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Original research article

A study to compare Ropivacaine and Levobupivacaine in lumbar plexus and sciatic nerve block for lower limb surgeries

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Abstract

Lower limb surgeries can be performed under general, regional and peripheral nerve block anesthesia. Yet post-operative pain and anesthetic side effects remain a problem. Regional blocks for lower limb like, paravertebral block, lumbar plexus block, femoral block, 3 in 1 block, sciatic nerve block, popliteal nerve block, ankle block, ring block involve the unilateral administration of local anesthetics to the nerve roots, nerves and related dermatomes. A prospective randomized study was conducted in patients who underwent lower limb surgeries. After obtaining the institution's ethical committee clearance, 100 cases who met a pre-defined inclusion and exclusion criteria were chosen. Written informed consent was obtained from all the patients before randomizing into Group R (0.5% Ropivacaine) and Group L (0.5% Levobupivacaine) using computer based tables. The onset and duration of sensory block in Group L and Group R were significantly different. The onset of both sensory and motor block was significantly less, and duration was significantly higher in the R group compared to Group L (p<0.05). In the post-operative period, patients in both group L and R did not require analgesics in first 24 hrs.

Keywords: Sciatic nerve block, Lumbar plexus block, levobupivacaine, ropivacaine, post-operative analgesia, lower limb surgeries, post-operative analgesia, faster ambulation.

Introduction

Lower limb surgeries, for which anesthesia is sought, can also be performed under lumbar plexus block (LBP) and sciatic nerve block (SNB). These techniques are segmental in nature, have an advantage that early ambulation is possible. This helps the patient to recover from the surgeries, and permit them to start their daily activities. It is also possible to do these surgeries under general anesthesia, neuraxial blockades like spinal analgesia, epidural blockade and regional blocks. Post-operative pain and side effect of anesthesia remain a problem. Hence LBP and SBP have the advantages like hemodynamic stability and early ambulation when compared to the other conventional techniques.

Lumbar plexus block (LPB) is one of the anesthetic options in the patients undergoing lower limb surgeries. LPB could be safe because it targets somatic nerve in psoas region. Effectiveness of LPB is attributed to the sufficient analgesia provided intraoperatively as well as postoperatively. Adequate muscle relaxation and immobility during surgery refers to its acceptability [1].

Sciatic nerve block (SNB) is usually combined with either femoral nerve block or lumbar plexus block for the lower limb surgeries [2, 3].

Ropivacaine[4] is a long-acting amide local anesthetic agent and first produced as a pure enantiomer. It produces effects similar to other local anesthetics via reversible inhibition of sodium ion influx in nerve fibers. Ropivacaine is less lipophilic than bupivacaine and is less likely to penetrate large myelinated motor fibers, resulting in a relatively reduced motor blockade. Thus, ropivacaine has a greater degree of motor sensory differentiation, which could be useful when motor blockade is undesirable. The reduced lipophilicity is also associated with decreased potential for central nervous system toxicity and cardio toxicity.

Levobupivacaine is an amino-amide local anesthetic drug belonging to the family of n-alkyl substituted pipecoloxylidide. It is the S-enantiomer of Bupivacaine. It is one of the many local anesthetics used in regional anesthesia practice. It is preferred by many anesthesiologists as it provides better cardiovascular stability.

Hence in this study we compared 0.5% ropivacaine and 0.5% levobupivacaine with the lumbar plexus

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block and sciatic nerve block for the lower limb surgeries.

Methodology

The study was a hospital based prospective, randomized clinical study conducted on patients undergoing lower limb surgeries. 100 cases who met a pre-defined inclusion and exclusion criteria were chosen for the study. The study was initiated after obtaining an ethical clearance from the institution's Ethical Clearance Committee. Written informed consent was obtained from all the patients included in the study. The patients were randomized into two study groups, Group R and Group L.

Randomization was done by computer based tables.

The first 'Group R' was to receive Ropivacaine 35ml ropivacaine 0.5% + 5ml Sodium bicarbonate. The second 'Group L' was to receive a combination of Levobupivacaine 35ml of levobupivacaine 0.5% + 5ml Sodium bicarbonate.

Selection of patients

Inclusion criteria

1. ASA I to III patients of either sex.
2. Aged between 20 to 60 years and >50kgs.
3. Undergoing unilateral lower limb surgery, like tibia implant removal, amputation, split skin graft, trendelenberg procedure for varicose veins etc.

Exclusion criteria

1. Patients with a history of allergic to local anesthetics.
2. Patients with history of mental dysfunction.
3. Patients refusal.
4. Morbid obesity, coagulopathy and significant cardiovascular, respiratory, renal, hepatic or metabolic disease or CNS disorders.
5. Infection at site of procedure.

Methods

Pre-operative evaluation

After obtaining the Institution's Ethical Committee's approval, 100 patients in age group of 20-60yrs, ASA 1 and 2, who were scheduled for unilateral lower limb surgeries and were enrolled in this randomized control study. The patients were selected based on those satisfying the inclusion criteria. They underwent a detailed pre anesthetic checkup including history, clinical examination and all routine investigations like complete blood count, blood sugar, Liver Function Test, Renal Function Test, Serum electrolytes, ECG and Chest X ray were done. An informed written consent was obtained from all the patients.

Pre-operative order

On the night before surgery all subjects will be pre-medicated with tablet alprazolam 0.25mg. Patients were instructed to stay nil per oral after 10pm.

Results

Onset of sensory block

Time of onset of sensory block after Lumbar Plexus Block in the two groups are L2 level block in Group L is 8.28±1.54 mins and Group R is 7.02±1.56 mins which has significant P value of <0.001**. L3 Level block in Group L is 8.32±1.57 mins and Group R is 7.02±1.56 mins which has significant P value of <0.001**. L4 Level block in Group L is 8.60±1.56 mins and Group R is 7.06±1.56 mins which has significant P value of <0.001**. L5 Level block in Group L is 9.02±1.42 mins and Group R is 7.50±1.56 mins which has significant P value of <0.001**

Time of onset of sensory block after Sciatic nerve block in the two groups studied are S1 level block in Group L is 8.74±1.32 mins and Group R is 7.40±1.23 mins which has significant P value of <0.001**. S2 level block in Group L is 9.10±1.37 mins and Group R is 7.48±1.18 mins which has significant P value of <0.001**. S3 level block in Group L is 9.52±1.39 mins and Group R is 7.82±1.21 mins which has significant P value of <0.001**. In our study the onset of sensory block was better with Group R when compared to Group L with a significant P value of <0.001.

Table 1: Onset Sensory Block-Comparison in two groups of patients studied.

Sensory Level	Group L	Group R	Total	P value
L2	8.28±1.54	7.02±1.56	7.65±1.67	<0.001**
L3	8.32±1.57	7.02±1.56	7.67±1.69	<0.001**
L4	8.60±1.56	7.06±1.56	7.83±1.74	<0.001**
L5	9.02±1.42	7.50±1.56	8.26±1.67	<0.001**

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Table 2: Onset of Sensory block- Comparison in two groups of patients studied

Sensory Level	Group L	Group R	Total	P value
S1	8.74±1.32	7.40±1.23	8.07±1.44	<0.001**
S2	9.10±1.37	7.48±1.18	8.29±1.51	<0.001**
S3	9.52±1.39	7.82±1.21	8.67±1.55	<0.001**

Onset of Motor Block

Time of onset of motor block after LP and ScN block in the two groups, are, in 10-15 mins in Group L is 3(6%)and Group R is 0(0%), in 16-20 mins Group L has 40 (80%) patients and Group R has 26 (52%) patients. By the end of 21-25 mins Group L has 7 (14%) and Group R has 24 (48%) which has significant P value of <0.001**.

Table 3: Comparison of onset of Motor block in two groups of patients studied

Onset of motor block in mins	Group L (n=50)	Group R (n=50)	Total (n=100)	P value
• 10-15	3(6%)	0(0%)	3(3%)	<0.001**
• 16-20	40(80%)	26(52%)	66(66%)	
• 21-25	7(14%)	24(48%)	31(31%)	

Comparison of onset of sensory and motor blockade in two groups

In our study the onset of sensory block in Group L is 12.84±1.87 minutes, in Group R is 12.12±1.165 minutes with the p value of 0.028 which is significant and onset of motor block in Group L is 18.24±2.37 minutes and Group R is 20.62±1.66 minutes having P value of <0.001 which is statistically highly significant. Hence in this study we have found that onset of sensory block was earlier in Group R when compared to Group L and onset of motor Block was earlier Group L when compared to Group R.

Table 4: Comparison of onset of sensory/Motor block in two groups of patients studied

	Group L	Group R	Total	P value
Onset of sensory block in mins	12.84±1.87	12.12±1.32	12.48±1.65	0.028*
Onset of motor block in mins	18.24±2.37	20.62±1.66	19.43±2.36	<0.001**

Bromage Scale

BROMAGESCALE was used to assess the motor block (Table 9) in the patients after 2 hrs, 4 hrs, 6 hrs 8 hrs, of administering the Lumbar Plexus block and sciatic nerve block. Group L at 2 hrs 98% had grade 3, at 4 hrs 42% had grade 2 and 58% had grade 3. At 6 hrs 44% showed grade 1, 56% showed grade 2, at 8 hrs 94% showed grade1. Group R showed Grade 1 (2%) and Grade 3(98%) at 2 hrs, Grade 2(48%) and Grade 3 (52%). At 6 hrs Grade 1 (36%), Grade 2 (62%), Grade 3 (2%), at 8 hrs Grade 1 (96%), Grade 2 (2%), Grade 3 (2%). With the p value of 0.948 which is not statistically significant. Both Group R and Group L there was no much difference with regard to the motor blockade.

Table 5: Bromage Scale distribution in two groups of patients studied

Bromage Scale	Group L (n=50)	Group R (n=50)	Total (n=100)	P value
2 hrs				
• 1	1(2%)	1(2%)	2(2%)	1.000
• 2	0(0%)	0(0%)	0(0%)	
• 3	49(98%)	49(98%)	98(98%)	
4hrs				
• 1	0(0%)	0(0%)	0(0%)	0.688
• 2	21(42%)	24(48%)	45(45%)	
• 3	29(58%)	26(52%)	55(55%)	
6 hrs				
• 1	22(44%)	18(36%)	40(40%)	0.541
• 2	28(56%)	31(62%)	59(59%)	
• 3	0(0%)	1(2%)	1(1%)	
8 hrs				
• 1	47(94%)	48(96%)	95(95%)	0.617
• 2	3(6%)	1(2%)	4(4%)	
• 3	0(0%)	1(2%)	1(1%)	
12 hrs				
• 0	50(100%)	50(100%)	100(100%)	1.000
• 1	0(0%)	0(0%)	0(0%)	

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• 2	0(0%)	0(0%)	0(0%)	
• 3	0(0%)	0(0%)	0(0%)	

Duration of Sensory block and motor block

Total duration of sensory block in Group L is 21.86±1.39 hrs and Group R is 28.02±3.30 hrs with a significant P value of <0.001. Motor block in Group L is 7.08±0.71 and Group R is 7.68±0.71 with P value of 0.8308 which is not statistically significant. Hence in our study there is significant sensory block in Group R.

Table 6: Total duration of Sensory block and Motor Block.

	Group L	Group R	Total	P value
Duration of Sensory Block in Hrs	21.86±1.39	28.02±0.84	24.94±3.30	<0.001**
Duration of Motor Block in Hrs	7.68±0.71	7.08±0.71	7.38±0.71	0.8308

Duration of sensory block in Group L, 20-22 hrs had 36 (72%) patients and 14 patients (28%) in 23-26 hrs. Group R there were 2 (4%) in 23-26 hrs and 48 (96%) patients had >26 hrs of sensory block. And its statistically significant with P value of <0.001.

Motor block in Group L 46% had 7 hrs of blockade, 40% had 8 hrs of blockade 14% of patients had 9 hrs of blockade. In Group R 46% had 7 hrs of blockade, 40% had 8 hrs of blockade 14% of patients had 9 hrs of blockade which is almost similar and with P value of 1 which is not significant.

Table 7: Duration of sensory and motor blockade in Group R, L.

	Group L (n=50)	Group R (n=50)	Total (n=100)	P value
Duration of Sensory Block in Hrs				
20-22	36(72%)	0(0%)	36(36%)	<0.001**
23-26	14(28%)	2(4%)	16(16%)	
>26	0(0%)	48(96%)	48(48%)	
Duration of Motor Block in Hrs				
7	23(46%)	23(46%)	46(46%)	1.000
8	20(40%)	20(40%)	40(40%)	
9	7(14%)	7(14%)	14(14%)	

Visual analogue scale

Post-operative pain assessment was done using the Visual Analogue Scale (Table 10 and 11) in all the 100 patients at time intervals of 0-2hrs, 2hrs, 4hrs, 6hrs, 8hrs, 12hrs and 24hrs. Group L showed 1.00±0.00, 1.42±0.50, 1.88±0.33, 1.82±0.63, 1.90±0.42, 2.24±0.52 respectively and in Group R showed 2.40±0.57, 2.40±0.53, 2.38±0.57, 1.02±0.14, 0.12±0.52, 0.40±0.49 with P value of <0.001 which is significant.

Table 8: Vas Score

VAS Score	Group L	Group R	Total	P value
2 hrs	1.00±0.00	2.40±0.57	1.70±0.81	<0.001**
4 hrs	1.42±0.50	2.40±0.53	1.91±0.71	<0.001**
6 hrs	1.88±0.33	2.38±0.57	2.13±0.53	<0.001**
8 hrs	1.82±0.63	1.02±0.14	1.42±0.61	<0.001**
12 hrs	1.90±0.42	0.12±0.52	1.01±1.01	<0.001**
16 hrs	2.24±0.52	0.40±0.49	1.32±1.05	<0.001**

Return of movements

In our study patient was able to move at 7 hrs 42% of the patients, at 8 hrs 44% and 14% at 9 hrs could flex their knee as well as dorsiflex the great toe in Group L and in Group R 48% could move at 7 hrs and 38% at 8 hrs and 14% at 9 hrs. Proprioception of Knee/ toe returned at 10 hrs for 42%, 11 hrs for 44% and 12 hrs for 14% of the patients in Group L. In Group R at 10 hrs 48%, at 11 hrs 24% and at 12 hrs 28% of the patients could propriocept their knee and toe. This was statistically insignificant. As mean in Group L patients could flex their knee at 7.27±0.070 hrs and Group R is 7.66±0.72 with the P value 0.673. Group L could dorsiflexion of Great Toe at 7.72±0.70 hrs and Group R 7.69±0.71 hrs. With P value of 0.673. Patients had proprioception of knee/ toe at 10.76±0.85 hrs in Group L and 10.80±0.86 in Group R with the P value of 0.815 which are not significant.

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Table 9: Return of Reflexes in hrs (mean)

Return of Movements in hrs	Group L	Group R	Total	P value
Flexion of knee	7.72±0.70	7.66±0.72	7.69±0.71	0.673
Dorsiflexion of Great Toe	7.72±0.70	7.66±0.72	7.69±0.71	0.673
Proprioception of Knee/ Toe	10.76±0.85	10.80±0.86	10.78±0.85	0.815

Table 10: Return of movements in hrs distribution in two groups of patients studied Chi-

Return of Reflexes in hrs	Group L (n=50)	Group R (n=50)	Total (n=100)	P value
Flexion of knee				
• 7	21(42%)	24(48%)	45(45%)	0.811
• 8	22(44%)	19(38%)	41(41%)	
• 9	7(14%)	7(14%)	14(14%)	
Dorsiflexion of Great Toe				
• 7	21(42%)	24(48%)	45(45%)	0.811
• 8	22(44%)	19(38%)	41(41%)	
• 9	7(14%)	7(14%)	14(14%)	
Proprioception of Knee/ Toe				
• 10	25(50%)	24(48%)	49(49%)	0.972
• 11	12(24%)	12(24%)	24(24%)	
• 12	13(26%)	14(28%)	27(27%)	

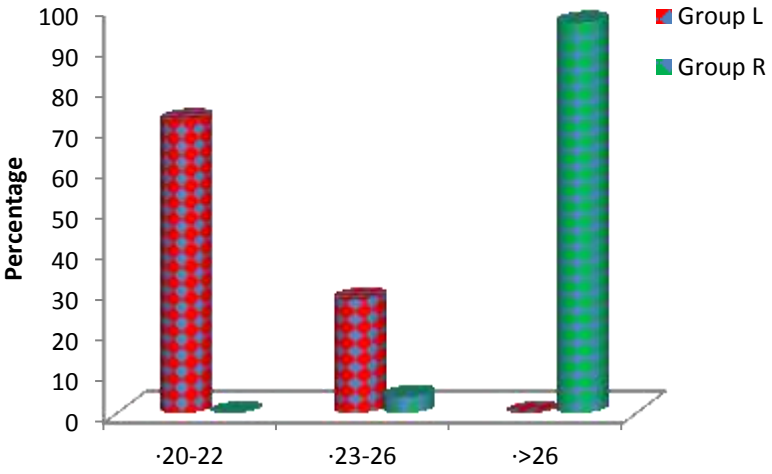

Fig 1:Duration of Sensory Block in Hrs

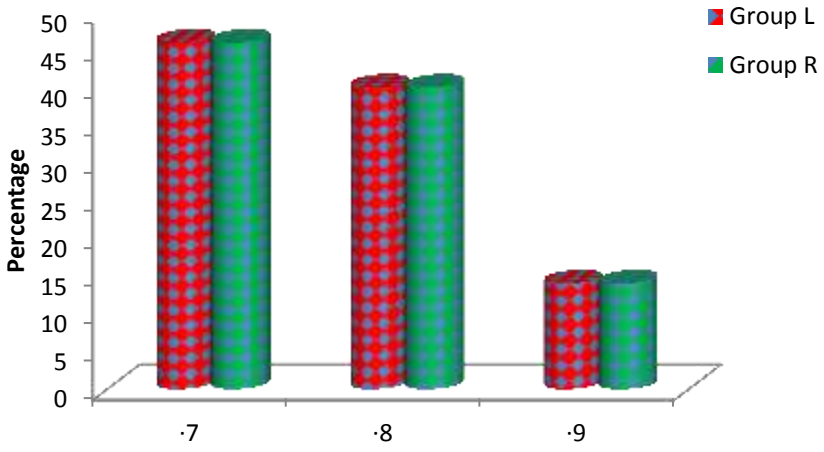

Fig 2: Duration of Motor Block in Hrs

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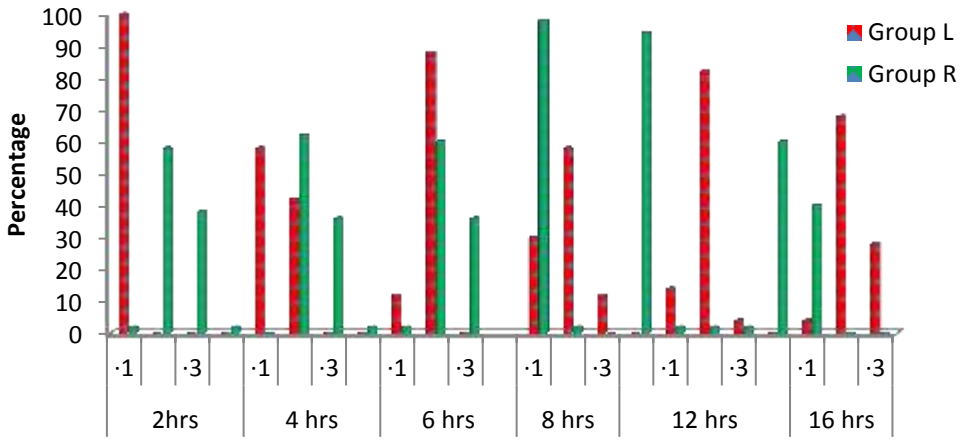

Fig 3: VAS Score

Discussion

We found that in our study the onset of sensory block was earlier in Group R was 12.12±1.32 mins when compared to Group L was 12.84±1.87 mins and onset of motor block was earlier in Group L was 18.24±2.37 mins when compared to Group R was 20.62±1.66 mins which was similar to the study done by Piangatelli C, De Angelis C [5], *et al*, where the motor onset time was shorter in Group L than in Group R.

In a study conducted by Mageswaranand Choy [6], The onset of sensory and motor block was earlier in group of patients who received levobupavacaine compared to patients who received ropivacaine in brachial plexus blocks. On the contrary, Nodulas [7] *et al*, found that both 0.5% Levobupivacaine and 0.5% ropivacaine had similar onset of action and a study conducted by Casati A, Borghi B, Fanelli G, Cerchierini E, Santorsola R, Sassoli V, Grispigni C, Torri G *et al*, [8] revealed onset time of surgical block at the sciatic nerve distribution was 30 min with levobupivacaine and 15 min with ropivacaine. Significant earlier onset of sensory blockade (p=0.027) and motor blockade (p=0.01), prolonged duration of sensory and motor blockade (p=0.0001) was observed in group of patients receiving levobupivacaine compared to ropivacaine, by Shantanu B *et al*, [9].

In a meta-analysis by Ang Li, *et al*, revealed that onset time of block, no matter sensory or motor, was significantly equivalent between 2 local anaesthetic agents. However it cannot be suggested that equivalent doses of LAs will produce equivalent effects as the rate of absorption varied largely, which depended on the regional vascularity density and the method of administration.

Total duration of sensory block in Group L is 21.86±1.39 hrs and Group R is 28.02±3.30 hrs with a significant P value of <0.001. Motor block in Group L is 7.08±0.71 and 81 Group R is 7.68±0.71 with P value of 0.83 which is not statistically significant. Hence in our study there is significant sensory blockade in Group R.

In a A double-blinded, randomized comparison of either 0.5% levobupivacaine or 0.5% ropivacaine for sciatic nerve block by Casati A [1] *et al*, [8]. No differences in the time to recovery of sensory and motor function were observed between the two groups, whereas median (range) duration of postoperative analgesia was 16 h (8-24 h) with levobupivacaine and 16 h (8-24 h) with ropivacaine (P = 0.83). They concluded by saying that 0.5% levobupivacaine and 0.5% ropivacaine provide comparable surgical anesthesia and postoperative analgesia.

It was reported in a meta-analysis that the duration of block could depend on protein binding and more highly protein-bound drugs could lead a longer duration of effect. Percent protein binding differed slightly but not significantly (94% in ropivacaine vs 95% in levobupivacaine). Besides, the difference in clinical factors such as block technique and magnitude of operations is correlated to duration of analgesia, as Cline *et al*, inferred.

Messina *et al*, [10] reported that the poor effect of levobupivacaine could be explained by the choice of a low concentration for this kind of surgery, which was sufficient for analgesia but not for anesthesia. Additionally, Mageswaran and Cho[6] reported that the supraclavicular approach could offer denser anesthesia in brachial plexus block, compared with the infraclavicular block.

Post-operative pain assessment was done using the Visual Analogue Scale in all the 100 patients at time intervals of 0-2hrs, 2hrs, 4hrs, 6hrs, 8hrs, 12hrs and 24hrs. Group L showed 1.00±0.00, 1.42±0.50, 1.88±0.33, 1.82±0.63, 1.90±0.42, 2.24±0.52 respectively and in Group R showed 2.40±0.57, 2.40±0.53, 2.38±0.57, 1.02±0.14, 0.12±0.52, 0.40±0.49 with P value of >0.001 which is significant.

There was a trend toward greater duration of sensory block in the levobupivacaine group for 8 hours and it was greater in ropivacaine after 8 hours extending up to 24 hours.

Protein binding differed slightly but not significantly (94% in ropivacaine vs 95% in

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levobupivacaine). Besides, the difference in clinical factors such as block technique and magnitude of operations is correlated to duration of analgesia, as Cline *et al*, inferred. Messina *et al*, [10] reported that the poor effect of levobupivacaine at a later time could be explained by the choice of a low concentration for this kind of surgery, which was sufficient for analgesia but not for anesthesia.

In our study patient was able to move at 7 hrs 42% of the patients, at 8 hrs 44% and 14% at 9 hrs could flex their knee as well as dorsiflexion the great toe in Group L and in Group R 48% could move at 7 hrs and 38% at 8 hrs and 14% at 9 hrs. Proprioception of Knee/ toe returned at 10 hrs for 42%, 11 hrs for 44% and 12 hrs for 14% of the patients in Group L. In Group R at 10 hrs 48%, at 11 hrs 24% and at 12 hrs 28% of the patients could proprioception of knee and toe. This was statistically insignificant. As mean in Group L patients could flex their knee at 7.27±0.070 hrs and Group R is 7.66±0.72 with the P value 0.673. Group L could dorsiflexion of Great Toe at 7.72±0.70 hrs and Group R 7.69±0.71 hrs with P value of 0.673. Patients had proprioception of knee/ toe at 10.76±0.85 hrs in Group L and 10.80±0.86 in Group R with the P value of 0.815 which are not significant.

Conclusion

From the present study, we found that 35 ml of 0.5% Ropivacaine + 5 ml of Sodium Bicarbonate provides rapid onset of sensory blockade, prolonged sensory blockade as compared to 35 ml of 0.5% Levobupivacaine + 5ml of Sodium Bicarbonate in combined sciatic and lumbar plexus block for lower extremity surgeries. It results in prolonged and high quality analgesia and the incidence of nausea and vomiting was also less. Time to first rescue analgesia was prolonged in patients who received ropivacaine when compared to patients who received levobupivacaine. Ropivacaine is more hemodynamically stable when compared to Bupivacaine. Sodium bicarbonate used as an additive helps in early onset of the sensory and motor block.

References

1. Peduto VA, Baroncini S, Montanini S, Proietti R, Rosignoli L, Tufano R, *et al*. A prospective, randomized, double blind comparison of epidural levobupivacaine 0.5% with epidural ropivacaine 0.75% for lower limb procedures. Eur J Anaesthesiol. 2003;20:979-83.
2. Koch T, Fichtner A, Schwemmer U, Standl T, Volk T, Engelhard K, *et al*. Levobupivacaine for epidural anaesthesia and postoperative analgesia in hip surgery: A multi-center effi cacy and safety equivalence study with bupivacaine and ropivacaine. Anaesthesist. 2008;57:475-82.
3. Yang CW, Jung SM, Kwan HU, Kung PS, Ryu SH. Comparison of epidural anesthesiology with 0.5% levobupivacaine and 0.5% ropivacaine for cesarean section. Korean J Anesthesiol. 2007;52:284-90.
4. Kountoudi M, Papadaki E, Pandazi A, Theohari E, Kouroukli I, Georgiou L. A comparison of epidural levobupivacaine 0.5% with ropivacaine 0.5% for inguinal hernia repair procedure: Blood pressure and heart rate alterations. Local Reg Anesth. 2004;21:103-104.
5. Salvi L, Sisillo E, Rondello N. Thoracic epidural analgesia. Eur J Anaesthesiol. 2005;22:723-4.
6. Grant CR, Checketts MR. Analgesia for primary hip and knee arthroplasty: the role of regional anesthesia. Continuing Education in Anaesthesia, Critical Care & Pain. 2008 Apr 1;8(2):56-61.
7. Mageswaran R, Choy YC. Comparison of 0.5% ropivacaine and 0.5% levobupivacaine for infraclavicular brachial plexus block. Med J Malaysia. 2010;65(4):300-3.
8. Nodulas N, Kaliakmanis D, Graikiotis A, Kouvalakidou A. Comparison of Levobupivacaine 0.5% and Ropivacaine 0.5% for digital nerve block in ambulatory surgery. European Journal of Anaesthesiology. 2011;28:120.
9. Casati A, Borghi B, Fanelli G, Montone N, Rotini R, Fraschini G, *et al*. Interscalene brachial plexus anesthesia and analgesia for open shoulder surgery: a randomized, double-blinded comparison between levobupivacaine and ropivacaine. Anesth Analg. 2003;96(1):253-9.
10. Singelyn FJ, Deyaert M, Joris D, Pendeville E, Gouverneur JM. Effects of intravenous patient-controlled analgesia with morphine, continuous epidural analgesia, and continuous three-in-one block on postoperative pain and knee rehabilitation after unilateral total knee arthroplasty. Anesthesia & Analgesia. 1998 Jul 1;87(1):88-92.