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ORIGINAL RESEARCH

Addition of Lidocaine to Ropivacaine and Sufentanil for Epidural Labour Analgesia: A Randomised Double-Blind Study on the Incidence of Epidural-Related Maternal Fever

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Background: Epidural-related maternal fever (ERMF) is a common complication of labour analgesia. In vitro evidence suggests ropivacaine provokes inflammatory cytokine release, while lidocaine may exert anti-inflammatory effects. We hypothesized that the addition of lidocaine to a ropivacaine-based epidural solution would reduce the incidence of ERMF.

Methods: In this randomised, double-blind trial, 400 parturients received epidural analgesia with 0.075% ropivacaine and 0.5 μg/mL sufentanil, with or without 0.5% lidocaine. The primary outcome was the incidence of ERMF (tympanic temperature ≥38.0°C).

Results: ERMF incidence was significantly lower in the lidocaine group (14.1%) than in the control group (28.3%), with an absolute risk reduction of 14.2% (95% *CI*: 5.6–22.7; *P*=0.0013). No significant differences were found in maternal antibiotic use or neonatal sepsis evaluations.

Conclusion: The addition of lidocaine to ropivacaine for epidural labour analgesia significantly reduced the incidence of ERMF. This finding suggests a simple and promising strategy for preventing this common complication, warranting further investigation into its mechanisms and clinical utility.

Keywords: analgesia, epidural, fever, labour pain, lidocaine, ropivacaine

Introduction

Epidural-related maternal fever (ERMF) complicates 15–25% of labour analgesia administrations.[1,2] This intrapartum fever is clinically significant, as it is associated with increased neonatal sepsis evaluations, maternal antibiotic administration, and prolonged hospitalization.[3–6] Despite its clinical importance, the pathophysiology of ERMF remains incompletely understood, and no reliably safe preventive strategy exists.[2]

A leading pathogenic theory centres on non-infectious inflammation, characterized by elevated proinflammatory cytokines.[7] Local anesthetics themselves are implicated in this process, with evidence suggesting they can induce cytokine release at a cellular level.[7–10] Notably, a recent in vitro investigation by Wohlrab et al demonstrated that ropivacaine exposure triggered a dose-dependent release of IL-6, IL-8, and PGE2 from human umbilical vein endothelial cells and placental trophoblasts.[11] In contrast, lidocaine was not associated with this proinflammatory response and even appeared to exhibit anti-inflammatory properties over time.[11]

These contrasting molecular effects prompted us to formulate the clinical hypothesis that supplementing ropivacaine with lidocaine for epidural labour analgesia could mitigate ERMF. To test this, we conducted a randomised, double-blind

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trial to compare the incidence of ERMF in parturients receiving a ropivacaine-sufentanil epidural solution with or without the addition of 0.5% lidocaine.

Materials and Methods

Study Design

This double-blind, parallel-arm, randomised controlled trial was approved by the institutional review board of Jiaxing University Affiliated Women and Children Hospital (IRB 2023–187) and prospectively registered with the Chinese Clinical Trial Registry (ChiCTR2300075546; Sept 8, 2023). The study was conducted in accordance with the Declaration of Helsinki and reported following CONSORT guidelines.

A pilot investigation indicated ERMF incidences of 30% and 16% without and with lidocaine, respectively. To detect this 14% difference with 80% power at a two-tailed αof 0.05, 146 participants per group were required. We enrolled 200 per group (400 total) to account for dropouts. Written informed consent was obtained from all participants prior to enrollment.

Patients and Setting

We enrolled 400 American Society of Anesthesiologists (ASA) physical status II parturients requesting epidural labour analgesia. Inclusion criteria comprised primiparity, a gestational age of 37–42 weeks, singleton pregnancy with cephalic presentation, age 20–40 years, and cervical dilation of 2–5 cm. All participants had normal white blood cell counts and hemoglobin levels, and an initial tympanic temperature <38.0 °C. Key exclusion criteria were contraindications to neuraxial analgesia, active infectious disease, premature rupture of membranes, hypertension, gestational diabetes, and thyroid disease. Parturients with a duration of analgesia <2 hours were excluded from the final analysis.

Study Protocol

The temperature in the delivery room was thermostatically controlled at 22 °C to maintain a stable thermal environment and minimize the potential confounding effect of ambient temperature fluctuations on maternal body temperature. Parturients were randomly assigned to one of two groups in a 1:1 ratio. Group R received an epidural solution of 0.075% ropivacaine and 0.5 μg/mL sufentanil. Group RL received the same solution with the addition of 0.5% lidocaine. Both solutions were prepared aseptically in advance by an anesthesia assistant not involved in the study to a total volume of 100 mL. Randomisation was performed according to computer-generated random numbers (Microsoft Excel, Microsoft Corporation, Redmond, WA, USA). Randomisation codes were placed into opaque sealed envelopes, one of which was opened for each patient after enrollment.

Epidural catheterization was performed at the L3-4 interspace using a loss-of-resistance to saline technique by one of two consultant anesthetists (Bei Shen or Jing Qian), who were blinded to group assignment. A test dose of 8 mL study solution was administered epidurally over one minute. Two minutes later, after confirming no signs of intravascular or intrathecal injection, an initial 8 mL bolus was administered at 350 mL/h via an infusion pump (Apon MC ZZB-IV, Jiangsu Apon Medical Technology, Jiangsu, China), followed by a programmed intermittent epidural bolus (PIEB) regimen of 8 mL every 40 minutes. Parturients who did not achieve an numeric rating scale (NRS) pain score ≤ 3 within 30 minutes after the loading dose were considered to have a non-functioning catheter and were withdrawn from the study, with further management at the anaesthetist's discretion. Only those with effective analgesia were included in the final analysis.

Analgesia was maintained using programmed intermittent epidural bolus (PIEB: 8 mL every 40 minutes) combined with patient-controlled epidural analgesia (PCEA: 8 mL bolus, 15-minute lockout). The maximum hourly dose was set at 40 mL. This regimen permitted a maximum theoretical lidocaine exposure of 200 mg/hour, representing a safety ceiling rather than a typical delivery rate. All parturients and their fetuses were continuously monitored for signs of local anesthetic systemic toxicity. Breakthrough pain, defined as a pain score >3 after one PCEA bolus prompting a request for additional analgesia, was treated with a 10 mL bolus of 0.25% ropivacaine. If the pain score remained >3 after 10 minutes, the catheter was excluded, and the patient was managed at the attending anesthesiologist's discretion.

Our labour management protocol involved amniotomy during active labour after engagement of the fetal head. The progress of labour was assessed through pelvic examinations at approximately two-hour intervals. Oxytocin was administered for labour augmentation when the rate of cervical dilation was < 1 cm/h with hypotonic uterine contractions, identified by internal electronic fetal monitoring.

Measurements

The primary outcome was the incidence of ERMF, defined as an intrapartum tympanic temperature ≥ 38.0°C. Temperature was measured using an infrared ear thermometer (IRT6520, Kaz Europe, Lausanne, Switzerland) prior to neuraxial analgesia and subsequently at 1-hour intervals. To ensure measurement accuracy and consistency, the thermometer was calibrated annually by the manufacturer in accordance with ISO 13485 standards, and all participating midwives and research nurses received standardized training prior to study initiation. Parturients who developed fever were managed according to standard labour room protocol, receiving either ibuprofen (0.2–0.3 g) or paracetamol (1–1.5 g) orally at the obstetrician's discretion. Antibiotic administration was similarly based on clinical assessment by the attending obstetrician.

Secondary outcomes included pain scores (assessed pre-epidural analgesia, 30- min post-loading, then hourly), patient satisfaction score (1–5), breakthrough pain, sensory block level (assessed with alcohol-soaked cotton) and motor block (modified Bromage score), frequency of vaginal examination, length of membrane rupture, delivery mode (vaginal, cesarean or instrumental), neonatal outcomes (Apgar scores umbilical arterial pH, NICU admission for sepsis evaluation), and side effects (pruritus, nausea, vomiting, hypotension, fetal bradycardia and prolonged deceleration).

Statistical Analysis

Statistical analyses were performed using GraphPad Prism ver 5.0 (GraphPad Software Inc., San Diego, CA, USA), IBM SPSS Statistics for Windows ver 22.0 (IBM Corp, Armonk, NY, USA) and Confidence Interval Analysis 2.2.0 (Trevor Bryant, University of Southampton, Southampton, UK). The primary outcome (the incidence of ERMF) was assessed on both intention-to-treat (ITT; all randomised participants, n=400) and per-protocol bases. Baseline characteristics were compared between analyzed and excluded patients to assess potential attrition bias. Group comparisons were conducted as follows: categorical variables (including ERMF incidence) using the chi-square test; normally distributed continuous variables, presented as mean (SD), using Student's *t*-test; and non-normally distributed continuous variables, presented as median (IQR), using the Mann–Whitney *U*-test. The normality of distribution was determined using the Kolmogorov–Smirnov test. Time to development of ERMF was compared using Kaplan-Meier survival analysis with the Mantel-Cox Log rank test. For serial pain score measurements, the standardized area under the curve (AUC) was calculated and compared between groups using the Mann–Whitney *U*-test. A two-tailed $P < 0.05$ was considered statistically significant.

Results

Of 430 parturients screened and assessed for eligibility, 400 parturients were randomised to Group R or Group RL (Figure 1). Fifty-seven parturients were excluded from the final per-protocol analysis for the following reasons: ineffective analgesia 30 minutes after the initial loading dose (n=9), incomplete data (n=20), first stage of labour less than two hours (n=10), unintentional dura puncture (n=5), or patient request to change pain management (n=13). Consequently, the final analysis included 343 patients. Baseline characteristics were comparable between the two treatment groups (Table 1).

The incidence of ERMF was significantly lower in Group RL than in Group R. This finding was consistent across different analytical methods. In the intention-to-treat analysis (which included all 400 randomised participants), the incidence was 15.0% (30/200) in Group RL versus 29.5% (59/200) in Group R ($P < 0.001$). The per-protocol analysis yielded similar results, with incidences of 14.1% (25/177) and 28.3% (47/166), respectively (absolute difference 14.2%, 95% CI 5.6 to 22.7; P=0.0013). Kaplan-Meier analysis further confirmed this benefit, demonstrating a significant prolongation of time to ERMF in Group RL (Figure 2).

Pain scores over time are shown in Figure 3. The standardised AUC value was significant lower in Group LR (1.9 [IQR 1.8–2.1]) than in Group R (2.0 [IQR 1.8–2.3]) ($P = 0.024$). There was no difference in the number of patients with

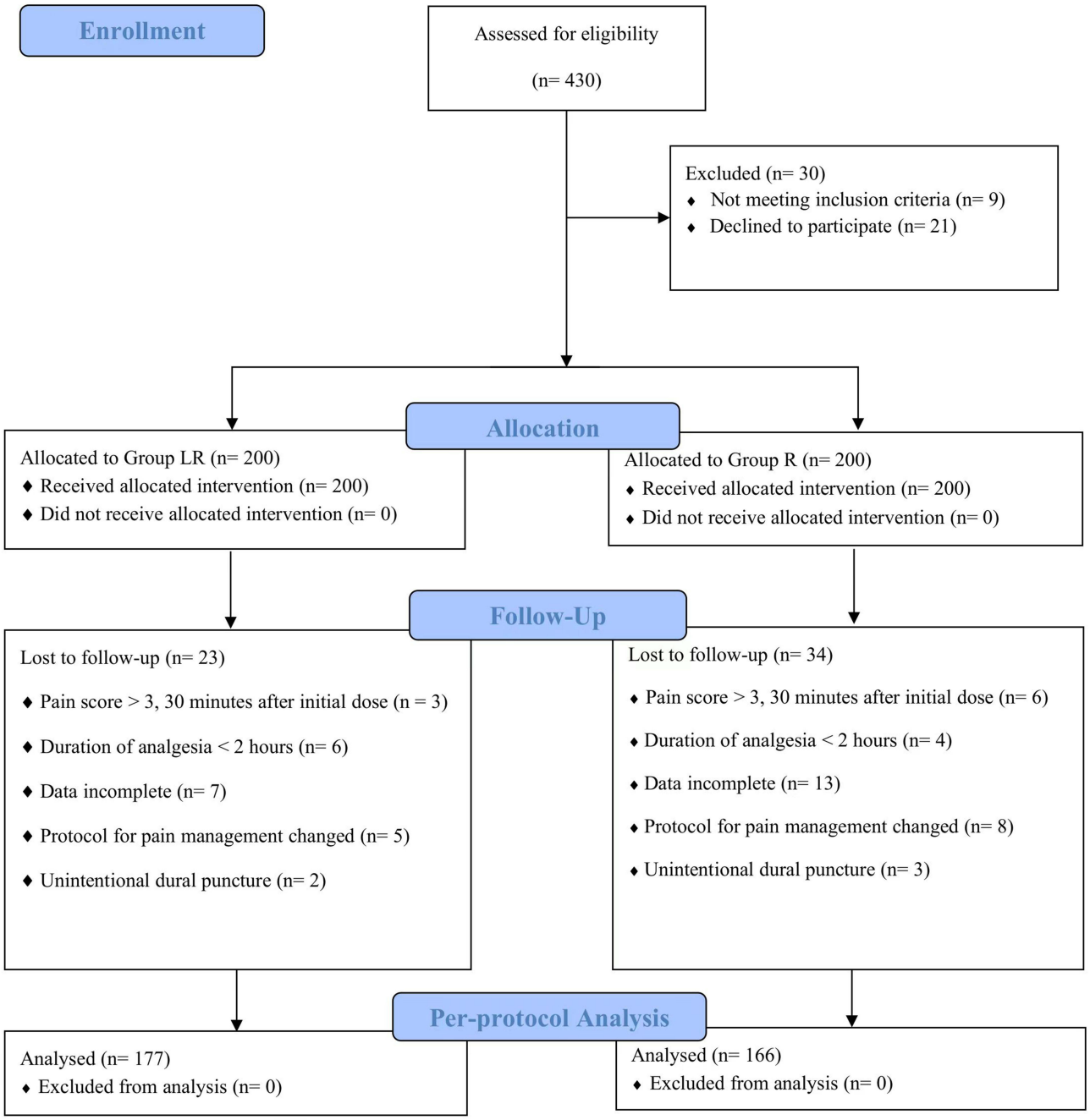

Figure 1 CONSORT flow diagram. This illustrates the enrollment and outcomes of parturients randomised to receive epidural analgesia with ropivacaine-sufentanil (Group R, n=200) or with added lidocaine (Group RL, n=200). The final per-protocol analysis included 343 women.

breakthrough pain between group LR (26/177 [14.7%]) and Group R (26/166 [15.7%]) ($P = 0.80$). Total consumption of ropivacaine and the number of PCEA boluses were smaller in Group RL compared with Group R (Table 2).

There was no difference between groups in maternal side effects, mode of delivery, or neonatal outcome (Table 2).

Table 1 Baseline Characteristics of the Study Participants

	LR Group (n = 177)	R Group (n = 166)	*P* value
Age, year	27.4 (3.9)	27.0 (3.0)	0.33
Weight, kg	69.5 (9.1)	69.7 (9.8)	0.81
Height, cm	162.1 (5.1)	161.0 (4.7)	0.05
Gestational age, wks	39.6 (1.3)	39.6 (1.3)	0.47
Cervical dilation at request for epidural analgesia, cm	2 (2–2)	2 (2–2)	0.22
Number of vaginal examinations	5 (5–7)	6 (5–7)	0.15
Length of membrane rupture, hour	7 (5–9)	7 (4–9)	0.49
Temperature at epidural analgesia initiation, °C	36.95 (0.278)	36.92 (0.282)	0.45

Notes: Data are presented as mean (SD) or median (IQR). Group definitions.
Abbreviations: RL, ropivacaine-sufentanil-lidocaine; R, ropivacaine-sufentanil.

Discussion

This randomised controlled trial demonstrates that the addition of 0.5% lidocaine to a ropivacaine-sufentanil epidural solution significantly reduced the incidence of ERMF without increasing the risk of adverse maternal or neonatal outcomes. Concurrently, the intervention provided superior analgesic efficacy, as reflected by lower pain scores, reduced ropivacaine consumption, and decreased demand for PCEA.

Given the relatively high incidence of ERMF in parturients receiving epidural analgesia[1,3,5,10,12] and its potential adverse outcomes,[3,13] there has been considerable interest in preventive strategies. However, no method to date has proven both effective and safe. Administration of paracetamol or broad-spectrum antibiotics does not reduce ERMF incidence.[14,15] Although high-dose methylprednisolone can decrease the incidence of intrapartum fever—supporting an inflammatory aetiology—its utility is offset by an associated increase in asymptomatic neonatal bacteremia.[16] A recent systematic review and meta-analysis of 34 studies concluded that no specific preventive or treatment measure for ERMF is supported by clear evidence.[17]

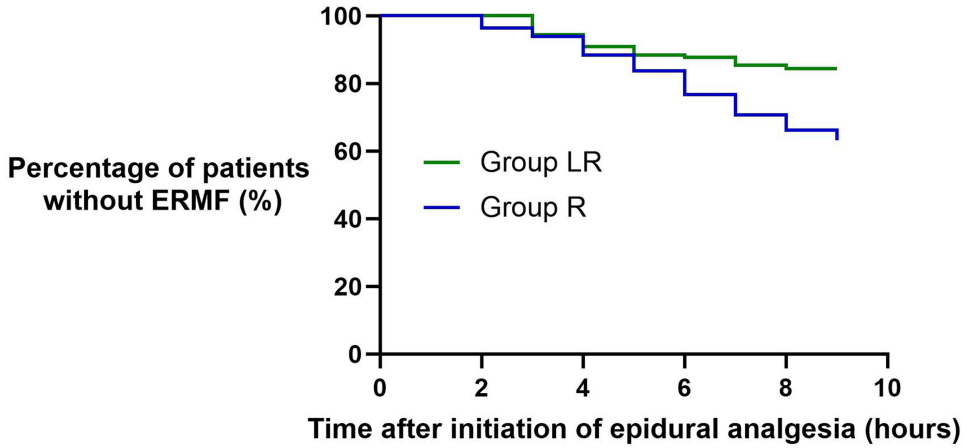

Figure 2 Kaplan-Meier analysis of epidural-related maternal fever (ERMF) incidence. Parturients in Group RL (ropivacaine-sufentanil-lidocaine) maintained a significantly higher rate of remaining afebrile compared to Group R (ropivacaine-sufentanil) throughout labour analgesia ($P < 0.001$, Log rank test).

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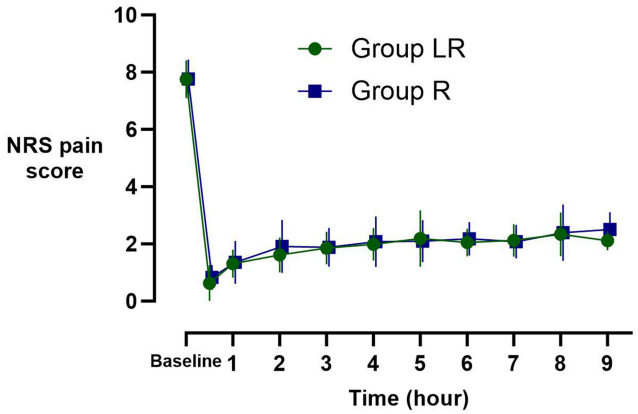

Figure 3 Numeric Rating Scale (NRS, 0–10) pain scores over time during labour analgesia for parturients receiving ropivacaine-sufentanil with lidocaine (Group RL) and those receiving ropivacaine-sufentanil alone (Group R). The standardized area under the curve (AUC) was significantly lower in Group RL ($P = 0.024$), indicating superior analgesic efficacy.

In contrast to the above, our study demonstrates that adding lidocaine to ropivacaine can decrease the incidence of ERMF by half without clinically important adverse effects. This clinically important finding merits further investigation into its reproducibility and potential routine practice.

Table 2 Maternal Fever Incidence, Analgesia Characteristics and Labor Outcomes

	Group LR (n = 177)	**Group R (n = 166)**	***P* value**
ERMF, n (%)	25 (14.12)	47 (28.31)	0.001
≥ 38.5 °C, n (%)	2 (1.1)	2 (1.2)	0.95
Parturients received antibiotics, n (%)	16 (9.04)	25 (15.06)	0.09
Breakthrough pain, n (%)	26 (14.69)	26 (15.66)	0.80
Total consumption of ropivacaine, mg	72 (54–90)	90 (72–114)	<0.0001
Number of PCEA boluses in patients requiring PCEA	3 (2–3)	5 (4–5)	<0.0001
Total consumption of lidocaine	420 (340–500)	–	–
Intrapartum cesarean delivery, n (%)	15 (8.47)	17 (10.24)	0.57
Instrumental vaginal delivery, n (%)	16 (9.03)	19 (11.45)	0.74
Admission to NICU, n (%)	12 (6.78)	19 (11.45)	0.60
Thoracic sensory block level at 30 min	T10 (T8-T10)	T10 (T8-T10)	0.08
Bromage score > 0 at 30 min, n (%)	10 (5.65)	11 (6.63)	0.82
Duration of analgesia, min	348 (274–437)	351 (279–491)	0.08
Duration of first stage of labor, min	390 (285–510)	420 (330–553)	0.06
Duration of second stage of labor, min	47 (32–63)	48 (35–69)	0.09
Oxytocin augmentation after analgesia	74 (41.81)	73 (44.24)	0.74

(*Continued*)

Table 2 (Continued).

	Group LR (n = 177)	Group R (n = 166)	*P* value
Adverse effects			
Pruritus	58 (32.76)	53 (31.93)	0.91
Nausea	28 (15.82)	25 (15.06)	0.88
Vomiting	19 (10.73)	17 (10.24)	1.00
Hypotension	8 (4.51)	9 (5.42)	0.81
Fetal bradycardia	3 (1.69)	3 (1.80)	1.00
Prolonged deceleration	5 (2.82)	4 (2.41)	1.00
Apgar score at 1 min	10 (10–10)	10 (10–10)	0.59
Apgar score at 5 min	10 (10–10)	10 (10–10)	0.45
Umbilical arterial pH	7.29 (0.062)	7.29 (0.059)	0.80
Patient satisfaction	5 (4.5–5.0)	5 (4.0–5.0)	0.10

Notes: Group definitions: RL, ropivacaine-sufentanil-lidocaine; R, ropivacaine-sufentanil. ERMF was defined as temperature ≥38.0°C. Data are n (%), mean (SD), or median (IQR). PCEA, patient-controlled epidural analgesia; NICU, neonatal intensive care unit.

In our protocol, lidocaine was added without reducing the ropivacaine concentration, resulting in a higher total local anesthetic dose for Group RL. This likely accounts for the improved analgesia observed but is an unlikely primary explanation for the reduction in ERMF, as evidence suggests local anesthetic concentration has minimal impact on its incidence.[18] Thus, while the contribution of the higher dose cannot be excluded, it is not the most plausible mechanism. A study using equipotent mixtures would be of interest to further investigate this.

The exact mechanism underlying ERMF remains incompletely elucidated, with current evidence favoring a non-infectious inflammatory process mediated by proinflammatory cytokines.[2,8,11] This is supported by in vitro findings that ropivacaine induces inflammatory cytokine release, whereas lidocaine inhibits it.[11] The 0.5% lidocaine concentration used herein is a clinically established epidural dose, which falls within a range documented to possess anti-inflammatory properties, thereby supporting its biological plausibility for mitigating ERMF.[19–22] Further studies are needed to elucidate the specific anti-inflammatory mechanisms of epidural lidocaine. In our study, the significant reduction in ERMF did not translate to differences in antibiotic use or NICU admissions. This is likely because these outcomes were influenced by complex clinical assessments rather than dictated by the study protocol, limiting definitive conclusions regarding their relationship with lidocaine administration.

We acknowledge several limitations in our study. First, we did not measure inflammatory cytokine levels; thus, the proposed anti-inflammatory mechanism of lidocaine, while plausible, remains speculative. Second, the addition of lidocaine without reducing ropivacaine concentration resulted in a higher total local anesthetic dose in the RL group. While this could have influenced the observed reduction in ERMF, we consider it an unlikely primary explanation, as existing evidence indicates that the concentration of long-acting amide local anesthetics has minimal impact on ERMF incidence.[18] In contrast, the specific anti-inflammatory properties of lidocaine demonstrated in prior in vitro studies provide a more biologically plausible mechanism.[11] Third, our single-center design and homogeneous population of low-risk primiparous women may limit generalizability. Fourth, the use of ropivacaine, rather than the more widely employed bupivacaine, may affect the extrapolation of our findings. Finally, although we achieved a significant reduction in ERMF, this did not translate to differences in broader clinical outcomes such as neonatal sepsis evaluations, likely due to the multifactorial nature of these clinical decisions. Further work is warranted to confirm our findings and determine whether lidocaine addition can improve clinical outcomes.

Conclusion

The addition of lidocaine to a ropivacaine-sufentanil epidural solution significantly reduced the incidence of maternal fever during labour. This intervention represents a simple and clinically applicable strategy to mitigate a common complication of neuraxial analgesia. Future studies should validate these findings and explore optimal dosing regimens.

Data Sharing Statement

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no competing interests for this work.

References

1. Sharma SK, McIntire DD, Wiley J, Leveno KJ. labour analgesia and cesarean delivery: an individual patient meta-analysis of nulliparous women. *Anesthesiology*. 2004;100:142–148. doi:10.1097/00000542-200401000-00023
2. Sultan P, Segal S. Epidural-related maternal fever: still a hot topic, but what are the burning issues? *Anesth Analg*. 2020;130:318–320. doi:10.1213/ANE.0000000000004576
3. Lieberman E, Lang J, Richardson DK, Frigoletto FD, Heffner LJ, Cohen A. Intrapartum maternal fever and neonatal outcome. *Pediatrics*. 2000;105:8–13. doi:10.1542/peds.105.1.8
4. Greenwell EA, Wyshak G, Ringer SA, Johnson LC, Rivkin MJ, Lieberman E. Intrapartum temperature elevation, epidural use, and adverse outcome in term infants. *Pediatrics*. 2012;129:e447–54. doi:10.1542/peds.2010-2301
5. Goetzl L, Cohen A, Frigoletto F Jr, Lang JM, Lieberman E. Maternal epidural analgesia and rates of maternal antibiotic treatment in a low-risk nulliparous population. *J Perinatol*. 2003;23:457–461. doi:10.1038/sj.jp.7210967
6. Segal S. labour epidural analgesia and maternal fever. *Anesth Analg*. 2010;111:1467–1475. doi:10.1213/ANE.0b013e3181f713d4
7. Sultan P, David AL, Fernando R, Ackland GL. Inflammation and epidural-related maternal fever: proposed mechanisms. *Anesth Analg*. 2016;122:1546–1553. doi:10.1213/ANE.0000000000001195
8. Del Arroyo AG, Sanchez J, Patel S, et al. Role of leucocyte caspase-1 activity in epidural-related maternal fever: a single-centre, observational, mechanistic cohort study. *Br J Anaesth*. 2019;122:92–102. doi:10.1016/j.bja.2018.09.024
9. Riley LE, Celi AC, Onderdonk AB, et al. Association of epidural-related fever and noninfectious inflammation in term labour. *Obstetrics Gynecol*. 2011;117:588–595. doi:10.1097/AOG.0b013e31820b0503
10. Smulian JC, Bhandari V, Vintzileos AM, et al. Intrapartum fever at term: serum and histologic markers of inflammation. *Am J Obstet Gynecol*. 2003;188:269–274. doi:10.1067/mob.2003.11
11. Wohlrab P, Boehme S, Kaun C, et al. Ropivacaine activates multiple proapoptotic and inflammatory signaling pathways that might subsume to trigger epidural-related maternal fever. *Anesth Analg*. 2020;130:321–331. doi:10.1213/ANE.0000000000004402
12. Sharma SK, Alexander JM, Messick G, et al. Cesarean delivery: a randomised trial of epidural analgesia versus intravenous meperidine analgesia during labour in nulliparous women. *Anesthesiology*. 2002;96:546–551. doi:10.1097/00000542-200203000-00007
13. Impey L, Greenwood C, MacQuillan K, Reynolds M, Sheil O. Fever in labour and neonatal encephalopathy: a prospective cohort study. *BJOG*. 2001;108:594–597. doi:10.1111/j.1471-0528.2001.00145.x

14. Goetzl L, Rivers J, Evans T, et al. Prophylactic acetaminophen does not prevent epidural fever in nulliparous women: a double-blind placebo-controlled trial. *J Perinatol*. 2004;24:471–475. doi:10.1038/sj.jp.7211128
15. Sharma SK, Rogers BB, Alexander JM, McIntire DD, Leveno KJ. A randomised trial of the effects of antibiotic prophylaxis on epidural-related fever in labour. *Anesth Analg*. 2014;118:604–610. doi:10.1213/ANE.0b013e3182a5d539
16. Goetzl L, Zighelboim I, Badell M, et al. Maternal corticosteroids to prevent intrauterine exposure to hyperthermia and inflammation: a randomised, double-blind, placebo-controlled trial. *Am J Obstet Gynecol*. 2006;195:1031–1037. doi:10.1016/j.ajog.2006.06.012
17. Cartledge A, Hind D, Bradburn M, et al. Interventions for the prevention or treatment of epidural-related maternal fever: a systematic review and meta-analysis. *Br J Anaesth*. 2022;129:567–580. doi:10.1016/j.bja.2022.06.022
18. Patel S, Ciechanowicz S, Blumenfeld YJ, Sultan P. Epidural-related maternal fever: incidence, pathophysiology, outcomes, and management. *Am J Obstet Gynecol*. 2023;228:S1283–S304.e1. doi:10.1016/j.ajog.2022.06.026
19. Hermanns H, Hollmann MW, Stevens MF, et al. Molecular mechanisms of action of systemic lidocaine in acute and chronic pain: a narrative review. *Br J Anaesth*. 2019;123:335–349. doi:10.1016/j.bja.2019.06.014
20. Elizagaray ML, Mazitelli I, Pontoriero A, et al. Lidocaine reinforces the anti-inflammatory action of dexamethasone on myeloid and epithelial cells activated by inflammatory cytokines or SARS-CoV-2 infection. *Biomed J*. 2023;46:81–92. doi:10.1016/j.bj.2022.07.008
21. Caracas HC, Maciel JV, Martins PM, de Souza MM, Maia LC. The use of lidocaine as an anti-inflammatory substance: a systematic review. *J Dent*. 2009;37:93–97. doi:10.1016/j.jdent.2008.10.005
22. Lin S, Jin P, Shao C, et al. Lidocaine attenuates lipopolysaccharide-induced inflammatory responses and protects against endotoxemia in mice by suppressing HIF1α-induced glycolysis. *Int Immunopharmacol*. 2020;80:106150. doi:10.1016/j.intimp.2019.106150