

Continuous Infusion Epidural Analgesia during Labor using 0.1% Ropivacaine with Two Different Fentanyl Concentrations Following a Fixed Bolus Dose - A Comparative Study

Shuaib Bin Aboobacker¹, Husna Ameenath², Thasleem Arif Kuttasseri³

¹Assistant Professor, Department of Anaesthesiology, Government Medical College, Manjeri, Malappuram, Kerala, India

²Assistant Professor, Department of Anaesthesiology, Government Medical College, Kozhikode Kerala, India

³Assistant Professor, Department of Anaesthesiology, Government Medical College, Manjeri, Malappuram, Kerala, India

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Corresponding Author: Dr. Shuaib Bin Aboobacker

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Abstract:

Background: Effective pain relief during labour improves maternal comfort, reduces stress responses, and enhances the overall childbirth experience. Epidural analgesia using low-dose local anesthetics combined with opioids is the current standard. Ropivacaine provides good sensory blockade with minimal motor block, and the addition of fentanyl improves analgesic quality. However, the optimal fentanyl concentration for continuous infusion with low-dose ropivacaine remains uncertain. This study compares two continuous infusion regimens- 0.1% ropivacaine with fentanyl 1 µg/mL versus 0.5 µg/mL-following a uniform induction bolus.

Methods: This prospective comparative study included labouring parturients requesting epidural analgesia. All received an initial epidural bolus of 10 mL 0.2% ropivacaine with 20 µg fentanyl. Participants were then allocated into two groups: Group A received a continuous epidural infusion of 0.1% ropivacaine with 1 µg/mL fentanyl, and Group B received 0.1% ropivacaine with 0.5 µg/mL fentanyl. Parameters assessed included analgesic efficacy (VAS), highest sensory level, motor blockade (Bromage score), hemodynamics, duration of labor, mode of delivery, maternal satisfaction, and adverse effects.

Results: Both regimens provided effective labour analgesia. Group A demonstrated slightly better pain scores with comparable onset time. Incidence of motor blockade was minimal in both groups, with no significant difference in sensory levels or hemodynamic changes. Maternal satisfaction was high in both groups, though marginally higher in Group A. Side effects such as pruritus and nausea were more frequent with the higher fentanyl concentration. Mode of delivery and neonatal outcomes were comparable.

Conclusion: Continuous epidural infusion of 0.1% ropivacaine with either 1 µg/mL or 0.5 µg/mL fentanyl provides safe and effective labor analgesia. The lower fentanyl concentration offers similar analgesic efficacy with fewer opioid-related side effects, making it a preferable option for routine practice.

Keywords: Labour Analgesia, Epidural, Ropivacaine, Fentanyl, Continuous Infusion, Maternal Satisfaction, Obstetric Anaesthesia.

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Introduction

The delivery of the infant into the arms of a conscious and pain-free mother is one of the most exciting and rewarding moments in medicine” – Moir. Pain is a noxious and unpleasant stimulus that induces fear and anxiety, triggering pathophysiological responses in the body. In the respiratory system, pain causes hyperventilation, increasing the work of breathing and oxygen consumption. Unrelieved stress during labor elevates plasma cortisol and catecholamine levels, reducing utero-placental blood flow by 35–70%, further compromising fetal oxygenation.

Although labor is a physiological process, it is unique in being the only normal condition consistently associated with severe pain, often considered among the most intense pain experiences, surpassed only by causalgia or traumatic digital amputation. Pain relief in labor has historically been surrounded by myths and controversy. Obstetric anesthesia began with James Young Simpson, who administered ether to a woman with a deformed pelvis, despite facing strong criticism. The debate continued until 1853, when

John Snow administered chloroform to Queen Victoria during the birth of Prince Leopold.[1]

The degree and management of labor pain significantly affect patient satisfaction and may have long-term emotional and psychological consequences.[2,3] Among available options, neuraxial analgesia remains the most effective, outperforming parenteral opioids, nitrous oxide, and nonpharmacologic methods, without adversely affecting the delivery mode or maternal and neonatal outcomes.[4] Current standard regimens in many institutions use a local anaesthetic combined with an opioid via continuous epidural infusion (CEI) with or without patient-controlled epidural analgesia (PCEA) boluses.[5]

Bupivacaine and ropivacaine are the most commonly used agents; ropivacaine is better tolerated and produces less motor blockade. [6,7] Optimal analgesia with ropivacaine alone can be achieved at a 0.2% concentration,[8] while the addition of fentanyl enhances analgesia and reduces local anesthetic requirements in a dose-dependent manner.[9] Most studies use 0.2% ropivacaine with varying opioid doses. This study aims to assess analgesic efficacy and patient satisfaction using two regimens of 0.10% ropivacaine combined with different fentanyl concentrations (1 mcg/ml vs. 0.5 mcg/ml) following a standard induction bolus of 10 ml 0.2% ropivacaine with 20 mcg fentanyl.

Aims and Objectives: The present study aims to compare two regimens of epidural analgesia by evaluating their analgesic efficacy, the highest level of sensory blockade achieved, hemodynamic parameters, the intensity of motor blockade using the Bromage Scale,[10] and overall patient satisfaction.

Materials and Methods

Study Design: This clinical case trial was conducted in the Department of Anesthesiology in association with the Department of Obstetrics and Gynecology at Government Medical College, Thrissur, from January 2014 to June 2015. Ethical clearance was obtained from the hospital ethics committee, and written informed consent was obtained from all participants. The study included parturients admitted to the labor room at Government Medical College, Thrissur, for safe confinement.

Inclusion and Exclusion Criteria: The study included parturients with ASA physical status I–II, gestational age of 36 weeks or more, uncomplicated pregnancies without cephalopelvic disproportion, normal fetuses in vertex presentation, and those in spontaneous or induced labor who provided the written informed consent. Exclusion criteria comprised parturient refusal, preterm gestation, coagulopathy, infection at the puncture site,

septicaemia, and active maternal haemorrhage or hypovolemia.

Sample Size Calculation: Total of 60 parturients classified into two groups of 30 each, as per statisticians' advice. The sample size was calculated using the formula $n = [Z\alpha + Z\beta \times SD^2] / d^2$ in each group.

$$Z\alpha = 5\%$$

$$Z\beta = 10\%$$

The S.D and d were calculated from the previous study.[11] With the formula, number of subjects in each group was calculated as 13.7

Data Collection Tools: The study used 0.2% ropivacaine, fentanyl, a complete epidural set, 2% lignocaine, syringes, an infusion pump, monitors (ECG, SpO₂, NIBP, defibrillator), resuscitation equipment, and a Numeric Rating Scale. After ethical approval, 60 eligible parturients received a 10 ml bolus of 0.2% ropivacaine with 20 µg fentanyl, then were randomized into Group L (0.1% ropivacaine + 0.5 µg/ml fentanyl at 10 ml/hr) or Group H (0.1% ropivacaine + 1 µg/ml fentanyl at 10 ml/hr) using computer-generated tables. A pretested proforma recorded demographic, clinical, and outcome data.

Data Collection Procedure: A detailed pre-anesthetic evaluation was conducted for each parturient, including demographic data, medical and obstetric history, vital signs, fetal heart rate, vaginal examination, and baseline Numeric Rating Scale (NRS) score. Written informed consent was obtained. In the labor analgesia suite, equipped with resuscitation and airway equipment, standard monitors (ECG, NIBP, SpO₂) were attached, intravenous access secured, and Ringer's lactate started. The parturient was positioned in left lateral decubitus, and after local anesthesia with 2% lignocaine, an 18G Tuohy needle was inserted at L3–L4 using the loss-of-resistance technique, followed by placement of a 20G epidural catheter. A 10 ml bolus of 0.2% ropivacaine with 20 µg fentanyl was administered in two 5 ml doses five minutes apart. After confirming no intravascular or intrathecal placement, infusion was started according to group allocation (Group L: 0.1% ropivacaine + 0.5 µg/ml fentanyl; Group H: 0.1% ropivacaine + 1 µg/ml fentanyl at 10 ml/hr). Pain (NRS), highest sensory level (pin-prick), motor blockade (Bromage scale), anaesthetic consumption, and additional boluses were recorded. Maternal and fetal adverse effects, including hypotension, desaturation, and distress, were monitored and managed. After delivery, patient satisfaction was assessed as "satisfied" or "not satisfied."

Statistical Analysis: In the present study, continuous data were expressed as mean ± standard deviation (SD) and range, and compared between

the two groups using Student's t-test. Categorical data were presented as numbers and percentages, with differences between groups analyzed using the chi-square test. A p value of ≤ 0.05 was considered statistically significant. Data analysis was performed using SPSS software.

Results

Table 1 shows that the two groups were comparable in age distribution, with no statistically significant difference ($p = 0.285$). Most participants were between 19–26 years.

Table 1: Distribution of Age Between Groups

Age Group (Years)	Low Dose Group	High Dose Group	Total
19–22	13	12	25
23–26	9	14	23
27–30	5	2	7
31–34	1	1	2
≥ 35	2	1	3
Total	30	30	60

Table 2 observes that most parturients in both groups belonged to the 60–69 kg range. Weight distribution was statistically comparable ($p = 0.06$).

Table 2: Distribution of Weight between Groups

Weight (kg)	Low Dose Group	High Dose Group	Total
50–59	15	8	23
60–69	13	21	34
70–79	2	1	3
Total	30	30	60

Table 3 shows equal distribution of parity and BMI categories across both groups, indicating good baseline comparability.

Table 3: Parity and BMI Distribution between Groups

Parity Distribution			
Parity	Low Dose	High Dose	Total
Primi	15	16	31
Multi	15	14	29
BMI Distribution			
BMI Category	Low Dose	High Dose	Total
Normal	15	16	31
Overweight	15	14	29
p (Parity) = 0.796			
p (BMI) = 0.176			

Table 4 indicates that cervical dilatation before analgesia was similar in both groups ($p = 0.382$), confirming baseline homogeneity.

Table 4: Baseline Cervical Dilatation at Time of Epidural Placement

Cervical Dilatation (cm)	Low Dose	High Dose	Total
2	4	6	10
3	10	11	21
4	10	12	22
5	5	1	6
6	1	0	1

Table 5 shows that duration of analgesia ranged from 120 to 640 minutes in both groups, with no significant difference ($p = 0.438$).

Table 5: Duration of Analgesia

Duration (minutes)	Low Dose	High Dose
100–200	12	10
201–300	8	9
301–400	8	7
401–500	2	2
501–600	0	1
601–700	0	1

Table 6 summarizes drug consumption. Ropivacaine usage was similar across groups, while fentanyl

dosage was significantly higher in the high-dose group as expected.

Table 6: Total Dose of Ropivacaine and Fentanyl Used

Parameter	Low Dose (Mean)	High Dose (Mean)	p value
Total Local Anesthetic (mg)	63.43	67.54	0.406
Total Opioid (μ g)	41.73	67.54	0.000

Table 7 provides a combined summary of clinical outcomes after epidural analgesia. Pain scores, sensory blockade, and delivery mode were

comparable. No motor blockade or hemodynamic instability occurred.

Table 7: Labor Analgesia Outcomes (VNS, Sensory Level, Mode of Delivery)

VNS Before Procedure		
VNS Score	Low Dose	High Dose
5-9	30	30
VNS After Analgesia		
VNS Score	Low Dose	High Dose
0	8	7
1	11	11
2	11	12
Highest Sensory Level		
Sensory Level	Low Dose	High Dose
T6	11	4
T8	13	13
T10	6	13
Mode of Delivery		
Type	Low Dose	High Dose
Normal Delivery	29	28
Assisted	1	2

Discussion

“Divine is the task of relieving pain” – Hippocrates. Labour is widely recognized as one of the most painful experiences in a woman’s lifetime. Severe labor pain can adversely affect both mother and fetus. Maternal responses to pain include increased mechanical work, hyperventilation, and elevated catecholamine release, which can lead to maternal hypoxia and hypocapnia. These physiological changes may reduce uterine blood flow, impair uterine contractility, and result in fetal hypoxia and metabolic acidosis. Effective labour analgesia is therefore essential to minimize these adverse maternal and fetal outcomes.

In the present study, 60 parturients with uneventful antenatal periods, including both primi- and second gravida, were administered epidural analgesia. The inclusion of both groups was based on the premise that parity alone does not significantly influence analgesic outcomes, as supported by Capogna G et al.[12] who suggested that similar epidural regimens can be applied for nulliparous and multiparous. The groups were comparable in terms of parity (Chi-square = 0.067, $p = 0.796$), confirming the validity of this approach.

All parturients received a 10 ml bolus of 0.2% ropivacaine plus 2 mcg/ml fentanyl, followed by random allocation into two groups: Group H (0.1%

ropivacaine with 1 mcg/ml fentanyl at 10 ml/hour) and Group L (0.1% ropivacaine with 0.5 mcg/ml fentanyl at 10 ml/hour). Breakthrough pain was managed with 5 ml boluses of the respective solution at intervals not shorter than 20 minutes. This regimen is supported by Lee BB et al.[13] who demonstrated that 0.1% ropivacaine provides adequate analgesia comparable to 0.2% ropivacaine for maintenance purposes.

Baseline characteristics, including age, height, weight, BMI, parity, cervical dilatation, and pre-analgesia pain scores, were comparable between the groups, indicating homogeneity. Mean ages were 24.70 ± 4.714 years in Group L and 23.57 ± 3.540 years in Group H ($p = 0.285$). Other parameters, including height, weight, BMI, cervical dilatation, and baseline VNS scores, showed no statistically significant differences ($p > 0.05$).

The mean duration of analgesia was similar between groups (Group L: 256.6 ± 95.87 min, Group H: 279 ± 124.19 min; $p = 0.438$). Total ropivacaine consumption was also comparable (Group L: 63.43 ± 16.34 mg, Group H: 67.54 ± 21.37 mg; $p = 0.406$). As expected, total fentanyl consumption was higher in Group H (67.54 ± 21.36 mcg) compared to Group L (41.72 ± 8.15 mcg). The number of additional bolus supplements did not differ significantly between groups (Group L: 0.47 ± 0.730 , Group H:

0.40 ± 0.675 , $p = 0.714$), consistent with the findings of Lee BB et al. [13]

Post-analgesia VNS scores were similar (Group L: 1.10 ± 0.803 , Group H: 1.17 ± 0.791 , $p = 0.747$), and no significant motor blockade was observed in either group, supporting the observations by J A Katz et al., [14] who reported minimal motor blockade with ropivacaine at these concentrations. The highest level of sensory blockade achieved was T6, which was comparable between groups (Chi-square = 5.846, $p = 0.054$). Maternal satisfaction was also similar, in agreement with the study with Lee BB et al. [13]

Both epidural regimens provided effective analgesia with minimal motor blockade, comparable sensory levels, and similar maternal satisfaction. The addition of higher doses of fentanyl reduced total analgesic consumption but did not significantly alter clinical outcomes, reinforcing the safety and efficacy of low-concentration ropivacaine-fentanyl combinations for labour analgesia.

Conclusion

In this study comparing two doses of fentanyl combined with ropivacaine for epidural labour analgesia, both concentrations were found to be equally effective in providing adequate pain relief throughout labour. The total local anaesthetic requirements were comparable between the groups, and both regimens demonstrated an excellent safety profile, with no motor weakness, hemodynamic instability, or increased incidence of caesarean deliveries. Patient satisfaction scores were also similar across the two concentrations. Overall, these findings suggest that a lower dose of fentanyl in combination with ropivacaine is sufficient to achieve effective and safe labour analgesia while maintaining high maternal satisfaction.

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