

A Comparison of Hemodynamic Stability of Isobaric Ropivacaine Versus Isobaric Ropivacaine with Dexmedetomidine in Lumbar Segmental Spinal Anaesthesia for Lumbar Stabilisation Surgery: A Randomized Controlled Study

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Abstract:

Background: Segmental spinal anesthesia with isobaric ropivacaine is commonly used in lumbar spine procedures because of its consistent sensory blockage, excellent safety profile, and little motor impairment. The addition of dexmedetomidine, an alpha-2 agonist, can improve block quality and duration, but it may potentially impair hemodynamic stability by producing hypotension and bradycardia.

Objective: To compare hemodynamic stability, onset, and duration of sensory and motor block between isobaric ropivacaine alone and in combination with dexmedetomidine.

Methods: Forty patients undergoing lumbar stabilisation surgery were randomized into two groups (n=20 each). Group A received 2 ml of 0.75% isobaric ropivacaine, while Group B received 1.8 ml ropivacaine with 6 µg dexmedetomidine. Hemodynamic parameters, onset, and duration of block were assessed.

Results: Group B showed a considerably faster start and longer duration of both sensory and motor block than Group A, showing that the addition of dexmedetomidine improved anesthetic efficacy. However, this advantage was related with an increased incidence of hypotension, detected in 7 patients in Group B versus no cases in Group A ($p < 0.05$). As a result, Group A displayed improved hemodynamic stability.

Conclusion: While dexmedetomidine improves block characteristics, isobaric ropivacaine alone provides superior hemodynamic stability apart from providing surgical anesthesia required for the procedure.

Keywords: Dexmedetomidine, Isobaric, Ropivacaine, Hemodynamic Stability, Anesthesia.

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Introduction

Lumbar spine surgeries are mostly done under general anaesthesia though spinal anesthesia is a popular approach for lumbar spine surgery due to its technical simplicity, quick onset, cost effectiveness and excellent analgesia. It is associated with reduced blood loss, decreased risk of post operative pulmonary complications and post operative nausea vomiting. Segmental spinal anesthesia provides even better hemodynamics with anesthesia limited to target spine level. Ropivacaine has grown in popularity among local anesthetics due to its excellent safety profile, low cardiotoxicity, and differential sensory-motor blocking. The use of isobaric solutions also provides better control over the spread of anesthetic, making it suited for segmental spinal procedures [1].

Adjuvants such as dexmedetomidine, a selective alpha-2 adrenergic agonist, have been increasingly popular in recent years for improving spinal anesthetic quality. Dexmedetomidine has been shown to increase the duration of sensory and motor block, improve analgesia, and minimize postoperative analgesic requirements. However, its use may result in adverse effects, particularly hemodynamic instability, such as hypotension and bradycardia [2].

Due to the length and complexity of the process, lumbar stabilization surgeries frequently necessitate a stable hemodynamic environment. Blood pressure and heart rate changes can have a negative impact on patient outcomes. Therefore, examining the balance

between enhanced anesthetic efficacy and hemodynamic safety is critical [3]. Previous research has shown that dexmedetomidine is beneficial as an adjuvant, although there is less data on its effect on hemodynamic stability in segmental spinal anesthesia, particularly for lumbar spine procedures. This is especially essential because segmental approaches seek to limit the transmission of anesthetic and minimize systemic effects [4].

This randomized controlled trial will evaluate isobaric ropivacaine alone to a combination of ropivacaine and dexmedetomidine in terms of hemodynamic stability, anesthetic onset, and duration in patients having lumbar stabilization surgery [5].

Methods

Study Design: Randomized controlled study

Sample Size: 40 patients

Groups:

- Group A: 2 ml 0.75% isobaric ropivacaine
- Group B: 1.8 ml ropivacaine + 6 µg dexmedetomidine

Inclusion Criteria:

- ASA I & II
- Laminectomy & discectomy limited to L3, L4, L5 level
- Surgical duration $\leq$ 120 minutes

Exclusion criteria:

- Patient refusal
- ASA III & IV
- Anticipated difficult airway
- Gross spinal deformity & rigidity
- Patient having known allergy to any of the study drugs

Methods of Study: A randomised controlled study was performed in IQ City Medical College & Hospital among forty patients undergoing lumbar spine stabilisation under segmental spinal anaesthesia over a period of one year starting from February 2025 to March 2026 after getting ethical clearance from institutional ethics committee. Pre-anaesthesia checkup was done and patients who fulfilled inclusion criteria were chosen for the study. They were explained about the risks and benefits of the study and informed consents were taken from each of them. The patients were randomly allocated

into two groups – Group A receiving segmental spinal anaesthesia with 2 ml of 0.75% isobaric ropivacaine and Group B receiving segmental spinal anaesthesia with 1.8ml of 0.75% isobaric ropivacaine along with 6µg of injection dexmedetomidine.

On the day of surgery patients were taken into operation theatre. Standard ASA monitor was attached. 18G intravenous line was secured and lactated ringer was started. Patients were made to sit and maintaining strict asepsis lumbar puncture was done at L2-L3 intervertebral space with 25G Quincke needle. The local anesthetic was then injected over 10 seconds after which patients were made to lie supine again. In all patient's lumbar puncture were performed by a senior anaesthesiologist who was not included in recording study variables. Level of block was assessed by loss of sensation to pinprick with 24G hypodermic needle. Once the block was achieved till T12 patients were made to lie in prone position and surgeons were allowed to proceed with surgery. Hypotension was denoted as 20% decrease from baseline BP and was treated with intravenous fluid bolus and intravenous bolus of 6mg of injection Mephentermine. Bradycardia was defined as heart rate below 50/min and was treated with inj. Glycopyrrolate 0.2 mg. Any episode of nausea-vomiting and respiratory distress were noted and treated with injection ondansetron 4 mg & moist oxygen at the rate of 2L/min through nasal prong respectively. All patients were given intravenous paracetamol infusion 1g 30 minutes after giving subarachnoid block. injection Pentazocin 30mg was kept as rescue analgesia. Readings of blood pressure and heart rate were taken every 5 minutes upto 30 mins after giving subarachnoid block and 15 minutes thereafter till 2 hours.

Outcome Measures:

- Hemodynamic parameters
- Onset of sensory block
- Duration of block
- Complications

Statistical Analysis:

- Independent t-test & chi-square test
- $p < 0.05$ considered significant

Results

Table 1: Demographic Data

Parameter	Group A	Group B	p-value
Age (years)	52 ± 8	48 ± 7	0.42
Gender (M/F)	12/8	13/7	0.75

Table 2: Block Characteristics

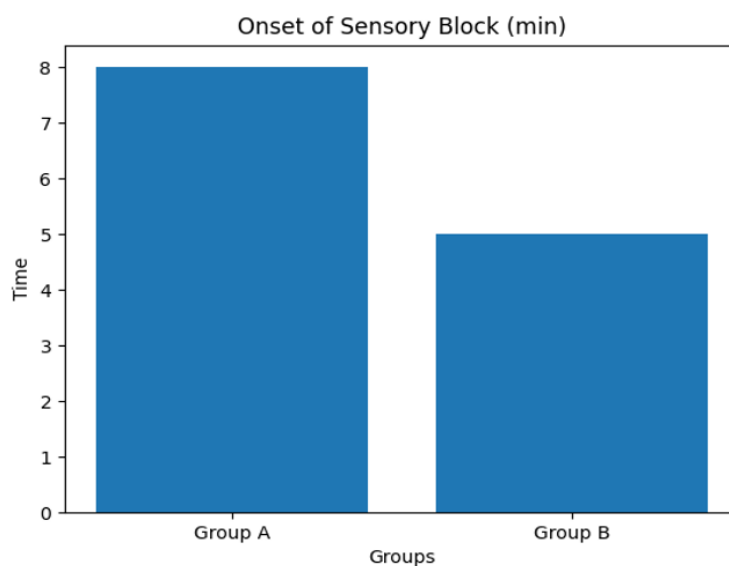
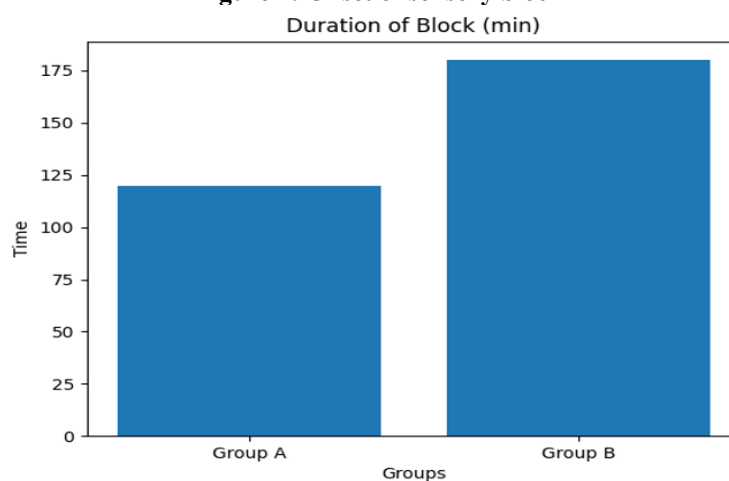
Parameter	Group A	Group B	p-value
Onset (min)	8 ± 2	5 ± 1	0.01
Duration (min)	120 ± 15	180 ± 20	<0.001

Table 3: Hemodynamic Changes

Parameter	Group A	Group B	p-value
Hypotension	2	7	0.01
Bradycardia	0	2	0.15

Table 4: Complications

Complication	Group A	Group B	p-value
Nausea/Vomiting	0	1	1.00
Rescue analgesia	No	No	NA
Shivering	3	1	0.30
Respiratory depression	No	No	NA

**Figure 1: Onset of sensory block****Figure 2: Duration of block**

Discussion

Segmental spinal anaesthesia has recently emerged as a quite popular alternative to general anaesthesia in lumbar stabilisation. As segmental spinal anaesthesia targets confined blockade of specific spinal segments, lesser doses of local anaesthetics is required ensuring hemodynamic and cardio-respiratory stability. As a result it escalates postoperative recovery, reduces hospital stays which aligns with enhanced recovery protocols. [12] This study evaluated the hemodynamic stability and anesthetic efficacy of isobaric ropivacaine alone to its combination with dexmedetomidine in lumbar segmental spinal anesthesia. The results show a trade-off between increased anesthetic properties and hemodynamic safety [6]. The addition of dexmedetomidine increased the onset and duration of sensory and motor blocks. Dexmedetomidine acts by depression of the release of presynaptic C-fiber transmitters and hyperpolarisation of postsynaptic dorsal horn neurons. Local anesthetic agents which act by blocking sodium channels has synergistic effect with α_2 -adrenoceptor agonist prolonging the motor block. The rapid onset observed in Group B is also due to the synergistic actions of ropivacaine and dexmedetomidine [7].

However, this advantage came at the expense of greater hemodynamic instability. Hypotension was seen in 7 patients in Group B, but not in Group A. Dexmedetomidine significantly affects both vascular tone and sympathetic activity ($p < 0.05$). The hypotension was treatable with fluids and vasopressors, but it emphasizes the importance of close monitoring [8]. Interestingly, very small number of patients of bradycardia were documented in group B, which could be attributed to the modest amount of dexmedetomidine administered. Furthermore, only one case in group B showed nausea or vomiting proving that both anesthetic procedures are rather safe [9]. Shivering was noted in 3 patients in group A which was treated by warming the patient and no pharmacological intervention was needed.

The higher hemodynamic stability in Group A shows that isobaric ropivacaine alone may be a better option for those who require steady cardiovascular parameters. On the other side, the longer duration of block in Group B may be beneficial in longer surgeries, in providing better satisfaction for both patients & surgeons or when extended postoperative analgesia is sought [10]. None of the patients in this study required rescue analgesia probably because of comparatively brief duration of surgery though paracetamol was given to all patients to alleviate position related muscular or visceral pain.

These findings are consistent with prior research, which found similar benefits and disadvantages

linked with dexmedetomidine. The anesthetic approach should consequently be tailored to the patient's condition, surgery time, and the necessity for continuous analgesia. The study's limitations include a limited sample size and no long-term follow-up. Future research with larger populations and more outcome measures is recommended [11].

Conclusion

This study shows that both isobaric ropivacaine alone and in conjunction with dexmedetomidine work well for lumbar segmental spinal anesthesia. However, there are few disparities between their clinical characteristics. The inclusion of dexmedetomidine causes a faster onset and longer duration of sensory and motor block, making it useful for longer surgical operations and improved postoperative pain management. Despite these benefits, its usage is associated with an increased incidence of hypotension, which may constitute a danger in vulnerable patient populations.

Isobaric ropivacaine alone gives improved hemodynamic stability, making it a safer choice in patients who require steady cardiovascular parameters. The absence of severe problems in both groups demonstrates the general safety of segmental spinal anesthetic procedures and its utility in lumbar spine surgeries as an effective and safe alternative to general anesthesia. In clinical practice, the decision between these two techniques should be based on patient characteristics, surgical needs, and risk-benefit analysis. When taking dexmedetomidine, it is critical to observe the patient closely and be prepared to treat hemodynamic abnormalities. More research with larger sample sizes and long-term effects is required to develop definitive guidance.

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