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Original Research Article

A COMPARATIVE STUDY OF THE EFFECTIVENESS OF 0.125% LEVOBUPIVACAINE WITH DEXAMETHASONE 4 MG VERSUS 0.125% ROPIVACAINE WITH DEXAMETHASONE 4 MG IN EPIDURAL LABOR ANALGESIA

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ABSTRACT

Background: Epidural analgesia remains the gold standard for labor pain relief, offering superior analgesia while preserving motor function and the natural progression of labor. Levobupivacaine and ropivacaine, both long-acting amide local anesthetics with favorable sensory-motor differentiation, are widely used for this purpose, and dexamethasone has emerged as an effective adjuvant capable of prolonging analgesia without increasing local anesthetic dosage. Comparative data on the two combinations remain limited, particularly with respect to analgesic efficacy, motor blockade, and maternal-neonatal safety. **Aims and Objectives:** To compare the effectiveness of 0.125% levobupivacaine with dexamethasone 4 mg versus 0.125% ropivacaine with dexamethasone 4 mg in epidural labor analgesia, with reference to onset and duration of analgesia, local anesthetic consumption, sensory and motor blockade, hemodynamic stability, and maternal and neonatal outcomes. **Materials and Methods:** This analytical experimental study was conducted over 18 months (April 2024-October 2025) at PESIMSR Hospital, Kuppam, among primigravida women admitted for normal vaginal delivery. Sixty parturients were allocated by purposive sampling into two equal groups of 30: Group LD received 0.125% levobupivacaine with dexamethasone 4 mg, and Group RD received 0.125% ropivacaine with dexamethasone 4 mg, both administered epidurally at the L3-L4 interspace. Onset and duration of analgesia, total local anesthetic dose, sensory (temperature discrimination) and motor (Bromage scale) blockade, visual analog scale (VAS) pain scores, hemodynamic parameters, mode of delivery, APGAR scores, and maternal adverse effects were recorded and compared using Student's t-test and the chi-square test, with $p<0.05$ considered significant. **Results:** Baseline demographic and obstetric characteristics were comparable between groups. Onset of analgesia and time to first painless uterine contraction were slightly but significantly earlier in Group RD, whereas duration of analgesia was significantly longer in Group LD (79.22 ± 11.71 min vs 60.44 ± 11.06 min, $p<0.0001$) with a significantly lower total local anesthetic requirement (26.6 ± 6.75 mg vs 38.45 ± 8.13 mg, $p=0.0001$). Sensory blockade distribution, Bromage motor block scores, VAS pain scores beyond baseline, hemodynamic parameters (heart rate, systolic and diastolic blood pressure, mean arterial pressure, SpO_2), mode of delivery, and APGAR scores were comparable between the two groups. Maternal adverse effects (hypotension, nausea/vomiting, pruritus, shivering) were mild and did not differ significantly between groups. **Conclusion:** Both epidural regimens provided effective, safe labor analgesia with minimal motor blockade and stable maternal hemodynamics. The addition of dexamethasone to levobupivacaine conferred a

significantly longer duration of analgesia and a clear local anesthetic-sparing effect compared with the ropivacaine-dexamethasone combination, without adversely affecting labor progress, mode of delivery, or neonatal well-being, suggesting levobupivacaine with dexamethasone may be a preferable epidural adjuvant combination for labor analgesia.

INTRODUCTION

Pain during labor is widely recognized as one of the most intense physiological pains experienced in clinical practice. Advances in the understanding of the neurophysiology of labor pain and the development of obstetric anesthesia as a distinct subspecialty have significantly improved the quality of labor analgesia. Among the various available pharmacological and non-pharmacological interventions, epidural labor analgesia remains the gold standard, as it provides superior pain relief while preserving motor function and allowing the natural progression of labor.[1] An ideal labor analgesic technique aims to reduce pain without interfering with the mother's ability to bear down, walk, or maintain pelvic floor tone, thereby supporting an unhindered delivery process.[2]

Levobupivacaine and ropivacaine, both long-acting amide local anesthetics, are extensively used for labor analgesia due to their favorable sensory-motor differentiation. Levobupivacaine, the pure levo-isomer of bupivacaine, offers similar anesthetic potency to its racemic counterpart but with reduced cardiotoxicity and central nervous system toxicity, providing reliable sensory blockade with minimal motor involvement and better perioperative hemodynamic stability. Ropivacaine, an S-enantiomer, possesses lower lipid solubility, reduced systemic toxicity, and enhanced sensory selectivity with minimal motor block, characteristics desirable in the obstetric setting.[3-5]

Adjuvants are increasingly incorporated into epidural solutions to improve block quality and prolong analgesia without increasing local anesthetic dosage or side-effects. Dexamethasone, a synthetic glucocorticoid, has emerged as an effective adjuvant in regional anesthesia, with its analgesic enhancement attributed to anti-inflammatory action, attenuation of ectopic neural discharge, and delayed conduction in C-fibers. When combined with local anesthetics in peripheral nerve blocks and neuraxial techniques, dexamethasone has demonstrated prolonged duration of analgesia and improved patient comfort, with contemporary literature reporting a favorable safety profile.[6-8]

Considering the demand for optimal pain control during labor with minimal motor impairment, comparing the clinical performance of levobupivacaine-dexamethasone and ropivacaine-dexamethasone combinations becomes relevant, as existing evidence suggests possible differences in sensory block quality, duration of analgesia, and motor block intensity.[7,8] The present study was therefore undertaken to compare the effectiveness of 0.125% levobupivacaine with dexamethasone 4 mg versus 0.125% ropivacaine with dexamethasone 4 mg in epidural labor analgesia, evaluating analgesic efficacy, motor blockade profile, and maternal and neonatal outcomes.

Aims and Objectives

The primary aim of this study was to compare the effectiveness of 0.125% levobupivacaine with dexamethasone 4 mg versus 0.125% ropivacaine with dexamethasone 4 mg in epidural labor analgesia. The specific objectives were to compare the two regimens with respect to:

1. Onset of analgesia and time to first painless uterine contraction.
2. Duration of analgesia and total local anesthetic requirement.
3. Sensory blockade level and motor blockade (Bromage scale).
4. Pain relief measured by the visual analog scale (VAS) at defined time intervals.
5. Maternal hemodynamic parameters (heart rate, blood pressure, mean arterial pressure, and SpO_2).
6. Mode of delivery and neonatal outcome (APGAR score).
7. Maternal adverse effects.

MATERIALS AND METHODS

This was an analytical experimental study conducted in the Department of Anaesthesiology, PESIMSR Hospital, Kuppam, over a period of 18 months (April 2024 to October 2025). The study population comprised pregnant women admitted for normal vaginal delivery, recruited by purposive sampling.

Based on the study by Wahdan et al., a sample size of 30 patients per group was calculated ($Z_{1-\alpha/2} = 1.96$, $Z_{1-\beta} = 0.84$, $\sigma = 17.8$, $\delta = 13.645$). Accordingly, 60 primigravida women were recruited and equally allocated by the lottery method into two groups of 30 each: Group LD received 0.125% levobupivacaine (prepared by diluting 2.5 mL of 0.5% stock with distilled water to 10 mL) with dexamethasone 4 mg, and Group RD received 0.125% ropivacaine (prepared identically) with dexamethasone 4 mg.

Inclusion Criteria

Primigravida women with gestational age 37-40 weeks; ASA physical status I-II; singleton pregnancy with vertex presentation; uncomplicated pregnancy with normal fetal heart rate (140-160 bpm); and cervical dilatation of 3-5 cm (active phase of first stage of labor).

Exclusion Criteria

Known hypersensitivity to study drugs; contraindication to or refusal of epidural analgesia; deranged coagulation profile; and severe anemia, local infection, or mental illness.

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Procedure

Each eligible participant underwent a baseline obstetric history, general and systemic examination, and recording of baseline vital parameters and fetal heart rate (cardiotocography), following written informed consent. Intravenous access was secured with an 18-gauge cannula and preloading performed with 500 mL Ringer's lactate. Under aseptic precautions, the epidural space was identified at the L3-L4 interspace using an 18-G Tuohy needle by the loss-of-resistance-to-air technique, and the epidural catheter was advanced 3-4 cm into the epidural space. Participants received the allocated drug combination as the first bolus; if analgesia was inadequate (VAS>4), additional boluses were administered until delivery, up to a maximum of 3 mg/kg for ropivacaine and 2.5 mg/kg for levobupivacaine.

Following the first bolus, the total dose and volume of study drug, time to onset of analgesia (skin-prick test), time to first painless uterine contraction, sensory block level (temperature discrimination), motor block (Bromage scale), vital parameters, VAS pain scores, duration of each stage of labor, mode of delivery, maternal adverse effects, and APGAR scores at birth were recorded.

Statistical Analysis

Data were entered in MS Excel 2007 and analyzed using SPSS version 20. Categorical variables were expressed as percentages and continuous variables as mean ± standard deviation. Numerical variables were compared using Student's t-test, and categorical variables using the chi-square test. A p-value <0.05 was considered statistically significant.

RESULTS

Sixty parturients were enrolled, 30 in each group. Baseline demographic and obstetric characteristics were comparable between the groups, except for a small but statistically significant difference in mean maternal age. [Table 1]

Table 1: Demographic and Obstetric Characteristics

Parameter	Group LD (n=30)	Group RD (n=30)	p value
Age (years)	27.47 ± 3.08	26.00 ± 2.97	0.032*
Gestational age (weeks)	38.68 ± 0.61	38.47 ± 0.60	0.09
Cervical dilatation at epidural (cm)	4.43 ± 0.82	4.57 ± 0.77	0.25
Membranes intact (n)	14	13	0.79

Table 2: Onset Characteristics of Analgesia

Parameter	Group LD	Group RD	p value
Time to onset of analgesia (min)	11.11 ± 1.96	10.23 ± 1.73	0.034*
Time to first painless contraction (min)	14.11 ± 1.96	13.23 ± 1.73	0.03*
Duration of analgesia (min)	79.22 ± 11.71	60.44 ± 11.06	<0.0001*
Total local anesthetic dose (mg)	26.6 ± 6.75	38.45 ± 8.13	0.0001*
Number of local anesthetic doses	2.5 ± 0.51	3.5 ± 0.51	<0.001*

The time to onset of analgesia and to first painless uterine contraction were slightly but significantly shorter in Group RD, while duration of analgesia was significantly longer and total local anesthetic requirement significantly lower in Group LD.

Table 3: Distribution Based on Maximum Sensory Blockade

Maximum sensory level	Group LD, n (%)	Group RD, n (%)	p value
T10	14 (46.7)	9 (30.0)	0.18
T9	7 (23.3)	11 (36.7)	0.25
T8	9 (30.0)	10 (33.3)	0.78

Table 4: Distribution Based on Maximum Bromage Scale

Maximum Bromage score	Group LD, n (%)	Group RD, n (%)	p value
0	15 (50.0)	11 (36.7)	0.29
1	15 (50.0)	19 (63.3)	0.29

Sensory blockade and motor block distribution were comparable between the groups, with no patient in either group developing a Bromage score >1.

Table 5: Pain Scores (VAS) at Key Time Intervals

Time point	Group LD (Mean ± SD)	Group RD (Mean ± SD)	p value
Baseline	7.37 ± 1.07	6.93 ± 0.87	0.04*
5 min	3.80 ± 1.00	4.10 ± 1.05	0.16
15 min	2.00 ± 0.88	2.20 ± 0.92	0.27
30 min	1.30 ± 0.78	1.50 ± 0.82	0.36
60 min	1.30 ± 0.82	1.20 ± 0.85	0.58

Baseline VAS scores were significantly higher in Group LD, but VAS scores decreased markedly and comparably in both groups following epidural administration and remained low throughout the observation period.

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Table 6: Heart Rate (bpm) at Key Time Points

Time (min)	Group LD (Mean ± SD)	Group RD (Mean ± SD)	p value
Baseline	83.03 ± 7.17	79.50 ± 6.95	0.05
5	82.67 ± 7.35	82.27 ± 8.05	0.84
15	80.83 ± 6.18	83.07 ± 8.21	0.23
30	81.30 ± 7.76	82.27 ± 8.35	0.64
60	81.15 ± 8.52	84.07 ± 8.68	0.32

Table 7: Systolic Blood Pressure (mmHg) at Key Time Points

Time (min)	Group LD (Mean ± SD)	Group RD (Mean ± SD)	p value
Baseline	124.27 ± 7.67	126.73 ± 8.82	0.253
5	125.57 ± 9.45	126.20 ± 9.82	0.8
15	122.40 ± 6.58	126.07 ± 9.02	0.7
30	127.70 ± 7.90	125.93 ± 9.33	0.62
60	127.65 ± 8.43	129.20 ± 8.67	0.69

Table 8: Diastolic Blood Pressure (mmHg) at Key Time Points

Time (min)	Group LD (Mean ± SD)	Group RD (Mean ± SD)	p value
Baseline	79.20 ± 4.64	78.70 ± 6.08	0.72
5	79.17 ± 6.05	77.37 ± 6.21	0.26
15	80.90 ± 4.51	79.10 ± 7.11	0.68
30	81.07 ± 5.53	80.57 ± 5.27	0.66
60	81.40 ± 5.97	79.53 ± 6.31	0.32

Table 9: Mean Arterial Pressure (mmHg) at Key Time Points

Time (min)	Group LD (Mean ± SD)	Group RD (Mean ± SD)	p value
Baseline	89.10 ± 6.94	90.87 ± 6.22	0.304
5	94.63 ± 4.80	93.64 ± 5.74	0.47
15	94.73 ± 3.69	94.76 ± 5.84	0.89
30	96.61 ± 4.44	95.69 ± 5.43	0.34
60	96.82 ± 4.65	96.09 ± 3.94	0.87

Table 10: SpO_2 (%) at Key Time Points

Time (min)	Group LD (Mean ± SD)	Group RD (Mean ± SD)	p value
Baseline	98.73 ± 1.14	98.47 ± 1.28	0.39
5	98.43 ± 1.25	98.30 ± 1.18	0.67
15	98.63 ± 1.25	98.40 ± 1.07	0.81
30	98.50 ± 1.11	98.30 ± 1.09	0.83
60	98.75 ± 0.91	99.00 ± 1.00	0.77

Heart rate, systolic and diastolic blood pressure, mean arterial pressure, and SpO_2 remained stable and statistically comparable between the two groups at all measured time points.

Table 11: Mode of Delivery

Mode of delivery	Group LD, n (%)	Group RD, n (%)	p value
Normal vaginal delivery	16 (53.3)	17 (56.7)	0.79
Instrumental	5 (16.7)	5 (16.7)	1.0
LSCS	9 (30.0)	8 (26.7)	0.77

Table 12: Neonatal Outcome (APGAR Score)

Parameter	Group LD	Group RD	p value
APGAR at 1 min	7.77 ± 0.82	7.80 ± 0.81	0.43
APGAR at 5 min	9.53 ± 0.51	9.43 ± 0.50	0.22

Table 13: Maternal Adverse Effects

Adverse effect	Group LD, n (%)	Group RD, n (%)	p value
Hypotension	7 (23.3)	5 (16.7)	0.51
Nausea/vomiting	10 (33.3)	9 (30.0)	0.78
Pruritus	2 (6.7)	1 (3.3)	0.55
Shivering	3 (10.0)	1 (3.3)	0.3
None	8 (26.7)	14 (46.7)	0.1

Mode of delivery and neonatal APGAR scores at 1 and 5 minutes were comparable between the two groups. Maternal adverse effects, including hypotension, nausea/vomiting, pruritus, and shivering, were mild, transient, and did not differ significantly between groups.

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DISCUSSION

Effective labor epidural analgesia should provide rapid onset of pain relief, sustained analgesia with minimal local anesthetic requirement, preservation of motor function, hemodynamic stability, and no adverse impact on maternal or neonatal outcomes. The present study demonstrated that both the levobupivacaine-dexamethasone (LD) and ropivacaine-dexamethasone (RD) regimens were effective and safe for epidural labor analgesia; however, the addition of dexamethasone to levobupivacaine conferred clinically meaningful advantages in duration of analgesia and local anesthetic sparing, without compromising obstetric or neonatal outcomes.

Demographic and obstetric characteristics

Both groups were comparable with respect to baseline demographic and obstetric variables, supporting the validity of intergroup comparison. Although mean maternal age was statistically higher in Group LD, the difference was small and clinically insignificant. Similar baseline comparability was reported by Atiénzar et al,[9] who found no significant demographic or obstetric differences across levobupivacaine, bupivacaine, and ropivacaine groups, validating outcome comparisons related to analgesic efficacy rather than patient characteristics.

Onset of analgesia and time to first painless uterine contraction

Onset of analgesia and time to first painless uterine contraction were slightly but significantly earlier in Group RD, though clinically effective analgesia was achieved rapidly in both groups, with more than 95% of parturients attaining satisfactory pain relief (VAS ≤3) within minutes of epidural administration. This suggests that dexamethasone does not delay the onset of neuraxial analgesia. Wahdan et al,[10] similarly reported comparable onset times between dexamethasone and control groups in intrathecal and epidural settings, and peripheral nerve block meta-analyses by Choi et al,[11] and Albrecht et al,[12] likewise found no delayed onset with dexamethasone.

Duration of analgesia

The most important finding was the significantly prolonged duration of analgesia in Group LD, with more patients remaining comfortable for longer periods without requiring rescue boluses. This is supported by Choi et al,[11] who reported prolonged analgesia duration in 70-80% of patients receiving dexamethasone as an adjuvant to long-acting local anesthetics, and by Albrecht et al,[12] who demonstrated substantial prolongation across multiple trials. In obstetric populations, Wahdan et al,[10] demonstrated prolonged spinal analgesia in nearly all parturients receiving dexamethasone as part of combined spinal-epidural analgesia, with their subsequent epidural study,[13] reporting a significantly lower proportion of patients requiring additional epidural supplementation, closely paralleling the present findings.

Total local anesthetic requirement

A significant reduction in total local anesthetic consumption was observed in Group LD, indicating a clear dose-sparing effect. This is consistent with Dube et al,[7] in whose trial parturients receiving intravenous dexamethasone required significantly lower hourly epidural levobupivacaine-fentanyl doses, and with Dhal et al,[14] who found that epidural dexamethasone reduced PCEA bolus requirements. Collectively, these findings reinforce that dexamethasone enhances the efficiency of neuraxial analgesia by reducing local anesthetic requirements.

Sensory block characteristics

Sensory block distribution was comparable between the groups, with no statistically significant difference in the level of maximum sensory blockade. Atiénzar et al,[9] similarly reported comparable sensory block profiles with levobupivacaine and ropivacaine, supporting predictable sensory blockade with both S-enantiomer local anesthetics, while Huang et al,[15] demonstrated consistent sensory block with low-concentration ropivacaine regimens.

Motor blockade

Minimal motor blockade was observed in both groups, with no patient in either group developing a Bromage score ≥2, consistent with Atiénzar et al,[9] who demonstrated lower proportions of motor blockade with levobupivacaine and ropivacaine compared with bupivacaine. Although peripheral nerve block meta-analyses have reported some prolongation of motor block with dexamethasone, obstetric neuraxial studies by Wahdan et al,[10] did not show a clinically significant increase in motor impairment, corroborating the present findings.

Pain scores (VAS)

Baseline VAS scores were higher in Group LD; however, both groups demonstrated rapid onset and sustained pain relief following epidural administration, with more than 95% of parturients in both groups maintaining low VAS scores throughout the observation period. These findings are consistent with the meta-analysis by Li et al,[16] which included over 2000 parturients and found no clinically significant differences in pain scores between epidural levobupivacaine and ropivacaine regimens, and further suggest that dexamethasone prolongs effective analgesia without compromising pain control quality.

Hemodynamic stability

Hemodynamic parameters remained stable in both groups throughout the study, with no episodes of severe hypotension, clinically significant bradycardia, hypoxia, or respiratory depression, indicating that dexamethasone did not adversely affect maternal cardiovascular or respiratory stability. These findings are consistent with Wahdan et al,[10,13] Dube et al,[7] and Dhal et al,[14] all of whom reported comparable hemodynamic profiles with epidural dexamethasone.

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Mode of delivery and neonatal outcomes

Mode of delivery and neonatal APGAR scores were comparable between the groups, with all neonates in both groups achieving APGAR scores ≥7 at 1 minute and ≥9 at 5 minutes. These findings align with Atiénzar et al,[9] Wahdan et al,[10,13] and the meta-analysis by Li et al,[16] none of which found significant differences in mode of delivery or neonatal well-being with dexamethasone as an epidural adjuvant.

Maternal adverse effects

Maternal adverse effects were mild, transient, and comparable between the groups, with no episode requiring aggressive intervention. These findings are consistent with Wahdan et al,[10,13] Dube et al,[7] and Dhal et al,[14] none of whom reported an increased incidence of hypotension, nausea, pruritus, or other maternal adverse effects with dexamethasone, despite reduced local anesthetic consumption.

Limitations

1. Pain intensity was assessed using the visual analog scale, which is inherently subjective and may be influenced by individual pain perception, anxiety, and labor dynamics.
2. Only a single concentration of levobupivacaine/ropivacaine and a fixed dose of dexamethasone were evaluated; dose-response relationships and optimal dosing strategies were not explored.
3. Maternal and neonatal parameters were assessed only during the intrapartum and immediate post-delivery period; long-term maternal outcomes and neonatal neurobehavioral or developmental outcomes were not evaluated.

CONCLUSION

Epidural labor analgesia using both study regimens was effective, safe, and well tolerated, providing satisfactory pain relief with minimal motor blockade and stable maternal hemodynamics. The addition of dexamethasone to 0.125% levobupivacaine produced a significantly longer duration of analgesia with a lower cumulative local anesthetic requirement compared with the ropivacaine-dexamethasone combination, indicating a definite local anesthetic-sparing effect. Importantly, this prolongation of analgesia did not adversely influence the progress of labor, mode of delivery, or neonatal well-being, and maternal adverse effects were mild, comparable between groups, and easily manageable. Levobupivacaine with dexamethasone thus emerges as a favorable epidural adjuvant combination for labor analgesia, offering prolonged and effective analgesia while maintaining maternal and fetal safety.

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