Int. J Med. Pharm. Res.
E-ISSN: 2958-3683 | **P-ISSN**: 2958-3675
Available on: https://ijmpr.in/

International Journal of
Medical and Pharmaceutical Research

ORGINAL ARTICLE **OPEN ACCESS**

A Comparative Study of Isobaric Ropivacaine 0.5% with Dexmedetomidine Versus Isobaric Levobupivacaine 0.5% with Dexmedetomidine in Intrathecal Thoracic Segmental Spinal Anaesthesia for Intra Abdominal Surgeries

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Received: 09-06-2025
Accepted: 20-07-2025
Available Online: 13-08-2025

A B S T R A C T

Background: Thoracic segmental spinal anaesthesia (TSSA) is a refined regional technique that targets specific dermatomes, offering hemodynamic stability and enhanced postoperative outcomes. Among local anaesthetics, isobaric ropivacaine and isobaric levobupivacaine with adjuvants such as dexmedetomidine are gaining popularity for TSSA in abdominal surgeries.

Aim: To compare the efficacy and safety of isobaric ropivacaine versus isobaric levobupivacaine with dexmedetomidine in thoracic segmental spinal anaesthesia for intra-abdominal surgeries.

Methods: This randomized controlled trial included 60 ASA I–II patients undergoing elective intra-abdominal surgeries under TSSA. Patients were randomly assigned into two groups:

- Group RD: Received isobaric ropivacaine 0.5% (2.5cc) with dexmedetomidine 10 µg
- Group LD: Received isobaric levobupivacaine 0.5% (2.5cc) with dexmedetomidine 10µg

Primary outcomes included onset and duration of sensory and motor block. Secondary outcomes included duration of analgesia, hemodynamic stability, and adverse effects.

Results: Group LD had a significantly faster sensory onset time (4.1 ± 0.6 min) compared to Group RD (5.2 ± 0.8 min) ($p<0.05$). Duration of analgesia was longer in Group LD (312 ± 26 min) than Group RD (234 ± 20 min) ($p<0.001$). Group LD also demonstrated a deeper and prolonged motor block. Both groups maintained stable hemodynamics, although mild bradycardia was observed in a few patients in Group LD.

Conclusion: Isobaric levobupivacaine with dexmedetomidine provides superior block characteristics and prolonged analgesia compared to isobaric ropivacaine, without compromising hemodynamic safety. It may be preferred in Thoracic segmental spinal anaesthesia(TSSA) for intra-abdominal surgeries.

Keywords: Thoracic segmental spinal anaesthesia, Ropivacaine, Levobupivacaine, Dexmedetomidine, Segmental spinal anaesthesia, Abdominal surgery.

INTRODUCTION

Spinal anaesthesia is the most commonly used technique for lower abdominal surgeries as it is very economical and easy to administer. A total 5% hyperbaric lignocaine was a drug of choice for intrathecal anesthesia but it has been associated with transient radicular irritation.

Levobupivacaine, the S-enantiomer of bupivacaine, is a long-acting local anaesthetic known for its reduced affinity for cardiac and central nervous system sodium channels, resulting in lower cardiotoxicity and neurotoxicity.[2–3] It has comparable anaesthetic potency to racemic bupivacaine, with a more favorable safety profile, making it increasingly popular among anaesthesiologists.[4]

Ropivacaine, another S-enantiomer, is the propyl analogue of bupivacaine. It exhibits lower lipid solubility, lower potency, and minimal cardiovascular and CNS toxicity. Notably, ropivacaine preferentially blocks Aδ and C fibres (pain fibres) more than Aβ fibres (motor fibres), resulting in a less intense motor blockade and faster motor recovery.[5,6] These properties make it well-suited for ambulatory and intermediate-duration surgeries.

Despite the widespread utility of spinal anaesthesia for lower limb and abdominal surgeries, prolonged intraoperative duration can challenge its efficacy. Early fading of the subarachnoid block may lead to intraoperative pain, patient discomfort, and procedural complications. To enhance the quality and duration of analgesia, various intrathecal adjuvants have been explored, including opioids (morphine, fentanyl, tramadol) and alpha-2 adrenergic agonists such as clonidine and dexmedetomidine.[7]

Dexmedetomidine, a highly selective alpha-2 adrenoceptor agonist, has an α2:α1 selectivity ratio eight times greater than clonidine.[8] Initially used as an intravenous sedative, it has shown opioid-sparing effects and can reduce inhalational anaesthetic requirements, both of which make it a valuable intrathecal adjuvant.[8,9]

AIM

To compare the effectiveness of isobaric Ropivacaine 0.5% with dexmedetomidine versus isobaric levobupivacaine 0.5% with dexmedetomidine in thoracic segmental Spinal Anaesthesia for intra-abdominal surgeries.

Primary outcomes included onset and duration of sensory and motor block. Secondary outcomes included duration of analgesia, hemodynamic stability, and adverse effects.

MATERIALS AND METHODS

Study Setting and Design

This prospective, hospital-based, randomized controlled study was conducted in the Department of Anaesthesia at Namo Medical Education & Research Institute, in collaboration with Shri Vinoba Bhave Civil Hospital, Silvassa. The study was carried out over a duration of two years, commencing from the date of approval by the Institutional Ethics Committee. Ethical clearance was obtained prior to the commencement of the study, and written informed consent was taken from each patient after clearly explaining the nature, purpose, risks, and benefits of the study in their own native language.

Patient Selection and Eligibility

Patients scheduled for elective intra-abdominal surgeries under thoracic segmental spinal anaesthesia were screened for eligibility. Inclusion criteria were; age between 20 and 60 years, American Society of Anesthesiologists (ASA) physical status I & II, and ability to provide informed consent. Exclusion criteria included patient refusal, known allergy to local anaesthetics, infection at the injection site, ASA physical status III & IV, bleeding or coagulation disorders, significant hepatic or renal dysfunction, cardiovascular or respiratory instability, epilepsy, spinal deformities (e.g., post-polio), and pre-existing neurological deficits such as hemiplegia.

Preoperative Assessment and Preparation

All enrolled patients underwent a detailed pre-anaesthetic evaluation which included clinical history, general and systemic examination, and appropriate investigations. Routine laboratory tests included complete haemogram, serum electrolytes, blood urea, serum creatinine, urine routine analysis, chest X-ray, and electrocardiogram (ECG). Patients were instructed to remain nil per oral for solids for 8 hours, liquids for 4 hours, and clear water for 2 hours before surgery. Preoperative anxiolytics was provided with oral tab. alprazolam 0.5 mg on the night before surgery.

On arrival in the preoperative room, intravenous (IV) access was secured with an 18G cannula, and IV fluids were initiated based on body weight and fluid requirements. Standard preoperative preparations were ensured including anaesthesia machine check, airway equipment readiness, and availability of emergency drugs. Patients were then shifted to the operating theatre where they were connected to standard monitoring devices; heart rate (HR), pulse oximetry (SpO_2), non-invasive blood pressure (NIBP) and ECG. Baseline parameters were recorded.

Premedication and Anaesthesia Technique

All patients received intravenous inj. ondansetron 4 mg as premedication to prevent intraoperative nausea and vomiting. Pre-loading was done with 10-15mL/kg of inj. Ringer lactate solution. Under strict aseptic precautions and using midline approach, spinal anaesthesia was performed at the T9–T10 intervertebral space in the sitting position using a 25G Quincke spinal needle. Free flow of cerebrospinal fluid (CSF) was confirmed before administering the intrathecal drug.

Patients were randomly assigned to one of two groups using a computer-generated random number table:

- **Group RD** (Ropivacaine + Dexmedetomidine): Received 2.5 mL of 0.5% isobaric ropivacaine combined with 10 mcg of dexmedetomidine intrathecally.
- **Group LD** (Levobupivacaine + Dexmedetomidine): Received 2.5 mL of 0.5% isobaric levobupivacaine combined with 10 mcg of dexmedetomidine intrathecally.

Allocation concealment was maintained using sequentially numbered, sealed, opaque envelopes. Drug preparation was done under sterile conditions by an anaesthesiologist not involved in the conduct of the surgery or postoperative assessment. The patients, surgeons, anaesthesiologists performing the surgery, and the postoperative assessors were all blinded to the group allocation.

Assessment of Sensory and Motor Blockade

Sensory block was assessed by the pinprick method using a 23G blunt hypodermic needle. Assessments were done at regular intervals: every 30 seconds for the first 2 minutes, every 1 minute for the next 5 minutes, every 5 minutes for the following 15 minutes, every 10 minutes for 30 minutes, and then every 15 minutes until the end of surgery. Postoperatively, sensory block was assessed every 30 minutes until complete regression.

Motor block was assessed using the **Modified Bromage Scale**: Grade 0: Full movement of lower limbs; Grade 1: Inability to raise extended leg; Grade 2: Inability to flex knee; Grade 3: Inability to flex ankle; Grade 4: Inability to move toes.

Definitions of Key Parameters

- **Onset of sensory block**: Time from intrathecal injection to loss of pinprick sensation at the desired level T4.
- **Time to maximum sensory block**: Interval from injection to highest level of sensory blockade achieved.
- **Onset of motor block**: Time from drug injection to Bromage Grade 1.
- **Time to maximum motor block**: Interval between drug injection and peak motor block.
- **Duration of motor block**: Time from onset of Bromage 1 to regression back to Bromage 0.
- **Duration of sensory block**: Time from highest sensory level until regression to S2 dermatome.

- **Duration of effective analgesia**: Time from onset of sensory block to first requirement of rescue analgesia (intravenous inj. paracetamol 10–15 mg/kg).
- **Hypotension**: Defined as a fall in systolic BP more than 30% from baseline or below 90 mmHg. Managed with IV fluid boluses and inj. mephentermine 6 mg IV as needed.
- **Bradycardia**: Defined as heart rate <60 bpm. Treated with atropine 0.6 mg IV.
- **Adverse effects**: Any episodes of nausea, vomiting, shivering, pruritus, respiratory depression, sedation, or any other complications were recorded.

Outcome Measures

The **primary outcome** was the comparison of the quality and level of sensory and motor blockade, maximum level of sensory and motor block between the two study groups.

Secondary outcomes included Hemodynamic parameters (pulse rate, systolic and diastolic BP, MAP, SpO_2, respiratory rate), Duration of effective analgesia Incidence of side effects and complications.

Statistical Analysis

All data were recorded in a structured proforma and entered into Microsoft Excel 2021. Categorical variables were presented as frequencies and percentages, and compared using the Chi-square test. Continuous variables were presented as mean ± standard deviation (SD). The unpaired t-test was used for normally distributed data and the Mann–Whitney U test for non-parametric data. A p-value < 0.05 was considered statistically significant. Statistical analysis was performed using **SPSS version 26.0**, and graphical representations were created using Microsoft Excel wherever applicable.

RESULTS

A total of **60 patients** were enrolled and randomly allocated into two groups (Group R and Group LD) with **30 patients in each group**. Both groups were comparable in terms of **demographic variables** such as age, weight, height, BMI, ASA status, and duration of surgery (p > 0.05), indicating no statistical difference at baseline.

Demographic & Baseline Characteristics:

Table 1: demographic variables

Parameter	RD Group	LD Group	p-value
Age (years)	37.9 ± 12.6	36.2 ± 12.8	0.65
Gender (M:F)	25:5	25:5	1.00
ASA I/II (%)	93.3 / 6.7	83.3 / 16.7	0.228
BMI (kg/m²)	32.7 ± 4.8	33.1 ± 5.1	0.82

All baseline characteristics were statistically comparable between groups.

Block Characteristics:

Table 2: block characteristics

Parameter	RD Group	LD Group	p-value
Onset Sensory (min)	2.89 ± 0.47	2.12 ± 0.72	<0.01
Onset Motor (min)	3.28 ± 0.49	2.57 ± 0.60	<0.01
Duration Sensory (min)	346.8 ± 29.7	412.2 ± 35.9	<0.01
Duration Motor (min)	247.2 ± 26.4	317.4 ± 48.6	<0.01
Duration Analgesia (min)	273.4 ± 27.7	358.8 ± 51.3	<0.01

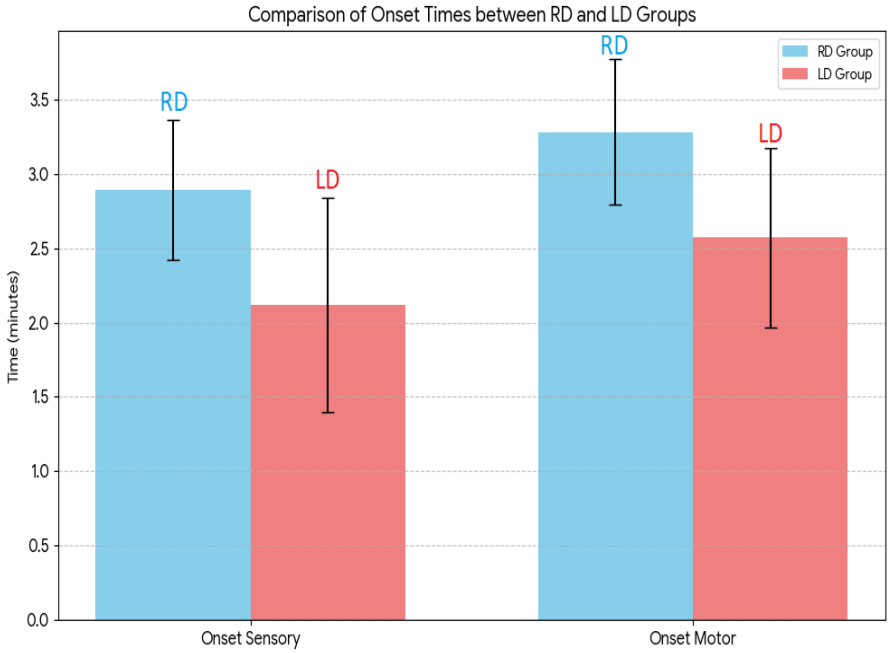


Figure 1: comparison of onset times between RD and LD groups

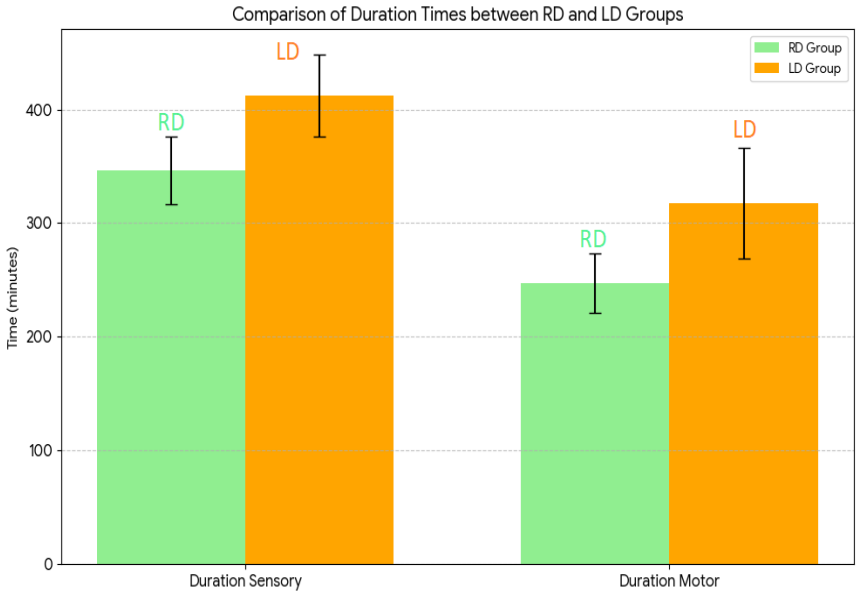
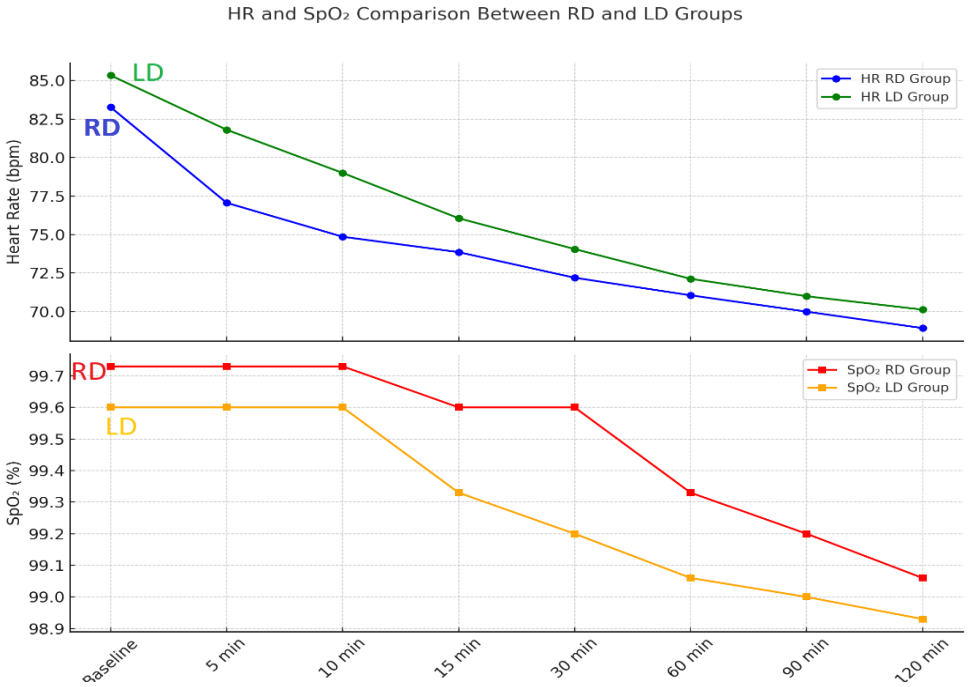


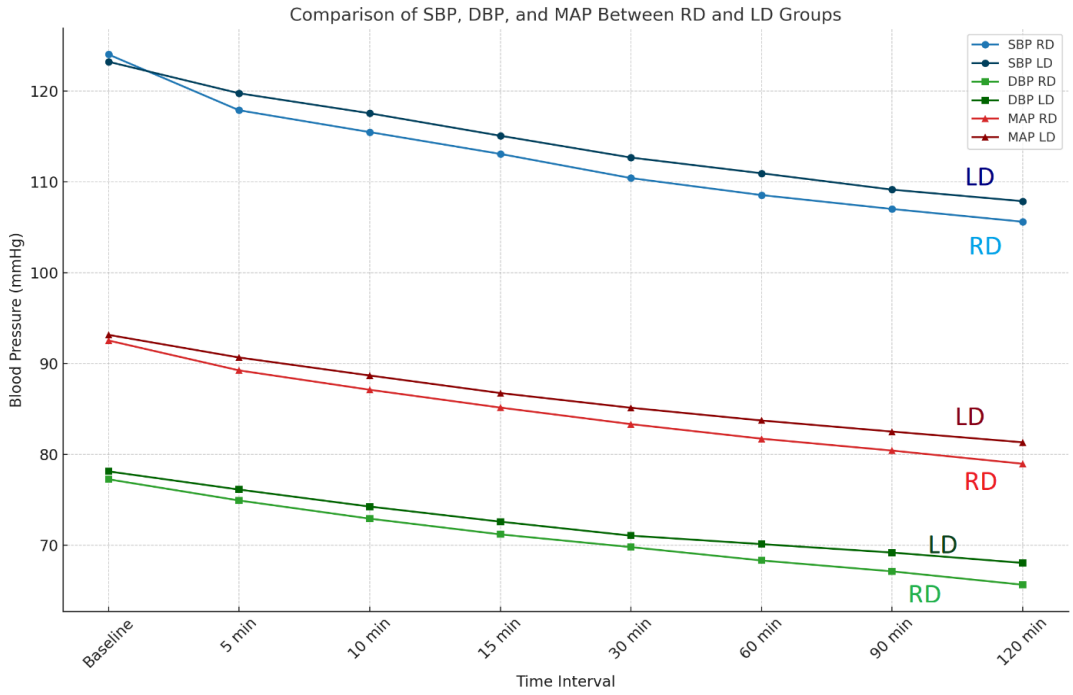
Figure 2: comparison of duration times between RD and LD.

Hemodynamics & SpO_2:

Heart Rate, SBP, DBP, MAP, SpO_2: All remained stable and comparable throughout the 6-hour intra/post-op period ($p > 0.05$).



Graph 1: heart rate and spo2 comparision between RD and LD

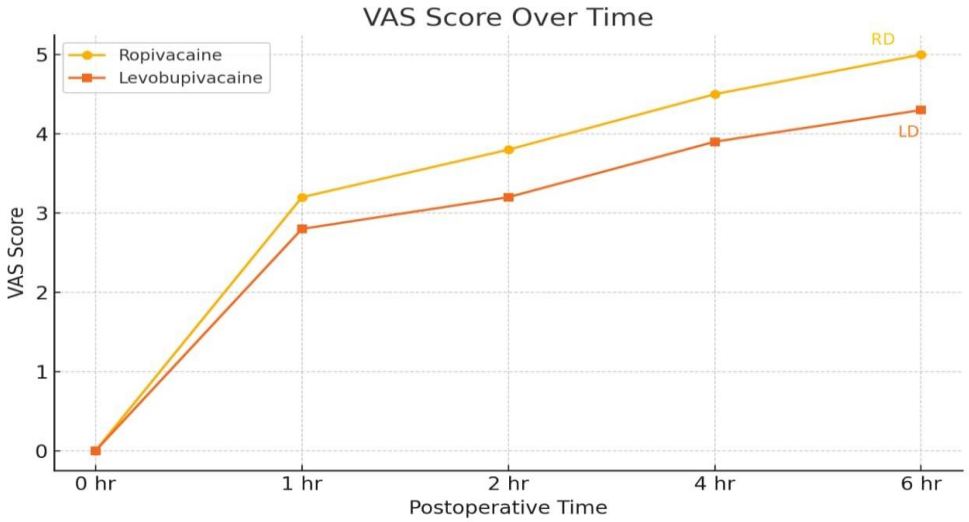


Graph 2: comparision of SBP, DBP and MAP between RD and LD groups.

Pain Scores (VAS):

Table 3: pain score(VAS)

Time Point	RD Group	LD Group	p-value
0–3 hours	0.0	0.0–0.1	NS
4 hours	3.1 ± 1.6	1.6 ± 1.6	<0.01
8 hours	4.0 ± 0.9	3.4 ± 1.0	<0.01



Graph 3: VAS score over time.

Lower pain scores after 4 hours were observed in the **Levobupivacaine** group.

Adverse Effects:

Table 4: adverse effects

ADR	RD Group	LD Group	p-value
Hypotension	1 (3.3%)	1 (3.3%)	1.00
Bradycardia	0	2 (6.7%)	0.48
PONV	3 (10%)	6 (20%)	0.28

All adverse events were statistically comparable and mild in both groups.

DISCUSSION

In the present study, levobupivacaine with dexmedetomidine demonstrated a significantly faster onset of both sensory (2.12 min) and motor block (2.57 min) compared to ropivacaine with dexmedetomidine (2.89 min and 3.28 min respectively, $p<0.01$). Similarly, the duration of sensory and motor blocks were significantly prolonged in the levobupivacaine group (412.2 min and 317.4 min, respectively) versus the ropivacaine group (346.8 min and 247.2 min, $p<0.01$).

These findings are supported by studies such as Govindarao D et al., who reported significantly faster onset and prolonged duration of block with levobupivacaine compared to ropivacaine.[12] BİLAL B et al. and Athar M et al. also noted similar results in terms of faster onset, prolonged regression time, and longer motor block with levobupivacaine.[13, 11] Mantouvalou M et al. observed that ropivacaine produced a shorter duration of both motor and sensory block compared to bupivacaine and levobupivacaine.[10]

Regarding postoperative analgesia, both groups showed comparable VAS scores up to 3 hours. However, after this period, levobupivacaine + dexmedetomidine provided significantly better analgesia. The mean time to first rescue analgesia was also longer in the levobupivacaine group (358.8 min) than in the ropivacaine group (273.4 min), ($p<0.01$). Similar findings were reported by Athar M et al. and Patel A et al., who demonstrated prolonged analgesia and better patient satisfaction in the levobupivacaine group.[11,1]

Hemodynamic parameters such as heart rate, blood pressure, and oxygen saturation remained stable in both groups throughout the intraoperative and postoperative periods. Adverse effects were minimal and comparable between the groups. A few cases of bradycardia were observed in the levobupivacaine group, but these were

self-limiting and not statistically significant. These findings align with previous studies by Mantouvalou M, Govindarao D, and BİLAL B, all of whom reported stable hemodynamics and minimal adverse effects in both groups.[10, 12, 13]

CONCLUSION

Study observed that inj. isobaric levobupivacaine 0.5% with dexmedetomidine for spinal anaesthesia leads to a faster and significantly longer duration of sensory and motor block as compared to inj. isobaric ropivacaine 0.5% with dexmedetomidine. It also prolonged the duration of post-op analgesia without any significant change in hemodynamic parameters. Both the groups were comparable with regards to adverse reactions profile. We thus conclude that inj. isobaric levobupivacaine with dexmedetomidine can be a useful alternative to ropivacine where prolonged sedation and analgesia is required, however ropivacaine should be preferred in short surgical procedure where early ambulation is warranted.

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