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A Compartive Study of Effectiveness of 0.125% Ropivacaine with Fentanyl 2mcg/ml Versus 0.125% Ropivacaine with Dexamethasone 0.25mg/ml in Epidural Labour Analgesia

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Abstract
Pain during labour is one of the most intense experiences a woman may endure, and providing safe, effective, and patient-centred pain relief has remained a cornerstone of modern obstetric care. Among the available options, epidural analgesia stands out as the most dependable and controllable method, offering pain relief that can be tailored to every stage of labour. Beyond mere analgesia, the aim of epidural techniques is to ensure maternal cardiovascular stability, reduce motor blockade, maintain foetal well-being, and improve the overall childbirth experience. This was a comparative, analytical, experimental study conducted in the Department of Anaesthesiology at PES Institute of Medical Sciences & Research (PESIMSR), Kuppam, Andhra Pradesh. The study was carried out over a period of 18 months, from May 2023 to October 2024. The study included pregnant women admitted for normal vaginal delivery who met the eligibility criteria. Participants were briefed about the procedure, and written informed consent was obtained in both English and the local language prior to enrolment. The onset of analgesia was significantly faster in the fentanyl group (8.0 ± 1.0 min) compared to the dexamethasone group (9.1 ± 1.2 min; $p < 0.001$), and the duration of analgesia was longer with fentanyl (149.3 ± 10.5 min vs 121.4 ± 9.8 min; $p < 0.001$), indicating superior analgesic longevity. This study establishes that ropivacaine combined with fentanyl offers a long duration of analgesia, better pain control, minimal motor impairment, and greater maternal satisfaction compared to the conventional dexamethasone combination.

INTRODUCTION

Pain during labor is one of the most intense experiences a woman may endure, and providing safe, effective, and patient-centered pain relief has remained a cornerstone of modern obstetric care. Among the available options, epidural analgesia stands out as the most dependable and controllable method, offering pain relief that can be tailored to every stage of labor. Beyond mere analgesia, the aim of epidural techniques is to ensure maternal cardiovascular stability, reduce motor blockade, maintain fetal well-being, and improve the overall childbirth experience.

In this context, ropivacaine has emerged as a preferred agent among long-acting amide local anesthetics. Developed as the pure S (-) enantiomer of bupivacaine, it was designed to lower the risks of cardiotoxicity and motor block typically associated with racemic bupivacaine[1,3]. One of its most valuable clinical properties is selective sensory blockade, which provides adequate analgesia while preserving motor function-an especially critical consideration during labor.

To further enhance the analgesic effect and reduce the required dose of local anesthetics, opioid adjuvants like fentanyl are frequently used. Fentanyl is a lipid-soluble opioid with strong receptor affinity, and when administered epidurally in low doses, it acts synergistically with ropivacaine to offer superior pain relief while minimizing motor block and systemic side effects[2,5]. Several clinical studies have validated the efficacy of the 0.125% ropivacaine with 2 mcg/ml fentanyl combination, showing significant pain relief, minimal motor blockade, reduced need for instrumental delivery, and overall greater maternal satisfaction[2,4-6]. Notably, a large-scale meta-analysis by Guo et al 2015 1. synthesizing data from over 2000 laboring women confirmed that this combination offers equivalent analgesic outcomes to bupivacaine-fentanyl while achieving a notably lower rate of motor blockade. These advantages make ropivacaine-fentanyl a reliable and well- established regimen for labor analgesia.

Meanwhile, attention has been growing around dexamethasone, a potent glucocorticoid with strong anti-inflammatory properties, as a promising non-opioid adjuvant in regional anesthesia. When administered epidurally, dexamethasone has been shown to prolong analgesia, reduce postoperative pain, and lower opioid requirements, thereby limiting opioid-related side effects[4,7]. Mechanistically, dexamethasone is believed to work through suppression of prostaglandin synthesis, inhibition of phospholipase A2, and modulation of nociceptive transmission in C-fibers[4].

Clinical evidence supporting this role is growing. For instance, Wu *et al* 2021[6]. Studied the use of ropivacaine-dexamethasone epidural combination in women with pre-eclampsia and found it resulted in better pain control, more stable hemodynamics, and lower stress hormone levels than ropivacaine alone. Similarly, Adel-Aziz *et al*[4]. demonstrated the utility of epidural dexamethasone in orthopedic surgeries, where it significantly prolonged analgesia and reduced opioid consumption, suggesting promising crossover applications in labor analgesia as well .

Adding to the body of evidence, Thacker *et al*[7]. recently compared walking epidurals using ropivacaine alone versus ropivacaine with fentanyl. Their study clearly favored the combination with fentanyl, reporting higher maternal satisfaction, lower pain scores, and improved overall outcomes.

Yet despite these encouraging findings, direct comparisons between fentanyl and dexamethasone as epidural adjuvants to ropivacaine in labor analgesia remain limited. There's a critical gap in understanding how these two combinations stack up in terms of duration and quality of analgesia, maternal hemodynamic responses, motor blockade, side effect profile, and neonatal outcomes.

The present study was conceptualized to address this very gap. By systematically evaluating and comparing the analgesic efficacy of 0.125% ropivacaine with fentanyl 2 mcg/ml versus 0.125% ropivacaine with dexamethasone 0.2 mg/ml, this study aims to contribute meaningful insights into refining labor analgesia protocols. It aspires to inform clinical decisions that balance effective pain control with safety, maternal comfort, and obstetric outcomes, ultimately moving toward more patient-centric and evidence-driven obstetric anesthesia practices.

Aims and Objectives: To compare the effectiveness of 0.125% Ropivacaine with Fentanyl 2 mcg/ml versus 0.125% Ropivacaine with Dexamethasone 0.2 mg/ml in epidural labor analgesia.

- To compare the onset and duration of analgesia.
- To assess the degree of motor blockade.
- To evaluate pain relief using the Visual Analogue Scale (VAS).
- To compare maternal hemodynamic stability and adverse effects.
- To assess fetal outcome using APGAR scores.

MATERIALS AND METHODS

This was a comparative , analytical, experimental study conducted in the Department of Anaesthesiology at PES Institute of Medical Sciences and Research (PESIMSR), Kuppam, Andhra Pradesh. (Registered No -M22010303127) The study was carried out over a

period of 18 months, from May 2023 to October 2024. The study included pregnant women admitted for normal vaginal delivery who met the eligibility criteria. Participants were briefed about the procedure and written informed consent was obtained in both English and local language prior to enrolment.

A purposive sampling method was used. Based on the reference study by Chuttani *et al*. 2018[8], and using standard statistical formulae for two means comparison, the calculated sample size was 88 participants, with 44 patients in each group. However, to ensure robustness and account for potential dropouts, a total sample size of 90 was planned, with 45 participants in each group. Sample size: Based on article 88 patients were allocated into two groups- 44 patients in each of the 0.125% Ropivacaine with Fentanyl 2mcg/ml and 0.125% Ropivacaine with Dexamethasone0.2mg/ml by applying a formula.

The study included primigravida women with a gestational age between 37 and 40 weeks. Only patients with ASA physical status I or II were considered eligible. Women with a singleton pregnancy in vertex presentation were included. Pregnancy had to be uncomplicated, with a normal fetal heart rate between 140 and 160 beats per minute. In addition, participants were required to be in active labor with cervical dilatation between 3 and 5 cm at the time of recruitment.. The study excluded patients with a known allergy to the study drugs, those with contraindications to epidural analgesia or who refused to participate, and those with an abnormal coagulation profile. Patients who showed a positive response to the epidural test dose (3 ml of lignocaine with adrenaline 1:200,000) were also excluded. In addition, women with severe anemia, local infection at the injection site, or mental illness were not considered for participation.

The study was conducted after obtaining approval from the hospital's Scientific and Ethics Committee. Participants were randomly allocated into two groups using a chit method by an anesthesiologist who was not directly involved in the study. Patients in Group RF received 0.125% Ropivacaine with Fentanyl 2 mcg/ml via the epidural route, while patients in Group RD received 0.125% Ropivacaine with Dexamethasone 0.2 mg/ml via the epidural route.

With the assistance of the Department of Obstetrics and Gynecology, patients who fulfilled the inclusion criteria were recruited. A detailed pre-anesthetic evaluation was performed for all participants. The procedure, along with its potential benefits and adverse effects, was clearly explained to the patients and their attendants, and informed written consent was obtained.

Before initiating the procedure, all patients were preloaded with 500 ml of Ringer's lactate solution. Standard monitoring was applied, including non-invasive blood pressure measurement, ECG, pulse oximetry, and cardiotocography (CTG) for continuous fetal monitoring. Epidural anesthesia was administered in the sitting position using the loss-of-resistance to air technique at the L3–L4 interspace. A Tuohy needle (18G) was used to identify the epidural space, and an epidural catheter was then advanced 3–4 cm cephalad. After confirming negative aspiration, a test dose of 3 ml of 2% lignocaine with adrenaline (1:200,000) was administered. Patients who demonstrated a positive response, defined as an increase in heart rate greater than 30 beats per minute, were excluded from the study.

Once correct catheter placement was confirmed, the allocated study drug, either Ropivacaine with Fentanyl (RF group) or Ropivacaine with Dexamethasone (RD group), was administered as a bolus dose. Additional bolus doses were provided intermittently whenever the Visual Analog Scale (VAS) score exceeded 4, and the total volume of drug administered was carefully documented.

The data were entered into Microsoft Excel 2007 and analyzed using SPSS version 20. Descriptive statistics were applied, with categorical variables expressed as percentages and continuous variables presented as mean ± standard deviation. For inferential statistics, the independent t-test was used to compare numerical variables between the two study groups, while the chi-square test was applied to analyze categorical variables. A p-value of less than 0.05 was considered to indicate statistical significance.

RESULTS AND DISCUSSIONS

The demographic profile in both groups was comparable. There were no statistically significant differences in maternal age, weight, or gestational age between the groups ($p > 0.05$). Similar demographic matching was also reported in studies by Gajjar *et al*.[5] and Paddalwar *et al*.[2], ensuring that observed effects were attributable to the drug combinations rather than patient variability.

The onset of analgesia was significantly faster in the fentanyl group (8.0 ± 1.0 min) compared to the dexamethasone group (9.1 ± 1.2 min; $p < 0.001$) and the duration of analgesia was longer with fentanyl (149.3 ± 10.5 min vs 121.4 ± 9.8 min; $p < 0.001$), indicating superior analgesic longevity.

VAS scores were significantly lower in the fentanyl group at 15, 30, and 60 minutes (all $p < 0.01$), indicating better sustained pain relief. Baseline VAS scores were comparable between groups ($p = 0.08$), confirming effective randomization.

A higher proportion of patients in the dexamethasone group retained full motor function (88.8% vs 68.8%; $p = 0.016$), reflecting a significant

Table 1: Demographic Characteristics

Parameter	Group RF (n=45)	Group RD (n=45)	p-value
Mean Age (years)	24.2 ± 2.8	24.5 ± 3.1	0.62
Mean Weight (kg)	62.4 ± 4.5	63.1 ± 5.2	0.38
Gestational Age (wks)	38.4 ± 0.6	38.3 ± 0.7	0.45

Table 2: Onset and Duration of Analgesia

Parameter	Group RF	Group RD	p-value
Onset of Analgesia (min)	8.0 ± 1.0	9.1 ± 1.2	<0.001
Duration of Analgesia (min)	149.3 ± 10.5	121.4 ± 9.8	<0.001

Table 3: Pain Assessment (VAS Score)

Time After Injection	Group RF (VAS Score)	Group RD (VAS Score)	p-value
Baseline	8.6 ± 0.3	8.5 ± 0.4	0.08
15 minutes	3.2 ± 0.4	3.6 ± 0.5	<0.01
30 minutes	2.5 ± 0.3	2.9 ± 0.4	<0.001
60 minutes	2.4 ± 0.3	2.7 ± 0.4	<0.001

Table 4: Motor Blockade (Modified Bromage Scale)

Motor Block Grade	Group RF (n=45)	Group RD (n=45)	p-value
Grade 0	31 (68.8)	40 (88.8)	0.016
Grade 1	10(22.2)	5 (11.1)	
Grade 2	2(8.8)	0	
Total with block (Grade =1)	12 (31.1)	5 (11.1)	

Table 5: Maternal Satisfaction

Satisfaction Level	Group RF (n=45)	Group RD (n=45)	p-value
Good	18 (40)	13 (28.9)	0.033
Very Good	19 (42.2)	17 (37.7)	
Excellent	13 (28.9)	10 (22.2)	
Overall satisfaction (VG + Excellent)	32 (71.1)	27 (60)	

Table 6: Neonatal Outcome-APGAR Scores

Time Point	Group RF (Mean ± SD)	Group RD (Mean ± SD)	p-value
1 Minute	8.1 ± 0.5	8.3 ± 0.4	0.07
5 Minutes	9.1 ± 0.3	9.3 ± 0.3	0.06

Table 7: Maternal Hemodynamics

Parameter	Group RF (Mean ±SD)	Group RD (Mean ±SD)	p-value
Baseline MAP (mmHg)	92 ± 6	91 ± 7	0.55
Lowest MAP	83 ± 5	84 ± 4	0.37
Baseline HR (bpm)	84 ± 8	83 ± 7	0.60
Lowest HR	78 ± 7	79 ± 6	0.52

Table 8: Adverse Effects

Adverse Event	Group RF (n=45)	Group RD (n=45)	p-value
Hypotension	2 (4.4)	1 (2.2)	0.56
Bradycardia	1 (2.2)	0 (0)	0.31
Nausea/Vomiting	6 (13.33)	2 (4.4)	0.05
Shivering	3 (6.6)	1 (2.2)	0.27
Pruritus	5(11.1)	0	0.01

motor-sparing effect. Total motor block incidence (Grade =1) was lower in the dexamethasone group (11.1%) compared to the fentanyl group (31.1%).

Overall maternal satisfaction (Very Good + Excellent) was greater in the fentanyl group (71.1%) than in the dexamethasone group (60%; p = 0.033), likely due to prolonged analgesia.

Both groups showed normal APGAR scores at 1 and 5 minutes with no statistically significant difference, indicating the safety of both drug combinations for neonatal well- being. Similar conclusions were reached in studies by Paddalwar *et al*.[2] and Wu *et al*.[6].

Pruritus was significantly higher in the fentanyl group (11.1% vs 0%; p = 0.01), reflecting known opioid-related side effects. Nausea and vomiting were more common in the fentanyl group (13.3% vs 4.4%; p = 0.05).

This comparative observational study evaluated the efficacy, maternal-neonatal safety, and tolerability of two epidural labor analgesia regimensn 0.125% ropivacaine with fentanyl (2mcg/ml) and 0.125% ropivacaine with dexamethasone (0.2 mg/ml) in 90 laboring women. The findings demonstrate that while fentanyl facilitated a faster onset of analgesia (8.0 ± 1.0 min vs. 9.1 ± 1.2 min, p < 0.001), longer duration of analgesia (149.3 ± 10.5 min vs. 121.4 ± 9.8 min, p<0.001), consistent with the established pharmacodynamic behavior of both agents[9].

Pain intensity, measured via VAS scores, was consistently lower in the fentanyl group at all observed intervals, particularly at 15, 30, and 60 minutes (p < 0.01, p<0.001), reflecting its sustained anti-nociceptive effect. Furthermore, a significantly higher proportion of patients in the dexamethasone group retained Grade 0 motor function (88.8% vs. 68.8%, p = 0.016),

supporting its motor-sparing profile and enhancing maternal mobility during labor.

Maternal satisfaction, a composite indicator of analgesic quality, mobility was higher in the fentanyl group, with 71.1% rating their experience as "Very Good" or "Excellent" (vs. 60% in the dexamethasone group, p = 0.033). Dexamethasone was attributed to reduced motor block, and significantly fewer opioid-related adverse effects, notably pruritus (0% vs. 11.1%, p = 0.01) and nausea (4.4% vs. 13.3%, p = 0.05)[8].

Neonatal outcomes, assessed using 1- and 5-minute APGAR scores, were statistically comparable between both groups (mean >8 and >9, respectively; p >0.05), 10 confirming no compromise in fetal safety. These findings reinforce that both adjuvants are perinatally safe when used within recommended epidural concentrations. Maternal hemodynamics remained stable throughout labor, with no significant hypotension or bradycardia observed in either group, further ensuring uteroplacental perfusion and fetal oxygenation.

In conclusion, this study establishes that ropivacaine combined with fentanyl offers long duration of analgesia, better pain control, minimal motor impairment, greater maternal satisfaction, compared to the conventional dexamethasone combination. Dexamethasone represents a viable and effective epidural adjuvant for labor analgesia, especially in settings aiming to reduce opioid use without compromising efficacy or safety. These findings support further integration of corticosteroid adjuvants into obstetric anesthesia protocols and merit validation through larger randomized trials.

CONCLUSION

In conclusion, Ropivacaine with fentanyl provides a better analgesia, better pain relief, greater maternal satisfaction, and has fewer opioid-related side effects, without compromising maternal or neonatal safety. These findings support fentanyl as a clinically effective and well-tolerated opioid adjuvant in epidural labor analgesia. Ropivacaine with dexamethasone provides less motor blockade, less side effects compaired to fentanyl, good maternal and neonatal safety.

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