Original Article

A Comparative Study of 0.0625% Bupivacaine–Fentanyl versus 0.1% Ropivacaine–Fentanyl for Labour Epidural Analgesia

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Abstract

Background: Epidural analgesia is considered the gold standard for labour pain relief. The goal of using low-concentration local anesthetic-opioid combinations is to minimise motor blockage and negative effects on mothers and newborns while still providing good analgesia. For labour epidural analgesia, 0.0625% bupivacaine–fentanyl and 0.1% ropivacaine–fentanyl were examined in this study. **Materials and Methods:** The Department of Anaesthesiology at the Surabhi Institute of Medical Sciences in Siddipet was the site of this prospective comparative study. Two groups of sixty ASA Grade II primiparous women in established labour, ages 20 to 30, were randomly assigned. Group RF (n=30) was given 0.1% ropivacaine with fentanyl, and Group BF (n=30) was given 0.0625% bupivacaine with fentanyl. Analgesic efficacy, sensory and motor blockade, haemodynamic parameters, top-up dose requirements, maternal satisfaction, mode of delivery, and neonatal outcomes were evaluated. **Results:** The onset of analgesia was significantly faster in Group RF than in Group BF (9.47 ± 1.38 vs. 13.01 ± 1.35 min; $p<0.001$). Group RF demonstrated significantly less motor blockade, reflected by a higher maximum Bromage score (3.90 ± 0.31 vs. 3.40 ± 0.68; $p<0.001$), and required fewer top-up doses (1.17 ± 0.79 vs. 2.17 ± 1.18; $p<0.001$). Pain scores were significantly lower in Group RF at 15 minutes, 25 minutes, 2 hours, and 4.5 hours. Sensory blockade, duration of labour, maternal satisfaction, instrumental delivery rates, neonatal APGAR scores, and haemodynamic parameters were comparable between groups. **Conclusion:** Both regimens provided effective and safe labour epidural analgesia. However, 0.1% ropivacaine–fentanyl offered faster analgesia, reduced motor blockade, lower pain scores, and fewer top-up requirements, making it a favourable option for labour analgesia.

Keywords: Labour analgesia; Epidural analgesia; Ropivacaine; Bupivacaine; Fentanyl.

Received: 06 May 2026 **Revised: 20 May 2026** **Accepted: 09 June 2026** **Published: 15 June 2026**

Introduction

One of the worst types of pain that women encounter is labour pain, which is linked to a great deal of physical and mental strain. Unrelieved pain during labour can trigger neuroendocrine responses that may adversely affect uterine contractions, maternal cardiovascular function, and fetal wellbeing. Therefore, effective pain relief is an essential component of modern obstetric care and contributes to improved maternal and neonatal outcomes.[1]

Among the available methods of labour analgesia, epidural analgesia is considered the gold standard because it provides superior pain relief compared with systemic opioids and non-pharmacological techniques. The technique involves administering analgesic drugs into the epidural space, producing effective sensory blockade while preserving maternal consciousness. This enables women to remain comfortable and actively participate in the birthing process. The use of epidural analgesia has increased worldwide, reflecting its proven efficacy and safety.[2]

Traditional epidural techniques used relatively high concentrations of local anaesthetics, particularly bupivacaine, which provided excellent analgesia but often resulted in significant motor blockade. During the second stage of labour, an excessive motor block may limit the mother's mobility and impede her ability to bear down effectively. Modern labour analgesia uses diluted amounts of opioids and local anaesthetics to get around these restrictions and provide efficient pain relief with little motor impairment.[3,4]

Bupivacaine's lengthy duration of action and excellent sensory blocking have made it the most often utilised local anaesthetic for childbirth epidural analgesia. However, concerns regarding its cardiotoxic and neurotoxic potential have encouraged the development of safer alternatives. Ropivacaine, a pure S-enantiomer of a long-acting amide local anaesthetic, was introduced with the aim of reducing toxicity while maintaining analgesic efficacy. Compared with bupivacaine, ropivacaine provides similar pain relief with less motor blockade, making it particularly suitable for labour analgesia where preservation of maternal mobility is desirable.[5,6]

The addition of fentanyl to epidural local anaesthetic solutions

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DOI:
10.21276/amit.2026.v13.i2.742

How to cite this article: Chakravarthy V, Sai YV. A Comparative Study of 0.0625% Bupivacaine–Fentanyl versus 0.1% Ropivacaine–Fentanyl for Labour Epidural Analgesia. Acta Med Int. 2026;13(2):659-664.

has become a standard practice in modern obstetric anaesthesia. Fentanyl enhances analgesic efficacy through synergistic action with local anaesthetics, allowing lower concentrations of local anaesthetic agents to be used. This combination improves pain control while minimizing adverse effects such as motor blockade and maternal hypotension.

For labour epidural analgesia, a number of studies have contrasted ropivacaine-fentanyl and bupivacaine-fentanyl combinations. Evidence suggests that both regimens provide effective pain relief and high maternal satisfaction. However, ropivacaine-based regimens have been associated with reduced motor blockade while maintaining comparable analgesic efficacy.[7] Low-concentration local anaesthetic solutions have also been shown to reduce motor impairment and assisted vaginal deliveries without compromising the quality of analgesia.[8]

Current methods of epidural analgesia are thought to be safe for both the mother and the foetus. Evidence currently available suggests that epidural analgesia has no effect on neonatal outcomes, including as Apgar ratings, and does not raise the likelihood of caesarean birth.[9] Nevertheless, the optimal choice of local anaesthetic remains a subject of ongoing research. Although several studies suggest advantages of ropivacaine over bupivacaine, direct comparisons between 0.0625% bupivacaine-fentanyl and 0.1% ropivacaine-fentanyl are limited, particularly in Indian populations.[10]

Therefore, the goal of the current study was to assess the safety and effectiveness of 0.1% ropivacaine-fentanyl and 0.0625% bupivacaine-fentanyl for labour epidural analgesia, with a focus on motor blockage, analgesic efficacy, maternal satisfaction, obstetric outcomes, and newborn health.

Materials and Methods

Study Design and Setting: After receiving approval from the Institutional Ethics Committee, this prospective, comparative study was carried out in the Department of Anaesthesiology at Surabhi Institute of Medical Sciences, Siddipet. The study was conducted between March 2024 and December 2025, a span of eighteen months. The initial phase involved understanding the research problem and preparation of the study proforma, followed by a pilot study, validation of the data collection tools, and patient recruitment. Subsequent phases included data analysis, interpretation of results, and preparation of the dissertation.

Study Population and Sample Size: The study included 60 primiparous parturients who met the eligibility requirements and requested labour epidural analgesia. Using computer-generated randomisation tables, participants were divided into two equal groups at random. For labour epidural analgesia, Group BF (n = 30) received 0.0625% bupivacaine with fentanyl, while Group RF (n = 30) received 0.1% ropivacaine with fentanyl.

Eligibility Criteria: Primigravid women aged 20–30 years with ASA physical status II, carrying a single fetus in cephalic presentation and in established labour with cervical dilatation of 3 cm were included in the study after obtaining written informed consent. Patients with significant aortic stenosis, coagulopathies, anatomical abnormalities of the spine, haemodynamic instability, ASA physical status III or higher, or known allergy to local anaesthetics were not allowed to participate.

Pre-procedure Assessment: Every eligible participant had a thorough pre-anesthesia evaluation that included a review of pertinent studies, a physical examination, and a medical history. Age, height, weight, and body mass index (BMI) were among the baseline demographic details that were noted. Baseline haemodynamic parameters including systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), heart rate (HR), and peripheral oxygen saturation (SpO_2) were also documented before initiation of epidural analgesia.

Epidural Technique: Standard monitoring, which included non-invasive blood pressure, pulse oximetry, and electrocardiography, was implemented following transfer to the labour room. An 18-gauge cannula was used to ensure intravenous access, and before to the procedure, each patient was given 500 mL of Ringer's lactate solution. With the patient in the left lateral position, the loss-of-resistance to saline technique and an 18-gauge Tuohy needle were used to locate the epidural space at the L3–L4 intervertebral level. A 20-gauge epidural catheter was inserted three to four centimetres into the epidural space and fastened. In order to rule out intrathecal or intravascular insertion, the proper placement of the catheter was verified with a test dose of 3 mL of 2% lignocaine with adrenaline (1:200,000).

Study Drug Administration: Patients in Group BF were administered a continuous epidural infusion of 0.0625% bupivacaine with fentanyl 2 μg/mL at a rate of 8–10 mL/h after receiving an initial epidural bolus of 10 mL. Patients in Group RF received an initial epidural bolus of 10 mL of 0.1% ropivacaine with fentanyl 2 μg/mL, followed by continuous infusion at a rate of 8–10 mL/h. The time of administration of the initial bolus was considered as time zero for all subsequent observations.

Outcome Assessment: The onset of analgesia, which is defined as the interval between the administration of an epidural medication and the attainment of a Visual Analogue Scale (VAS) pain score of ≤3, was the main end measure. A 10-point VAS was used to measure pain intensity, with 0 denoting no pain and 10 denoting the worst possible agony. Loss of cold sensation was used to assess sensory blockage bilaterally, and the maximum dermatomal level attained was noted. Motor blockade was assessed using the modified Bromage scale at regular intervals throughout labour. Maternal haemodynamic parameters, including SBP, DBP, MAP, HR, and SpO_2, were recorded at baseline, 5, 10, 15, 20, 25, and 30 minutes after epidural administration and subsequently every 30 minutes until delivery. A drop in SBP of more than 20% from baseline or an absolute value of less than 90 mmHg was considered hypotension, which was treated with intravenous fluids and ephedrine as needed.

Labour and Neonatal Outcomes: The duration of labour from epidural catheter insertion until delivery was recorded. Additional top-up doses of the respective study drug were administered whenever the VAS score exceeded 4 or analgesia was considered inadequate, and the total number of top-ups was documented. The mode of delivery was classified as normal vaginal delivery, instrumental vaginal delivery, or caesarean

section. Maternal satisfaction with labour analgesia was assessed after delivery using a 4-point verbal rating scale ranging from poor to excellent. Neonatal outcome was evaluated using Apgar scores at 1 and 5 minutes after birth, and any neonatal complications or need for resuscitation were documented. Maternal adverse effects such as hypotension, bradycardia, nausea, vomiting, pruritus, shivering, respiratory depression, and local anaesthetic toxicity, along with fetal heart rate abnormalities, were also recorded.

Statistical Analysis: All study data were recorded in a predesigned case record form and entered into Microsoft Excel for analysis. Categorical variables were shown as frequencies and percentages, whilst continuous variables were given as mean ± standard deviation. For continuous variables, the student's t-test was used to compare the two groups; for categorical variables, the Chi-square test or Fisher's exact test were used. Statistical significance was defined as a p-value of less than 0.05.

Results

The mean age was comparable between Group BF (25.73 ± 2.95 years) and Group RF (24.60 ± 3.20 years) (p=0.159). In Group BF, 40.0% of participants were aged 20–25 years and 60.0% were aged 26–30 years, compared with 53.3% and 46.7%, respectively, in Group RF (p=0.438). The mean BMI was 24.70 ± 2.41 kg/m² in Group BF and 25.12 ± 2.44 kg/m² in Group RF (p=0.512). Normal BMI was observed in 46.7% and 53.3% of participants, while overweight status was present in 53.3% and 43.3% of participants in Groups BF and RF, respectively; one participant (3.3%) in Group RF was obese (p=0.606). All participants in both groups belonged to ASA Grade II (100%) [Table 1].

Table 1: Baseline demographic and clinical characteristics of the study participants in the Bupivacaine–Fentanyl (BF) and Ropivacaine–Fentanyl (RF) groups.

Variable	Group BF (n=30)	Group RF (n=30)	p-value
Mean age (years)	25.73 ± 2.95	24.60 ± 3.20	0.159
Age category 20–25 years	12 (40.0)	16 (53.3)	0.438
Age category 26–30 years	18 (60.0)	14 (46.7)	
BMI (kg/m²)	24.70 ± 2.41	25.12 ± 2.44	0.512
Normal BMI	14 (46.7)	16 (53.3)	0.606
Overweight	16 (53.3)	13 (43.3)	
Obese	0 (0.0)	1 (3.3)	
ASA Grade II	30 (100)	30 (100)	—

Group RF experienced a considerably shorter mean onset of analgesia (9.47 ± 1.38 min) than Group BF (13.01 ± 1.35 min) (p<0.001). Group BF (6.33 ± 1.58 h) and Group RF (6.38 ± 1.58 h) had similar labour durations (p=0.903). The maximum Bromage score was significantly higher in Group RF (3.90 ± 0.31) than in Group BF (3.40 ± 0.68) (p<0.001), indicating less motor blockade with ropivacaine. The mean number of top-up doses required was significantly lower in Group RF (1.17 ± 0.79) compared with Group BF (2.17 ± 1.18) (p<0.001) [Table 2].

Table 2: Comparison of analgesic characteristics, motor blockade, and labour outcomes between the Bupivacaine–Fentanyl and Ropivacaine–Fentanyl groups.

Variable	Group BF	Group RF	p-value
Onset of analgesia (min)	13.01 ± 1.35	9.47 ± 1.38	<0.001
Duration of labour (h)	6.33 ± 1.58	6.38 ± 1.58	0.903
Maximum Bromage score	3.40 ± 0.68	3.90 ± 0.31	<0.001
Top-up doses	2.17 ± 1.18	1.17 ± 0.79	<0.001

The maximum sensory block level achieved was T10 in 60.0% of patients in Group BF and 30.0% of patients in Group RF, whereas T9 was observed in 23.3% and 40.0%, and T8 in 16.7% and 30.0% of patients, respectively. Despite the fact that a higher percentage of patients in Group RF had higher sensory block levels (T8–T9), there was no statistically significant difference between the groups (p=0.078) [Table 3].

Table 3: Distribution of maximum sensory block level achieved following epidural analgesia in the study groups.

Level	BF n (%)	RF n (%)	p-value
T8	5 (16.7)	9 (30.0)	0.078
T9	7 (23.3)	12 (40.0)	
T10	18 (60.0)	9 (30.0)	

Six patients (20.0%) in Group BF and seven patients (23.3%) in Group RF required instrumental delivery; there was no significant difference between the groups (p=1.000). Five (16.7%) and seven (23.3%) patients in Group BF and Group RF, respectively, evaluated maternal satisfaction as excellent, twenty (66.7%) and twenty-two (73.3%) as good, and five (16.7%) and one (3.3%) as fair (p=0.234). The mean APGAR score at 1 minute was 8.13 ± 0.78 in Group BF and 8.17 ± 0.46 in Group RF (p=0.840), while at 5 minutes it was 9.13 ± 0.78 and 9.47 ± 0.57, respectively (p=0.063) [Table 4].

Table 4: Comparison of obstetric outcomes, maternal satisfaction, and neonatal outcomes between the Bupivacaine–Fentanyl and Ropivacaine–Fentanyl groups.

Variable	Group BF	Group RF	p-value
Instrumental delivery	6 (20.0)	7 (23.3)	1.000
Maternal satisfaction – Excellent	5 (16.7)	7 (23.3)	0.234
Maternal satisfaction – Good	20 (66.7)	22 (73.3)	
Maternal satisfaction – Fair	5 (16.7)	1 (3.3)	
APGAR at 1 min	8.13 ± 0.78	8.17 ± 0.46	0.840
APGAR at 5 min	9.13 ± 0.78	9.47 ± 0.57	0.063

The baseline maternal hemodynamic parameters were comparable between the two groups. The mean baseline SBP was 125.93 ± 8.03 mmHg in Group BF and 123.73 ± 6.02 mmHg in Group RF (p=0.235). The mean baseline DBP was 72.90 ± 7.23 mmHg and 72.57 ± 5.97 mmHg, respectively (p=0.846). The mean baseline MAP was 90.63 ± 5.80 mmHg in Group BF and 89.67 ± 4.77 mmHg in Group RF (p=0.484).

The mean baseline HR was 90.03 ± 7.71 bpm in Group BF and 88.03 ± 7.87 bpm in Group RF (p=0.324), while the mean baseline SpO_2 was 99.07 ± 0.58% and 99.03 ± 0.72%, respectively (p=0.844). No statistically significant differences were observed in any baseline hemodynamic parameter between the groups [Table 5].

Table 5: Baseline maternal hemodynamic parameters in the Bupivacaine–Fentanyl and Ropivacaine–Fentanyl groups.

Parameter	Group BF	Group RF	p-value
Baseline SBP (mmHg)	125.93 ± 8.03	123.73 ± 6.02	0.235
Baseline DBP (mmHg)	72.90 ± 7.23	72.57 ± 5.97	0.846
Baseline MAP (mmHg)	90.63 ± 5.80	89.67 ± 4.77	0.484
Baseline HR (bpm)	90.03 ± 7.71	88.03 ± 7.87	0.324
Baseline SpO_2 (%)	99.07 ± 0.58	99.03 ± 0.72	0.844

A statistically significant difference in systolic blood pressure was observed at 2 hours, with Group BF showing a higher mean SBP (114.23 ± 8.82 mmHg) compared with Group RF (109.57 ± 6.26 mmHg) (p=0.021). Similarly, the mean heart rate was significantly higher in Group BF than in Group RF at 3 hours (87.77 ± 7.98 vs. 83.33 ± 8.63 bpm; p=0.043) and at 4 hours (85.93 ± 7.19 vs. 81.04 ± 7.95 bpm; p=0.022) [Table 6].

Table 6: Significant differences in maternal hemodynamic parameters observed during labour between the study groups.

Parameter	Time point	BF	RF	p-value
SBP	2 h	114.23 ± 8.82	109.57 ± 6.26	0.021
HR	3 h	87.77 ± 7.98	83.33 ± 8.63	0.043
HR	4 h	85.93 ± 7.19	81.04 ± 7.95	0.022

The baseline pain intensity scores were comparable between Group BF (7.93 ± 0.64) and Group RF (7.87 ± 0.82) (p=0.727). At 15 minutes, the mean pain score was significantly lower in Group RF than in Group BF (0.77 ± 0.68 vs. 1.57 ± 0.86; p<0.001). Similar significant differences were observed at 25 minutes (0.73 ± 0.74 vs. 1.27 ± 0.91; p=0.015), 2 hours (0.70 ± 0.70 vs. 1.63 ± 1.19; p<0.001), and 4.5 hours (0.77 ± 0.93 vs. 1.57 ± 1.25; p=0.046), with Group RF consistently demonstrating lower pain scores than Group BF [Table 7].

Table 7: Comparison of pain intensity scores at selected time points during labour in the Bupivacaine–Fentanyl and Ropivacaine–Fentanyl groups.

Time point	BF	RF	p-value
Baseline	7.93 ± 0.64	7.87 ± 0.82	0.727
15 min	1.57 ± 0.86	0.77 ± 0.68	<0.001
25 min	1.27 ± 0.91	0.73 ± 0.74	0.015
2 h	1.63 ± 1.19	0.70 ± 0.70	<0.001
4.5 h	1.57 ± 1.25	0.77 ± 0.93	0.046

Discussion

The present study compared 0.0625% bupivacaine–fentanyl with 0.1% ropivacaine–fentanyl for labour epidural analgesia. Both groups were comparable with respect to age, BMI, and ASA status, thereby minimizing the influence of demographic variables on study outcomes.

The ropivacaine group experienced a substantially faster onset of analgesia (9.47 ± 1.38 min) than the bupivacaine group (13.01 ± 1.35 min) (p<0.001). Mounika et al. reported similar results.[11] who observed lower pain scores at 20 and 30 minutes in the ropivacaine group, and by Shenvi et al,[16] who also demonstrated a faster onset with ropivacaine. In contrast, Chethanananda et al,[17] and the meta-analysis by Guo et al,[18] found no significant difference in onset between the two regimens. The faster onset observed in the present study therefore supports the findings favouring ropivacaine.

Regarding sensory blockade, 60.0% of patients in the bupivacaine group achieved a T10 block, whereas 40.0% and 30.0% of patients in the ropivacaine group achieved T9 and T8

levels, respectively. However, the difference was not statistically significant (p=0.078). This observation is consistent with Chethanananda et al,[17] Bhatia et al,[12] and the meta-analysis by Guo et al,[18] all of whom reported comparable sensory blockade between bupivacaine–fentanyl and ropivacaine–fentanyl combinations.

Motor blockade was significantly lower in the ropivacaine group, with a higher maximum Bromage score (3.90 ± 0.31 vs. 3.40 ± 0.68; p<0.001). This finding agrees with Mounika et al,[11] who reported significantly greater motor blockade in the bupivacaine group (p=0.0074), and with the meta-analysis by Guo et al,[18] which demonstrated significantly lower motor blockade with ropivacaine (OR 0.38; p<0.00001). However, Chethanananda et al,[17] Shivani et al,[13] Shenvi et al,[16] and Dresner et al,[19] reported no significant difference in motor blockade between the two regimens.

The number of top-up doses required was significantly lower in the ropivacaine group (1.17 ± 0.79 vs. 2.17 ± 1.18; p<0.001), indicating more sustained analgesia. This finding is supported by Mounika et al,[11] who reported superior analgesic quality with ropivacaine. Furthermore, the ropivacaine group showed improved analgesic maintenance during labour, with significantly reduced pain intensity scores at 15 minutes (p<0.001), 25 minutes (p=0.015), 2 hours (p<0.001), and 4.5 hours (p=0.046).

Both groups maintained stable hemodynamic profiles. Baseline SBP, DBP, MAP, HR, and SpO_2 values were comparable. Although significant differences were observed in SBP at 2 hours (p=0.021) and HR at 3 and 4 hours (p=0.043 and p=0.022, respectively), all values remained within normal physiological limits. These findings are in agreement with Mounika et al,[11] Bhatia et al,[12] Najeeb et al,[14] and Chethanananda et al,[17] who reported no clinically significant hemodynamic disturbances with either regimen. Similarly, Kulkarni et al,[15] found minimal differences between the groups, while Shivani et al,[13] reported occasional hypotension in both groups without significant clinical consequences.

In the ropivacaine group, 23.3% of patients needed instrumental delivery, compared to 20.0% in the bupivacaine group (p=1.000). Mounika et al,[11] Chethanananda et al,[17] and Dresner et al. are all in agreement with this result,[19] and the meta-analysis by Guo et al,[18] all of whom reported comparable rates of instrumental delivery between the two regimens. However, Shenvi et al,[16] observed a higher rate of instrumental delivery in the ropivacaine group.

In both groups, mothers were quite satisfied. In the bupivacaine group, 16.7% of patients claimed excellent satisfaction, whereas in the ropivacaine group, 23.3% reported high satisfaction (p=0.234). Although the difference was not statistically significant, the trend towards greater satisfaction with ropivacaine is similar to the findings of Mounika et al,[11] who reported significantly better maternal satisfaction with ropivacaine (p=0.0005). In contrast, Chethanananda et al,[17] Shivani et al,[13] Dresner et al,[19] and the meta-analysis by Guo et al,[18] found comparable maternal satisfaction between the two groups.

Neonatal outcomes were favourable and comparable in both groups. Mean APGAR scores at 1 minute were 8.13 ± 0.78 and 8.17 ± 0.46 (p=0.840), while scores at 5 minutes were 9.13 ± 0.78 and 9.47 ± 0.57 (p=0.063) in the bupivacaine and ropivacaine groups, respectively. These findings are consistent with Mounika et al,[11] Bhatia et al,[12] Chethanananda et al,[17] Najeeb et al,[14] Shivani et al,[13] and the meta-analysis by Guo et al,[18] all of which demonstrated comparable neonatal outcomes between bupivacaine–fentanyl and ropivacaine–fentanyl regimens. Overall, the neonatal data confirm the safety of both epidural analgesic combinations.

The present study has several strengths, including its prospective comparative design, uniform inclusion of ASA Grade II primiparous women, standardized epidural technique, and comprehensive assessment of analgesic efficacy, motor blockade, maternal satisfaction, obstetric outcomes, neonatal wellbeing, and hemodynamic parameters. The comparable baseline characteristics between groups enhanced the validity of the findings. It is important to recognise some limitations, though. The study's limited sample size of 60 participants and single location may have limited how far the findings may be applied. Additionally, long-term maternal and neonatal outcomes were not evaluated, and the study population was restricted to healthy primiparous women, limiting extrapolation to higher-risk obstetric populations.

Conclusion

Both 0.0625% bupivacaine–fentanyl and 0.1% ropivacaine–fentanyl provided effective and safe labour epidural analgesia with comparable obstetric outcomes, maternal satisfaction, neonatal wellbeing, and overall hemodynamic stability. However, the ropivacaine–fentanyl combination was associated with a significantly faster onset of analgesia, lower pain scores at selected time points, fewer top-up dose requirements, and significantly less motor blockade compared with the bupivacaine–fentanyl combination. These advantages suggest that 0.1% ropivacaine with fentanyl may be a more favourable option for labour epidural analgesia, particularly when preservation of motor function and sustained analgesic efficacy are desired. Further large-scale multicentric studies are warranted to confirm these findings and evaluate long-term maternal and neonatal outcomes.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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