

A COMPARATIVE STUDY OF EFFECTIVENESS OF HYPERBARIC BUPIVACAINE, HYPERBARIC ROPIVACAINE AND HYPERBARIC LEVOBUPIVACAINE IN PATIENTS UNDERGOING LOWER SEGMENT CAESAREAN SECTION: A RANDOMIZED CLINICAL TRIAL

Received : 29/07/2026
Received in revised form : 27/08/2026
Accepted : 09/09/2026

Keywords:
Hyperbaric Bupivacaine, Hyperbaric Levobupivacaine.

Corresponding Author:
Dr. Leimapokpam Chandramani Singh,
Email: lchandramani2023@gmail.com

DOI: 10.47009/jamp.2026.8.5.52

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2026; 8 (5); 329-334



Leimapokpam Chandramani Singh¹, Laishram Dhanachandra Singh², Rita Rajkumari², Thiyam Jamebond Meetei³, Ayekpam Panthoisana Chanu³, Sukham Thoibahenba⁴

¹Senior Resident, Department of Anaesthesiology, JNIMS, Imphal, Manipur, India.

²Assistant Professor, Department of Anaesthesiology, JNIMS, Imphal, Manipur, India.

³PGT, Department of Anaesthesiology, JNIMS, Imphal, Manipur, India.

⁴Professor, Department of Anaesthesiology, JNIMS, Imphal, Manipur, India.

ABSTRACT

Background: Spinal anaesthesia is one of the most popular techniques used for various infra umbilical surgeries including Gynaecological, Urological and Orthopedic procedure. Bupivacaine has been the most widely used drug for Spinal anaesthesia. On notifying life threatening cardiotoxicity of Bupivacaine, the search for newer, safer local anaesthetic drugs began. To overcome this side effect, Ropivacaine a long-lasting drug with less cardiotoxicity was discovered. Hyperbaric Levobupivacaine is used as local anaesthetic in spinal anaesthesia for lower segment caesarean section. In this prospective randomized control study, we are comparing the clinical effectiveness and safety of hyperbaric Bupivacaine, hyperbaric Ropivacaine and hyperbaric Levobupivacaine using equal doses and to assess the suitability of the three drugs for LSCS. **Objectives:** The objectives were (i) to compare the onset and duration of sensory and motor block of intrathecal hyperbaric Bupivacaine, Ropivacaine and Levobupivacaine in patients undergoing LSCS (ii) to compare the hemodynamic changes and side effects and to (iii) to compare post-operative analgesic profile. **Materials and Methods:** A double-blinded, randomized clinical trial study was conducted in the Department of Anaesthesiology, JNIMS, Porompat, Manipur during 2023-25 among patients undergoing LSCS, under spinal anaesthesia. Only patients aged 18-40 years, coming for non-urgent caesarean delivery, who were categorized under ASA II or less and willing to participate were included. 41 patients were recruited by using block randomization to each of the three arms of Bupivacaine group (BH), Ropivacaine group (RH) and Levobupivacaine group (LH). The outcome variables were onset and duration of sensory and motor block, level of sensory block and motor block, intra-operative hemodynamic alterations, duration of post-operative analgesia, quality of analgesia and complications related to spinal anaesthesia. **Results:** The three study groups were comparable in time duration on onset of sensory block reaching T6 level. The mean time was 2.24±1.48 minutes in BH, 2.05±1.02 minutes in LH, and 2.22±1.01 minutes in RH. However, the mean duration time of peak sensory block segment was 6.00±3.12 minutes in BH, 4.12±1.86 minutes in LH, and 3.59±1.30 in RH, with statistically significant difference among the groups ($p < 0.001$). Also, the mean duration of sensory block 2-segment regression time was 91.80±5.27 minutes in BH, 91.02±3.98 minutes in LH, and 86.59±8.25 minutes in RH, with statistically significant difference among the groups ($p < 0.001$). Further, the mean duration of sensory block regression to T10 was 180.59±17.12 minutes in the BH, 168.44±20.22 minutes in LH, and 155.61±30.42 minutes in RH, with statistically significant difference among the groups ($p < 0.001$). The three study groups were comparable in time duration on onset of motor block. The mean time was 288±1.17 minutes in BH, 2.93±0.787 minutes in LH, and 2.66±0.794 minutes in RH. The difference was

not statistically significant ($p = 0.385$). But, the mean duration of motor block (time taken for Bromage score to change from 3 to 0 was 264.68 ± 10.83 minutes in BH, 246.05 ± 13.24 minutes in LH, and 237.17 ± 5.84 minutes in RH, with statistically significant difference among the groups ($p < 0.001$). Again, there was statistically significant difference in SBP among the three groups at baseline, 6 minutes and 30 minutes respectively ($p < 0.05$). At these time points, LH demonstrated comparatively higher mean SBP rates than the other two groups. There was also statistically significant difference in DBP among the three groups at baseline, 6 minutes, and 30 minutes respectively ($p < 0.05$). In the present study, 15 (36.6%) patients had hypotension episode in BH group, 03 (7.3%) patients had hypotension episode in LH group and 06 (14.6%) patients had hypotension episode in RH group. The difference was statistically significant ($p < 0.001$).

INTRODUCTION

Spinal anaesthesia is one of the most popular techniques used for various infra umbilical surgeries including Gynaecological, Urological and Orthopedic procedure. Spinal anaesthesia was introduced to clinical practice by Karl August Bier in 1898. Cocaine - the drug which led to the discovery of spinal anaesthesia, had many side effects and eventually Lignocaine became the preferred drug. Later 5% Lignocaine heavy was reported to cause transient neurological symptoms and it was withdrawn from regular use. Since then, Bupivacaine has been the most widely used drug for Spinal anaesthesia. On notifying life threatening cardiotoxicity of Bupivacaine, the search for newer, safer local anaesthetic drugs began. To overcome this side effect, Ropivacaine a long-lasting drug with less cardiotoxicity was discovered.

Intrathecal Ropivacaine was found to be safe, having shorter duration of action than Bupivacaine and lesser incidence of transient neurological symptom as compared with intrathecal Lignocaine. Intrathecal use of hyperbaric Local Anaesthetic agents has become more popular as they produce predictable block characteristics and reliable Spinal Anaesthesia. The quest for searching newer and safer anaesthetic agents is one of the primary needs in anaesthesiology practice.

Hyperbaric Levobupivacaine is used as local anaesthetic in spinal anaesthesia for lower segment caesarean section (LSCS). Initially levobupivacaine was introduced as an isobaric solution. But the quality of block achieved with isobaric levobupivacaine was sometimes inadequate. To rectify this shortcoming, hyperbaric levobupivacaine was prepared by adding 8% glucose to isobaric levobupivacaine before intrathecal injection.^[1] Hyperbaric Levobupivacaine gave a better quality of motor and sensory block along with improved hemodynamic profile.^[2]

In this prospective randomized control study, we are comparing the clinical effectiveness and safety of hyperbaric Bupivacaine, hyperbaric Ropivacaine and hyperbaric Levobupivacaine using equal doses and to assess the suitability of the three drugs for LSCS.

Aim and Objectives: The current study was done to compare the effectiveness of hyperbaric Bupivacaine, hyperbaric Ropivacaine and hyperbaric Levobupivacaine when these drugs are injected intrathecally in patients undergoing caesarean section. The objectives were (i) to compare the onset and duration of sensory and motor block of intrathecal hyperbaric Bupivacaine, Ropivacaine and Levobupivacaine in patients undergoing LSCS (ii) to compare the hemodynamic changes and side effects and to (iii) to compare post-operative analgesic profile.

MATERIALS AND METHODS

A double-blinded, randomized clinical trial study was conducted in the Department of Anaesthesiology, Jawaharlal Nehru Institute of Medical Sciences, Porompat, Manipur during 2023-25 among patients undergoing LSCS, under spinal anaesthesia. Only patients aged 18-40 years, coming for non-urgent caesarean delivery, who were categorized under ASA II or less and willing to participate were included. Patients with complicated obstetric conditions, cardiac diseases, blood dyscrasias, known drug-allergy and all conditions that are contraindication to spinal anaesthesia were excluded.

A sample size of 41 in each of the three arms was calculated by using reference study of Jagdeep Sharma et al,^[3] - the mean duration (SD) of postoperative analgesia in Levobupivacaine was 126.15 (15.15) mins and Ropivacaine was 114.68 (11.3) mins.

They were consecutively recruited till the calculated sample size is achieved. Study participants were categorised into 3 groups Bupivacaine group (BH), Ropivacaine group (RH) and Levobupivacaine group (LH) following a restriction block randomization with block size of 3. Group BH received 2 ml of 0.5% Bupivacaine heavy with fentanyl 15mcg., Group RH received 2ml of 0.75% Ropivacaine heavy with fentanyl 15mcg, and Group LH received 2 ml of 0.5% Levobupivacaine heavy with fentanyl 15mcg.

The outcome variables were onset and duration of sensory and motor block, level of sensory block (as determined by pin prick) and motor block (according to modified Bromage scale), intra-operative

hemodynamic alterations (HR, ECG, BP SpO₂), duration of post-operative analgesia, quality of analgesia (using Visual Analog scale) and complications related to spinal anaesthesia (hypotension, nausea, vomiting, shivering, respiratory depression etc.).

Data were recorded by using a pre-tested, semi-structured proforma. A detailed pre-anaesthetic check-up was done in all the participating patients. All the patients were advised overnight fasting. On arrival to the OT, all the basic monitors like NIBP, pulse oximeter, ECG were applied and a baseline vitals PR, BP, SPO₂ were recorded. Preloading was done with ringer lactate 15ml/kg 20mins prior to spinal block. Premedication was done with intravenous Injection Ondansetron 4mg before the block. The drugs codes sealed in envelopes numbered, were opened by the designated consultant of the work area just before the administration of anaesthesia and drug was prepared using sterile technique according to group allocated. The drug was then handed over to the attending anaesthesiologist in a coded form who was unaware about the study design and the study groups. Observer was not be present while the block is being administered. Spinal anaesthesia was performed in lateral position under strict aseptic condition with 25G Quincke needle at L3-L4 interspace with the study drugs according to the group allocation.

After spinal injection, all patients were monitored for the following: Heart rate, BP, SpO₂, MAP and it was recorded for every 3 minutes for the first 15 minutes and then every 5 minutes until the completion of surgery. If the patient developed bradycardia, the patient was treated with intravenous 0.6mg atropine sulphate. If there was hypotension, the patient was treated with intravenous fluid and intravenous mephentermine 3mg, if required. If SPO₂ was less than 92% on room air, it was treated with O₂ supplementation. Continuous ECG monitoring was done till the end of surgery.

The level of sensory block was assessed by pin prick. The onset of sensory block was defined as the time from the injection of drug till loss of sensation at T6 dermatome. The highest level of sensory block and the time to reach it was noted. The duration of sensory block is defined as time to regress from

highest level of block attained till T10 dermatome. The duration of sensory block was noted.

Motor block was assessed by modified Bromage scale. The onset of motor block is defined as time taken from injection of drug till modified Bromage grade 3 was reached and maximum motor block is considered when Bromage grade 4 is achieved. The duration of motor block is defined as time taken to regress from Modified Bromage grade 3 to grade 0. The onset of motor block, the time to complete motor block and the duration of motor block was noted.

Data collected were entered into MS-Excel and then were transferred into SPSS-27V/ Jamovi.2.4.11. Descriptive statistics like Mean, Median, SD and proportion was used for data analysis and analytical statistics like chi-square/Fisher exact test and t-test or ANOVA test was used to compare the difference in the effectiveness in the three intervention groups. P value < 0.05 was taken as statistically significant.

Approval for the study was obtained from the Institutional Ethics Committee, JNIMS and informed written consent from the patients concerned was obtained. Patient anonymity and data confidentiality were strictly maintained.

RESULTS

The mean age (SD) of the study participants was 30.20 (6.96) years in the in BH, 27.83 (6.961) years in RH and 29.83 (5.177) years in LH. Most of the baseline demographic characteristics were comparable among the three groups. However, the mean weight among the patients in BH had a higher mean weight (67.59 ± 9.241 kg) compared to the LH (63.98 ± 6.824 kg) and RH (64.61 ± 8.68 kg) groups, and this difference was statistically insignificant (p > 0.05). Further, the mean height among the patients in BH had a lower mean height (154.83 ± 8.86cm) compared to the LH (158.27 ± 5.55 cm) and RH (161.12 ± 4.15 cm) groups (p < 0.05).

Baseline hemodynamic parameters prior to analgesia were also comparable. But, the mean pulse rate before analgesia was 98.44±17.03bpm in BH was higher compared to that 82.56±8.39 bpm in LH, and 87.76±11.15bpm in the RH. Pulse rate in Bupivacaine group compared to that others group were significant difference (p<0.05).

Table 1: Comparison of Sensory block characteristics between the groups

Time (min)	Bupivacaine			Levobupivacaine			Ropivacaine			p-value
	Min	Max	Mean (SD)	Min	Max	(Mean (SD)	Min	Max	(Mean (D)	
Onset of sensory block reaching T6 level	1	7	2.24 (1.48)	1	6	2.05 (1.02)	1	7	2.22 (1.01)	0.722
Maximum height of sensory block segment	2	15	6.00 (3.12)	1	10	4.12 (1.86)	1	6	3.59 (1.30)	<0.001*
2-segment regression time	80	98	91.80 (5.27)	80	99	91.02 (3.98)	60	90	86.59 (8.25)	<0.001*
Duration Of sensory block regression to T10	125	196	180.59 (17.12)	120	190	168.44 (20.22)	120	190	155.61 (30.42)	<0.001*

The three study groups were comparable in time duration on onset of sensory block reaching T6 level. The mean time was 2.24 ± 1.48 minutes in BH, 2.05 ± 1.02 minutes in LH, and 2.22 ± 1.01 minutes in RH. The difference was not statistically significant ($p = 0.722$). However, the mean duration time of peak sensory block segment was 6.00 ± 3.12 minutes in BH, 4.12 ± 1.86 minutes in LH, and 3.59 ± 1.30 in RH, with statistically significant difference among the groups ($p < 0.001$). Also, the mean duration of sensory block

2-segment regression time was 91.80 ± 5.27 minutes in BH, 91.02 ± 3.98 minutes in LH, and 86.59 ± 8.25 minutes in RH, with statistically significant difference among the groups ($p < 0.001$). Further, the mean duration of sensory block regression to T10 was 180.59 ± 17.12 minutes in the BH, 168.44 ± 20.22 minutes in LH, and 155.61 ± 30.42 minutes in RH, with statistically significant difference among the groups ($p < 0.001$). [Table 1]

Table 2: Comparison of motor block characteristics between the groups

Time (in min)	Bupivacaine			Levobupivacaine			Ropivacaine			p-value
	Min	Max	Mean (SD)	Min	Max	Mean (SD)	Min	Max	Mean (SD)	
Onset of motor block (Bromage >3)	1	7	288 (1.17)	2	6	2.93 (0.787)	1	5	2.66 (0.794)	0.385
Duration of motor block (time taken for Bromage score to change from 3 to 0)	246	290	264.68 (10.83)	220	260	246.05 (13.24)	230	246	237.17 (5.84)	<0.001

The three study groups were comparable in time duration on onset of motor block (Bromage >3). The mean time was 288 ± 1.17 minutes in BH, 2.93 ± 0.787 minutes in LH, and 2.66 ± 0.794 minutes in RH. The difference was not statistically significant ($p = 0.385$). But, the mean duration of motor block (time taken for Bromage score to change from 3 to 0) was 264.68 ± 10.83 minutes in BH, 246.05 ± 13.24 minutes in LH, and 237.17 ± 5.84 minutes in RH, with statistically significant difference among the groups ($p < 0.001$). (Table 2)

There was statistically significant difference in pulse rate among the three groups at baseline, 3 minutes, 12 minutes, 15 minutes and 30 minutes respectively ($p < 0.05$). At these time points, the Bupivacaine group demonstrated comparatively higher mean pulse rates than the other two groups. (Fig. 1) Also, there was statistically significant difference in SpO_2 among the three groups at baseline, 3 minutes, 9 minutes, 12 minutes, 15 minutes, 45 minutes respectively ($p < 0.05$). Again, there was statistically significant difference in SBP among the three groups at baseline, 6 minutes and 30 minutes respectively ($p < 0.05$). At these time points, LH demonstrated comparatively higher mean SBP rates than the other two groups. There was also statistically significant difference in DBP among the three groups at baseline, 6 minutes, and 30 minutes respectively ($p < 0.05$).

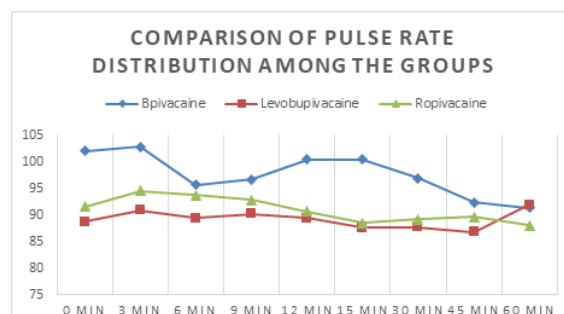


Figure 1: Line chart showing mean pulse rate in the three groups

There was statistically significant difference in MAP among the three groups at baseline, 6 minutes, and 30 minutes respectively ($p < 0.05$). [Figure 2]

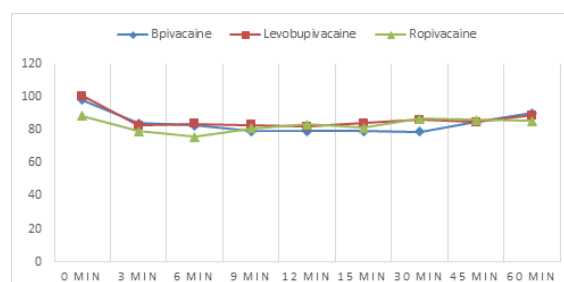


Figure 2: Line chart shows MAP (mmHg) in the three groups

In the present study, 15 (36.6%) patients had hypotension episode in BH group, 03 (7.3%) patients had hypotension episode in LH group and 06 (14.6%) patients had hypotension episode in RH group. The difference was statistically significant ($p < 0.001$). The mean (SD) duration time of surgery was 62.34 (7.835) minutes in RH group, 53.63 (13.95) minutes in BH group and 50.71 (8.358) minutes in LH group,

with statistically significant difference among the groups ($p < 0.05$).

DISCUSSION

Regarding the sensory block characteristics, our study found no statistically significant difference in the time of onset to reach the T6 level among the three groups, with all groups achieving the desired level in approximately 2 minutes. This indicates that Bupivacaine, Levobupivacaine, and Ropivacaine are all equally efficient for rapid surgical preparation. However, the Bupivacaine group achieved a significantly higher maximum sensory level compared to Levobupivacaine and Ropivacaine. Furthermore, the duration of sensory block was longest in the Bupivacaine group and shortest in the Ropivacaine group, reflecting the higher intrinsic potency of Bupivacaine. Vijayalakshmi et al compared hyperbaric drug forms of levobupivacaine and Ropivacaine and found that, mean time for two segment sensory regression were significantly higher in Ropivacaine group.^[1] On the contrary, Luck et al found that, there was no significant difference between Bupivacaine and levobupivacaine.^[2] Lee et al observed that, maximum spread of sensory block onset was similar among bupivacaine, ropivacaine and levobupivacaine group.^[4] Meanwhile, Purohit et al in his study, observed that, ropivacaine as compared to bupivacaine showed slower onset of sensory block.^[5] Patel et al also observed that, levobupivacaine had faster onset and longer duration of sensory block.^[6]

The motor block characteristics revealed a similar trend. While the onset of a Bromage >3 block was comparable across all groups, the duration of the motor block—measured by the time taken for the Bromage score to return to 0—was significantly longer in the Bupivacaine group. Ropivacaine demonstrated the fastest motor recovery. This confirms the "sensory-motor dissociation" property of Ropivacaine and Levobupivacaine, which allows for effective surgical anaesthesia while permitting earlier return of limb movement. This is a significant advantage in modern obstetric practice, as it facilitates early maternal ambulation and reduces the risk of postoperative complications like deep vein thrombosis. Vijayalakshmi et al, Mantouvalou et al and Lee et al found significantly shorter motor block in Ropivacaine group.^[1,4,7] Khundongbam et al observed significantly varying motor block by 5 mins.^[8] while Cappelleri et al, Ogum et al and Purohit et al observed shorter spinal block resolution in Ropivacaine group.^[5,9,10] Meanwhile Casati et al observed time of onset and maximum level of block attained similar among the different groups.^[11]

The hemodynamic profile revealed critical differences in maternal safety. The incidence of hypotension was significantly higher in the Bupivacaine group (36.6%) compared to Levobupivacaine (7.3%) and Ropivacaine (14.6%).

Dar et al also observed 66% of patients receiving bupivacaine developed hypotension.^[12] Singh et al found both ropivacaine and levobupivacaine to be reliable in terms of safety and efficacy.^[13]

Levobupivacaine maintained the most stable Systolic Blood Pressure and Mean Arterial Pressure throughout the monitoring period, particularly at the 6-minute and 30-minute intervals. The higher pulse rates observed in the Bupivacaine group were likely a compensatory response to the rapid sympathetic blockade and subsequent drop in blood pressure. These findings suggest that Levobupivacaine offers a superior safety profile for patients where hemodynamic stability is a priority. Sharma et al in their study observed that, levobupivacaine and ropivacaine provided minimal haemodynamic variability.^[3]

Finally, the postoperative profile showed that Bupivacaine provided the longest time to the first request for rescue analgesia. However, at the 4-hour postoperative mark, Levobupivacaine patients reported lower Visual Analog Scale (VAS) scores. This suggests that while Bupivacaine has the longest absolute duration, Levobupivacaine provides a high quality of residual analgesia with significantly fewer cardiovascular side effects, making it a highly effective choice for LSCS.

Regarding side effect of hypotension, the bupivacaine group had higher chance of causing it as compared to the other two groups.

CONCLUSION

The findings of this study lead to the conclusion that while all three hyperbaric local anaesthetics provide reliable surgical anaesthesia for patients undergoing LSCS, they offer distinct clinical advantages and disadvantages that should guide the anaesthesiologist's choice. Hyperbaric Bupivacaine remains the gold standard in terms of sheer potency and duration of action, making it a reliable choice for prolonged or complex surgeries. However, its use is closely associated with a higher risk of maternal hypotension and a prolonged motor block that may delay the patient's ability to move and recover in the immediate postoperative period.

Hyperbaric Ropivacaine, on the other hand, is concluded to be an excellent alternative when the clinical priority is rapid recovery and early maternal ambulation. Its shorter duration of motor block and relatively stable hemodynamic profile make it suitable for routine, uncomplicated caesarean sections where the surgeon is experienced and the operative time is expected to be short. However, it is slightly less potent than its counterparts, which must be considered during dosage calculation to avoid patchy or inadequate blocks.

Ultimately, this study concludes that Hyperbaric Levobupivacaine represents the most balanced and favorable choice for spinal anaesthesia in obstetric practice. It successfully bridges the gap between the

high potency of Bupivacaine and the safety profile of Ropivacaine. Levobupivacaine provides a sensory block and duration of analgesia that is nearly identical to Bupivacaine, ensuring surgical comfort, but with significantly less cardiovascular depression and a much lower incidence of hypotension. Furthermore, it allows for a faster return of motor function than Bupivacaine. Therefore, for the dual goals of maximizing maternal safety and ensuring high-quality surgical anaesthesia, Hyperbaric Levobupivacaine is recommended as the preferred agent for LSCS.

Conflict of interest: Nil

Source of funding: None

REFERENCES

1. Vijayalakshmi, Channaiah B, Lakshmipriya, Mallesh L, Anand S, Kattishettar DP, et al. Comparative study of intrathecal 0.42% hyperbaric levobupivacaine versus 0.42% hyperbaric ropivacaine for elective infraumbilical surgeries. *Eur J Mol Clin Med* [Internet]. 2022;9(7):6101+. Cited 2026 Jan 5. Available from: <https://link.gale.com/apps/doc/A737509520/HRCA>
2. Luck JF, Fettes PDW, Wildsmith JAW. Spinal anaesthesia for elective surgery: a comparison of hyperbaric solutions of racemic bupivacaine, levobupivacaine, and ropivacaine. *Br J Anaesth*. 2008;101(5):705–10.
3. Sharma J, Gupta R, Kumari A, Mahajan L, Singh J. A Comparative Study of 0.25% Levobupivacaine, 0.25% Ropivacaine, and 0.25% Bupivacaine in Paediatric Single Shot Caudal Block. *Anesthesiol Res Pract*. 2018 Oct 31;2018:1486261. doi: 10.1155/2018/1486261. PMID: 30515207; PMCID: PMC6234439
4. Lee YY, Ngan Kee WD, Chang HK, So CL, Gin T. Spinal ropivacaine for lower limb surgery: a dose response study. *Anesth Analg*. 2007 Aug;105(2):520-3. doi: 10.1213/01.ane.0000267523.66285.57. PMID: 17646516.
5. Purohit S, Badami R, Kavi C. Comparison of intrathecal 0.5% hyperbaric bupivacaine with 0.5% hyperbaric ropivacaine in lower limb and lower abdominal surgery. *JMSCR*. 2017;5(8):26995–7002.
6. Patel AM, Naik AP, Panchal NN. Effectiveness of ropivacaine versus levobupivacaine for spinal anaesthesia and analgesia in lower limb surgery. *JMSCR*. 2018;6(2):930–7.
7. Mantouvalou M, Ralli S, Arnaoutoglou H, Tziris G, Papadopoulos G. Spinal anaesthesia: comparison of plain ropivacaine, bupivacaine and levobupivacaine for lower abdominal surgery. *Acta Anaesthesiol Belg*. 2008;59(2):65–71.
8. Khundongbam K, Laithangbam P, Hemjit T, Asem J, Longjam E. A comparative study of spinal anesthesia with hyperbaric ropivacaine plus fentanyl and hyperbaric bupivacaine plus fentanyl in lower abdominal and lower limb surgery. *J Med Soc*. 2016;30:50–4.
9. Cappelleri G, Aldegheri G, Danelli G, Marchetti C, Nuzzi M, Iannandrea G, et al. Spinal anesthesia with hyperbaric levobupivacaine and ropivacaine for outpatient knee arthroscopy: a prospective, randomized, double-blind study. *Anesth Analg*. 2005 Jul;101(1):77-82, table of contents. doi: 10.1213/01.ANE.0000155265.79673.56. PMID: 15976210.
10. Ögün CÖ, Kirgiz EN, Duman A, Ökesli S, Akyürek C. Comparison of intrathecal isobaric bupivacaine–morphine and ropivacaine–morphine for Caesarean delivery. *Br J Anaesth*. 2003;90(5):659–664. doi:10.1093/bja/aeg123.
11. Casati A, Moizo E, Marchetti C, Vinciguerra F. A prospective, randomized, double-blind comparison of unilateral spinal anesthesia with hyperbaric bupivacaine, ropivacaine, or levobupivacaine for inguinal herniorrhaphy. *Anesth Analg*. 2004 Nov;99(5):1387-1392. doi: 10.1213/01.ANE.0000132972.61498.F1. PMID: 15502035.
12. Dar FA, Mushtaq MB, Khan UM. Hyperbaric spinal ropivacaine in lower limb and hip surgery: a comparison with hyperbaric bupivacaine. *J Anaesthesiol Clin Pharmacol*. 2015;31(4):466–70.
13. Singh G, Rathod NM, Patel K. Comparison of equipotent doses of hyperbaric ropivacaine and hyperbaric levobupivacaine in spinal anaesthesia for lower abdominal and lower limb surgeries. *Indian J Anaesth Analg*. 2019;6(1):249–54.