aged between 20 and 60 years, and scheduled to undergo elective foot and ankle surgery were included. Patients provided informed consent. The opaque envelope method was used to randomly divide all the patients into two groups: group R and group L of 50 each. The groups received either 20 mL of 0.5% ropivacaine or 20 mL of 0.5% levobupivacaine, respectively.

Patients who had infection at the injection site, pregnancy, obesity [body mass index (BMI) $>30 \text{ kg m}^{-2}$], bleeding disorders and peripheral neuropathy or neurological deficit were excluded. The routine monitoring including continuous electrocardiography (ECG), non-invasive blood pressure (NIBP), and plethysmography for peripheral oxygen saturation (SpO_2) was applied and baseline vital parameters were recorded. IV access was secured with an 18 gauge cannula and a crystalloid solution ($5 \text{ mL kg}^{-1} \text{ hr}^{-1}$) was started. All patients received IV midazolam 1 mg 10 min prior to

block. All blocks (sciatic and femoral) were performed by an anaesthesiologist with substantial expertise in both regional techniques by using nerve stimulator (Stimuplex®, B. Braun). The initial stimulation frequency and intensity of the stimulating current was set at 2 Hz, and 1 mA, respectively, and was decreased gradually to $\leq 0.3 \text{ mA}$ after achieving an appropriate muscle response. After the standard skin preparation, 20 mL of 0.5% ropivacaine was used for femoral nerve block in all patients regardless of whether or not tourniquet was required, before sciatic nerve block.

After standard skin preparation, landmarks for the classic Labat approach for sciatic nerve block were drawn according to the technique described by Labet G (12). A 15° beveled 100 mm Teflon-coated needle (Stimuplex®, B. Braun) was introduced in a slightly lateral postero-anterior direction until twitching was noted in the foot muscles. The plantar flexion and inversion of foot and dorsal flexion and eversion of foot, corresponding to the tibial nerve and to the common peroneal nerve, respectively, with a stimulating current of $\leq 0.3 \text{ mA}$ suggest appropriate positioning of needle. When subsequent injection of 1 mL of the anaesthetic solution stopped the twitching, the location of the nerve was considered correct and 20 mL of 0.5% levobupivacaine or ropivacaine was injected with repeated aspiration.

The progression of sensory block was assessed using a 22-gauge hypodermic needle and compared with the another leg every 5 minutes after completion of injection until complete loss to pin prick sensation and then every 2 hours in the postoperative period until complete recovery. The grading of pin prick test was conducted according to scores 0, 1, and 2, as normal sensation, blunted sensation (analgesia), and absence of sensation (anaesthesia), respectively. The onset of sensory block was considered from the end of LA injection to the complete loss of sensation to pin prick, and the duration of sensory block was considered from onset of sensory block to reappearance of pinprick sensation in the sciatic nerve distribution.

The Modified Bromage scale (MBS; Table 1) was used every 5 minutes after completion of injection until inability of patient to move the ankle and toes of the operating limb (score 3) to assess motor power in the postoperative period every 2 hours until complete recovery (13).

Table 1. Modified Bromage scale

Score	Criteria
0	The patient is able to move hip, knee, and ankle
1	Patient is unable to move hip but able to move knee and ankle
2	Patient is unable to move hip and knee but able to move ankle
3	Patient is unable to move hip, knee, and ankle

Table 2. Demographic variables in groups R and L

Variables	Group R (n=50)	Group L (n=50)	p
Age (years), mean±SD	37.96±13.92	38.54±14.04	>0.9
Sex (M/F)	40/10	38/12	0.809
ASA- PS (I/II)	44/6	46/4	0.739
Height (cm), mean±SD	161.86±3.72	161.96±4.16	0.899
Weight (kg), mean±SD	61.08±4.16	59.90±4.04	0.153
Duration of surgery (min), mean±SD	47.90±8.08	49.30±6.22	0.414
SD: standard deviation; M: male; F: female; ASA-PS: American Society of Anaesthesiologist- Physical status; R: ropivacaine; L: levobupivacaine			

Table 3. Characteristics of block in both groups

Variables	Group R	Group L	p
Onset of sensory block (min), mean±SD	15.50±11.26	18.30±9.92	0.707
Onset of motor block (min), mean±SD	25.30±12.18	29.80±10.59	0.102
Duration of sensory block (min), median (95% CI)	647.50 (624.99–674.41)	1065.0 (1054.5–1068.90)	<0.0001
Duration of motor block (min), median (95% CI)	535 (524.77–559.83)	945 (947.13–1013.3)	<0.0001
Duration of analgesia (min), median (95% CI)	840 (759.23–812.77)	1320 (1273.4–1321.8)	<0.0001
SD: standard deviation; CI: confidence interval			

Table 4. Number of Rescue Analgesic doses consumed during observation period

No of rescue	Group R (n=50)	Group L (n=50)
1	00 (0%)	50 (100%)
2	47 (94%)	00 (0%)
3	03 (6%)	00 (0%)
Mean±SD	2.06±0.23	1.00±00

The onset of motor block was defined as the time interval between the end of LA injection to the inability of patient to move the ankle and toes of the operating limb (MBS score

3). Duration of motor block was defined as time interval between onset of motor block to the recovery of ankle and toe motion of the operating limb (MBS score 0).

The block was considered successful, delayed, incomplete, and failure if the sensory block in both the tibial and the common peroneal nerve distribution was achieved within the first 30 min, within 30–45 min of the performance, if analgesic supplement was required to complete surgery, and if there was an absence of anaesthesia in either of sensory distributions of the sciatic nerve 45 min after injection, respectively. The surgery in a patient with incomplete block was accomplished with additional local infiltration of lidocaine by the surgeon and IV fentanyl, and in patients with block failure, a standard general anaesthesia was given using laryngeal mask airway. These patients were not included in the study. The visual analogue scale (VAS) score was used to assess postoperative pain every 2 hour after completion of surgery (14). The rescue analgesic dose with IV injection tramadol 100 mg was administered by the nursing staff whenever patient demanded or VAS score of ≥ 3 was recorded any time during the observation period of 24 hours.

The duration of analgesia was considered from the time of completion of LA injection to the requirement of first rescue analgesia to patient. Any side effect in the perioperative period, such as nausea, vomiting, and haemodynamic changes, were recorded. For sample size calculation, according to previous studies (15), the analgesic duration achieved by equal volume of 0.5% levobupivacaine would be 20% longer than that with 0.5% ropivacaine with a standard deviation (SD) of 25 min. The minimum sample size calculated was 34 patients per group for a power of 90% with a 2-tailed significance level of 5% ($\beta=0.1$ and $\alpha=0.05$). We enrolled a total of 50 patients in each group to reduce the risk of β error that occurred in previous studies because of small sample size (7, 16).

Statistical analysis

The statistical analysis was performed using the Statistical Package for Social Sciences (IBM SPSS statistics for windows, Armonk, NY, USA) version 20.0. Normally distributed continuous variables were presented as mean±SD and analysed using unpaired Student t'test, while abnormally distributed data were presented as median (95% CI). For categorical variables Chi-square or Fisher's exact test were used to assess the difference between the groups. The $p<0.05$ was considered statistically significant.

Results

There was no statistically significant difference in the demographic variables (age, sex, ASA-physical status [PS], height, weight, and mean duration of surgery; Table 2). The mean time to onset of sensory block (15.50±11.26 min in group R and 18.30±9.92 min in group L; $p=0.707$) and the mean time to onset of motor block (25.30±12.18 min in group R and 29.80±10.59 min in group L, $p=0.102$) between two groups

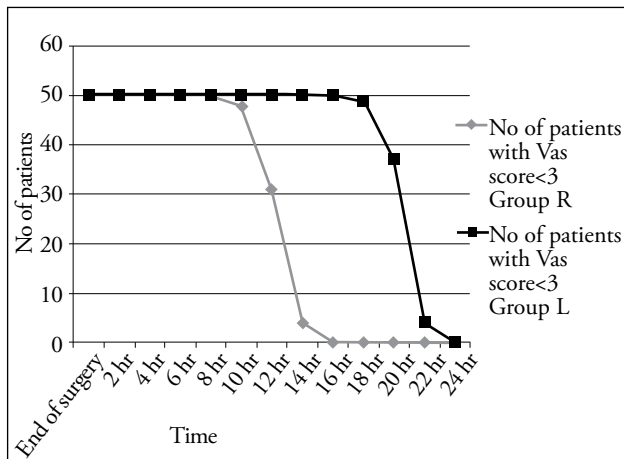


Figure 1. Number of patients with adequate analgesia (VAS score <3) at different time intervals during observation period

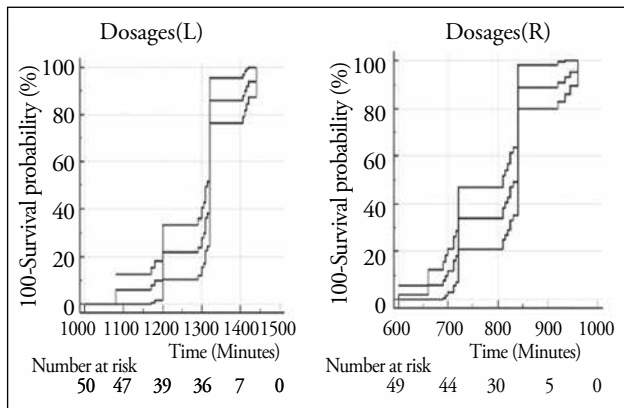


Figure 2. Kaplan-Meier survival curve for time to first rescue analgesic

were comparable (Table 3). The magnitude of haemodynamic changes in heart rate (HR) and mean arterial pressure (MAP) between the groups were also comparable. Nine patients in group R and four in group L showed delayed onset of sensory block, while only two patients in group R and one in group L received IV fentanyl 100 µg to complete the surgery; however, the none of the patients required general anaesthesia.

The duration of sensory block recorded as median (95% CI) was significantly prolonged in group L (1065.0 [1054.5-1068.90] min) compared to group R (647.50 [624.99-674.41] min; $p<0.0001$). Similarly significantly longer duration of motor block recorded as median (95% CI) was found in group L (945 [947.13-1013.3] min) compared to group R (535 [524.77-559.83] min; $p<0.0001$; Table 3).

There was a significant difference between the groups in the VAS score measured at 14 hours postoperation (Figure 1); 90% of group R patients achieved a VAS score of ≥ 3 compared with groups L, which was 0% at the 14 hours of observation.

The time to first rescue analgesia/duration of analgesia recorded as median (95% CI) was significantly longer in group

L, 1320 min (1273.4-1321.8), compared to group R, 840 min (759.23-812.77; $p<0.0001$; Figure 2).

The number of total mean rescue analgesic doses of tramadol was (2.06 \pm 0.23) in group R compared to group L (1.00 \pm 0.0) in the postoperative period ($p<0.0001$; Table 4).

No adverse effect in terms of nausea, vomiting, and haemodynamic instability (hypotension, bradycardia, tachycardia) was seen in both the groups for 24 hours.

Discussion

This prospective, randomised, double-blind study was conducted to provide data of clinical use of 0.5% levobupivacaine and 0.5% ropivacaine for sciatic nerve block using classical posterior approach (Labat approach) for foot and ankle surgery. It was observed that 0.5% levobupivacaine provided longer lasting postoperative analgesia with lesser rescue analgesic doses compared to 0.5% ropivacaine.

The result of our study in terms of postoperative analgesia is similar to that conducted by Fournier et al. (8). In their study, a total of 40 patients were enrolled and received equal volume (20 mL) and concentration (0.5%) of both study drugs for sciatic nerve block. The median postoperative analgesia provided by levobupivacaine was longer (1605 min [575-2400]) than that provided by ropivacaine (1035 min [590-1500]). Compared to our study (1320 min [1273.4-1321.8] in group L versus 840 min [759.23-812.77] in group R), the duration of analgesia in their study was longer in both the groups. The possible explanation for this could be that in their study, all patients received 1 g oral paracetamol every 6 hours in postoperative period to prevent sudden and unpleasant recovery of nociception in the operated limb irrespective of the pain score. Moreover, the mean age (years) in both groups (58 \pm 13 in group R and 55 \pm 16 in group L) was more than that in our study (37.96 \pm 13.92 in group R and 38.54 \pm 14.04 in group L), and age-related changes in peripheral nerves, i.e. decreased inter-Schwann cell distance and conduction velocity, tend to make elderly individuals more sensitive to peripheral nerve block (16).

In contrast, Santorsola et al. (17) achieved analgesia of approximately 16 hours with 20 mL 0.5% ropivacaine, levobupivacaine, and bupivacaine in all groups, which was not clinically significant. These controversial results could be explained by presence of type 2 error in their study due to relatively small sample size (7, 11). In our study, the sample size was considerably more than that of previous studies, and majority of the patients underwent ankle fracture surgeries.

As many lower limb surgeries require tourniquet, we administered femoral nerve block to all patients with 20 mL 0.5% ropivacaine. In our study, we included the ankle surgeries, which had majority of nerve supply from tibial nerve; thus, we assumed that 0.5% ropivacaine used for femoral nerve block would not affect our observations and results of comparison of 0.5% ropivacaine or levobupivacaine used.

Cline et al. (9) compared 40 mL 0.5% levobupivacaine to 40 mL 0.5% ropivacaine in axillary brachial plexus block and found significantly longer mean duration of analgesia (832 ± 285 min) with levobupivacaine compared to ropivacaine (642 ± 247 min; $p=0.013$). The observed difference in the postoperative analgesia provided by levobupivacaine and ropivacaine was only 3 hours in their study, while it was 8 hours in our study. This shows that the duration of blockade may depend on regional techniques. Cacciapuoti et al found that 1 mg kg^{-1} 0.5% levobupivacaine provides 3.5 hours longer duration of analgesia compared to 1.45 mg kg^{-1} 10.5% ropivacaine in axillary plexus block (10).

Recently, Casati et al. (11) reported significantly shorter median (95% CI) duration of analgesia with 20 mL 0.75% ropivacaine (13 [11-14] hours) compared with equal volume 0.5% levobupivacaine (16 [15-19] hours; $p=0.002$). In our study, we used similar volumes and concentrations of levobupivacaine and ropivacaine. The duration of sensory and motor nerve block as well as postoperative analgesia was longer in levobupivacaine compared to ropivacaine. The different potency ratio of levobupivacaine and ropivacaine was the possible explanation of this finding. Ropivacaine is about 40% less potent than racemic bupivacaine, while levobupivacaine has the same potency of racemic bupivacaine (18). Levobupivacaine had shown to be less toxic compared to racemic bupivacaine (19-21), which in turn leads to the possibility of LA toxicity, where more than one nerve blocks are required to accomplish the surgery.

In our study duration of action of the two drugs was different because of difference in molarity as well as different protein binding nature of ropivacaine and levobupivacaine (90%-92% vs. 95%). The potency of drug also depends on the type of block (22-24).

The vasoconstrictor property of aminoamide LA, vascularity of the injection site, lipid solubility (5), and addition of epinephrine may contribute to decreased absorption of LA into systemic circulation. This leads to prolonged nerve exposure to LA and reduced plasma levels, which lead to an increased duration of anaesthesia produced by the LA agent (25). The vasoconstrictor property depends on the inward shift of calcium ion through voltage-gated calcium channels present on cell membranes and lipid forms major component of it. The degree of lipophilicity of the LA agent (levobupivacaine is more lipophilic than ropivacaine) may have significant effects on the cell membranes, thereby changing the gating of ion channels of the calcium channel. Thus, levobupivacaine being highly lipophilic remains in contact with nerve fibres for longer duration and therefore provides longer postoperative analgesia.

Conclusion

The results of present study demonstrate that 20 mL 0.5% levobupivacaine provides longer postoperative analgesia com-

pared to the same volume and concentration of ropivacaine when used for the sciatic nerve block for foot and ankle surgeries with reduced need of rescue analgesia.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Dr. S.N. Medical College (F.1/Acad/MC/JU/15-9355).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

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