RESEARCH

Comparison of the Effectiveness of Local Anesthetic Infiltration Of 0.25% Ropivacaine And 0.375% Ropivacaine on Cesarean Section Incision with Spinal Anesthesia

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ABSTRACT

Background: Postoperative discomfort subsequent to a caesarean delivery significantly influences the recuperation process and necessitates efficacious therapeutic intervention. Ropivacaine is a local anesthetic used to manage this pain, but there is limited comparison between its 0.25% and 0.375% concentrations.

Objective: To evaluate the comparative efficacy of varying dosages of ropivacaine, specifically 0.25% and 0.375% concentrations, as local anesthetic infiltrates during the surgical procedure of Cesarean section incision.

Methods: This randomized controlled trial (RCT) encompassed a cohort of 60 patients who underwent cesarean sections utilizing spinal anesthesia at Adam Malik Hospital, Medan, Haji Hospital Medan, Prof. Chairuddin P. Lubis USU Hospital Medan, and Putri Hijau Hospital Medan. The participants were stratified into three distinct groups: ropivacaine 0.25% (n=20), ropivacaine 0.375% (n=20), and a control group (n=20). Pain intensity was quantitatively assessed employing the numerical rating scale (NRS) at intervals of 2, 6, 12, and 24 hours postoperatively. Furthermore, the utilization of supplementary analgesics and the occurrence of adverse effects were meticulously documented. Statistical analysis of the data was conducted utilizing the Kruskal-Wallis test ($p<0.05$).

Results: Both ropivacaine 0.25% and 0.375% groups demonstrated significantly lower NRS pain scores at 2, 6, 12, and 24 hours postoperatively compared to the control group ($p<0.05$). Patients receiving ropivacaine infiltration also showed a significantly reduced need for additional analgesics compared to those who did not receive ropivacaine. However, no statistically significant differences in postoperative pain scores or supplemental analgesic requirements were observed between the 0.25% and 0.375% ropivacaine groups ($p>0.05$).

Conclusions: Both 0.25% and 0.375% ropivacaine effectively reduce postoperative pain and the need for additional analgesics compared to the control group. However, there was no significant difference between the two ropivacaine concentrations.

Keywords: cesarean section; dosage concentration; local anesthetic; postoperative pain; ropivacain

INTRODUCTION

Post-operative discomfort following cesarean section may go unreported and inadequately addressed. In a cross-sectional investigation examining post-operative pain among 215 hospital patients in Norway in 2011, effective pain management was operationally defined as an average pain score over the preceding 24 hours of ≤ 3 on the Numerical Rating Scale (NRS, scores ranging from 0 to 10). This standard was not attained in 38% of the cohort.[1] Previous studies have demonstrated that the prevalence of acute post-operative pain subsequent to cesarean delivery ranges from 78.4% to 92.7% in developing nations, indicating a critical need for enhancements in pain management practices.[2] Meanwhile, a research endeavor conducted in Medan revealed that within the initial two hours following the surgical procedure, the incidence of severe pain was 52.7%, and this figure decreased to 36.1% at eight hours post-operation.[3]

Post-operative analgesia endeavors to facilitate subjective comfort, mitigate nociceptive transmission, and attenuate neuroendocrine responses to pain, thereby promoting the accelerated recuperation of physiological functions. Sufficient analgesic intervention is imperative to safeguard against perioperative complications, which may include detriment to the circulatory, respiratory, and central nervous systems induced by harmful stimuli. The prevention and optimal management of post-operative discomfort are of paramount importance. Systemic modalities represent prevalent analgesic strategies and may be correlated with adverse effects such as pruritus, nausea and vomiting, sedation, and respiratory depression. This also has implications for maternal-infant bonding, initiation of breastfeeding in neonates, and overall maternal satisfaction.[4]

Nguyen et al. executed a study aimed at evaluating the efficacy of incision infiltration utilizing 7.5 mg/ml ropivacaine for cesarean delivery in 2010, stratifying patients into ropivacaine and control cohorts. They deduced that this intervention yielded a 30% diminution in overall analgesic consumption, particularly concerning opioids, during the initial 24 hours following the surgical procedure. Additionally, it significantly extended the duration until the initial analgesic request from patients to two hours and 26 minutes. No statistically significant disparity was observed in visual analog scale (VAS) scores between the two cohorts.[5] Another investigation contrasted epidural morphine with continuous incision infusion of ropivacaine for a duration of 48 hours post-surgery to alleviate pain and mitigate adverse effects. A total of 58 women were randomly assigned to one of the two groups. The findings indicated a preference for the ropivacaine cohort in terms of superior pain relief, reduced side effects, diminished treatment requirements, and shorter hospital admissions ($p<0.001$).[6]

Patients administered with ropivacaine exhibited superior pain management, extended analgesic efficacy, and necessitated a reduced amount of analgesic agents in comparison to individuals treated with normal saline solution.[7] In contrast to bupivacaine, ropivacaine is deemed the more advantageous option for cesarean deliveries owing to its negligible effects on hemodynamic stability and its abbreviated duration of sensory and motor blockade, which facilitates recovery and enhances patient safety.[8] It effectively diminishes the requirement for additional analgesics without eliciting significant adverse effects in elective cesarean procedures.[9] In a research investigation conducted by

Wang W et al.[10], the administered dosage of ropivacaine for local anesthesia was identified as 0.5% hyperbaric ropivacaine at 8.0 mg. The suggested dosage of ropivacaine for minor nerve blocks and incision infiltration for surgical anesthesia in adults with a body weight of 60 kg or greater is 225 mg of a 7.5 mg/ml solution, and for post-operative analgesia, it is up to 200 mg of a 2 mg/ml solution;[11] however, contemporary studies regarding ropivacaine indicate an extended duration of skin analgesia with higher dosages than those previously employed.[12]

According to Cao et al., ropivacaine plays an important role in postoperative pain management following cesarean section, with higher concentrations demonstrating superior analgesic efficacy compared to lower concentrations. Their study identified the minimum effective concentration (MEC90) of ropivacaine for post-cesarean analgesia to be 0.5%, which provided better pain control than concentrations of 0.25% and 0.375%.[13] Similarly, Tripathi et al. reported that the use of 0.5% ropivacaine for postoperative analgesia after cesarean delivery resulted in lower pain scores and reduced analgesic requirements without significant adverse effects.[14]

However, concerns regarding the safety of higher concentrations of ropivacaine have been reported. Shen D et al. demonstrated that local infiltration of 0.5% ropivacaine was associated with muscle tissue damage and an increased inflammatory response, whereas lower concentrations, such as 0.25% ropivacaine, did not adversely affect muscle integrity.[15] These findings suggest a potential trade-off between analgesic efficacy and local tissue safety when higher concentrations of ropivacaine are used.

In the context of cesarean section, several clinical studies have shown that local wound infiltration or continuous wound infusion of ropivacaine effectively reduces postoperative pain scores, delays the time to first request for rescue analgesia, and decreases opioid consumption compared with no infiltration. These findings support the role of ropivacaine wound infiltration as part of a multimodal analgesic strategy targeting incisional pain following cesarean delivery.

Despite the growing evidence supporting the effectiveness of ropivacaine for post-cesarean analgesia, the optimal concentration for single-shot wound infiltration remains uncertain. Importantly, there is a lack of studies directly comparing commonly used concentrations, particularly 0.25% versus 0.375% ropivacaine, in patients undergoing cesarean section under spinal anesthesia. Therefore, this study aimed to compare the effectiveness of 0.25% and 0.375% ropivacaine as local anesthetic infiltration at the cesarean section incision, focusing on postoperative pain intensity and the need for additional analgesia within the first 24 hours.

METHODS

This investigation utilized a comparative analytic experimental approach characterized by a double-blind randomized controlled trial (RCT) design. The research was executed at Adam Malik Hospital Medan, Haji Hospital Medan, Prof. Chairuddin P. Lubis USU Hospital Medan, and Putri Hijau Hospital Medan. The study was initiated subsequent to the acquisition of approval from the USU Research Ethics Committee. The subjects were selected utilizing randomized block and simple random sampling methodologies conducted through a lottery technique within the population that fulfilled the specified inclusion and

exclusion criteria. The inclusion criteria comprised women aged 18-41 years, with term pregnancies (37-42 weeks), classified as American Society of Anesthesiologists physical status 2, individuals who provided informed consent, and patients administered spinal anesthesia. The exclusion criteria encompassed: multiple gestations, patients with obstetric complications (eclampsia, preeclampsia), a documented history of chronic illnesses (chronic kidney failure, uncontrolled diabetes mellitus, uncontrolled hypertension, autoimmune disorders, uncontrolled asthma, congenital heart disease, hypersensitivity to study medications, and a prior medical history involving substances that influence pain perception (opioids).

The methodological approach employed in this investigation was characterized by the application of probability sampling, specifically utilizing simple random sampling. The requisite sample size was determined to be n = 60, which encompassed 20 samples allocated to the ropivacaine 0.375% cohort, 20 samples assigned to the ropivacaine 0.25% cohort, and 20 samples designated for the cohort devoid of ropivacaine, culminating in a total participant count of n = 60 respondents

The sample population was systematically allocated into three distinct cohorts: cohort one (ropivacaine 0.25%), cohort two (ropivacaine 0.375%), and cohort three (absence of ropivacaine). Participants who fulfilled the specified inclusion and exclusion parameters were subjected to randomization via the randomizer.org application, which meticulously randomized the sequence of pharmacological administration. Research participants completed a comprehensive questionnaire assessing sociodemographic attributes and pertinent health history. The investigators received assistance from volunteers enrolled in the *"Program Pendidikan Dokter Spesialis (PPDS)"*, specifically those in semesters 3 through 8, in executing both spinal and local anesthesia procedures. The cesarean delivery was conducted utilizing spinal anesthesia, achieving a block height at the T4 vertebral level. The pharmaceutical agents were meticulously prepared by the researcher overseeing the randomization process.

Preparation and dilution of ropivacaine: A volume of 20 cc of 0.75% ropivacaine was combined with 40 cc of 0.9% NaCl; subsequent to thorough mixing, a volume of 20 cc was extracted to produce a solution of ropivacaine at a concentration of 0.25% (50 mg). Furthermore, 20 cc of 0.75% ropivacaine was mixed with 20 cc of 0.9% NaCl; following the mixing process, a volume of 20 cc was withdrawn to achieve a concentration of ropivacaine at 0.375% (75 mg). Upon completion of randomization and preparation of the drug, the researcher dispensed the medications to volunteers for administration to the research subjects on the designated study day. During the procedure of fascial suturing, patients received infiltration with a local anesthetic agent. In the control cohort (absence of ropivacaine), no ropivacaine wound infiltration was administered.

All participants received standardized postoperative systemic analgesia (paracetamol and ketorolac) in accordance with the institutional postoperative pain management protocol.

The numeric rating scale (NRS) pain scores, incidence of adverse effects, and necessity for supplementary analgesia were meticulously documented at predetermined intervals: 2 hours (T1), 6 hours (T2), 12 hours (T3), and 24 hours

(T4). Rescue analgesia was administered when the patient's NRS score was > 3, using an intravenous bolus of fentanyl 1 mcg/kg body weight, and the administration was recorded at each observation time point.

RESULTS

Based on the research results, the characteristics of the research samples were obtained from a total of 60 samples, divided into 20 samples in the group without ropivacaine, 20 samples in the ropivacaine 0.25% group, and 20 samples in the ropivacaine 0.375% group.

In this study, the basic characteristics reported consist of age and body mass index (BMI). In Table 1, the age of the group without ropivacaine has a mean ± SD of approximately 28.4 ± 7.14 years, the group with ropivacaine 0.25% has a mean ± SD of approximately 32.4 ± 5.17 years, and the group with ropivacaine 0.375% has a mean ± SD of approximately 31.9 ± 5.54 years. The BMI of the group without ropivacaine has a mean ± SD of approximately 24.4 ± 5.70 kg/m², the group with ropivacaine 0.25% has a mean ± SD of approximately 26.7 ± 4.39 kg/m², and the group with ropivacaine 0.375% has a mean ± SD of approximately 26.5 ± 4.26 kg/m².

Based on gestational age, the group without ropivacaine had the highest percentage at 37-38 weeks, accounting for 45%, while in the ropivacaine groups, the highest percentage was at 38-39 weeks, which was 40% and 45%. Additionally, the highest gravida across all groups was the first pregnancy, with each group showing 45%, 50%, and 50%, respectively.

In Table 2, it is noted that the average NRS score at T1 for subjects without ropivacaine, with ropivacaine 0.25%, and with ropivacaine 0.375% are 2.65, 2.20, and 2.20, respectively. Additionally, the NRS scores at T2 for subjects without ropivacaine, with ropivacaine 0.25%, and with ropivacaine 0.375% are 3.65, 2.80, and 2.25, respectively. The NRS scores at T3 for subjects without ropivacaine, with ropivacaine 0.25%, and with ropivacaine 0.375% are 2.60, 2.10, and 2.15, respectively. Meanwhile, the NRS scores at T4 for subjects without ropivacaine, with ropivacaine 0.25%, and with ropivacaine 0.375% are 1.60, 1.05, and 1.00, respectively. Based on the Mann-Whitney analysis, the NRS data at T1, T2, T3, and T4 indicate significant differences (p=0.017; p=0.001; p=0.005; p=0.001) among the groups.

In Table 3, it is noted that the average NRS score at T1 for subjects without ropivacaine and with ropivacaine 0.25% are 2.65 and 2.20, respectively. The average NRS score at T2 for subjects without ropivacaine and with ropivacaine 0.25% are 3.65 and 2.80, respectively. The average NRS score at T3 for subjects without ropivacaine and with ropivacaine 0.25% are 2.60 and 2.10, respectively. The average NRS score at T4 for subjects without ropivacaine and with ropivacaine 0.25% are 1.60 and 1.05, respectively. Based on the Mann-Whitney analysis, the NRS data at T1, T2, T3, and T4 for the ropivacaine 0.25% group and the group without ropivacaine show significant differences (p=0.018; p=0.002; p=0.006; p=0.000) among the groups.

In Table 4, it is noted that the average NRS score at T1 for subjects without ropivacaine and with ropivacaine 0.375% are 2.65 and 2.20, respectively. The average NRS score at T2 for subjects without ropivacaine and with ropivacaine 0.375% are 3.65 and 2.25, respectively. The average NRS score at T3 for subjects without ropivacaine and with ropivacaine

0.375% are 2.60 and 2.15, respectively. The average NRS score at T4 for subjects without ropivacaine and with ropivacaine 0.375% are 1.60 and 1.00, respectively. Based on the Mann-Whitney analysis, the NRS data at T1, T2, T3, and T4 for the ropivacaine 0.375% group and the group without ropivacaine show significant differences (p=0.018; p=0.001; p=0.016; p=0.001) among the groups.

In Table 5, it is noted that the average NRS score at T1 for subjects without ropivacaine, ropivacaine 0.25%, and ropivacaine 0.375% are 2.20 and 2.20, respectively. The average NRS score at T2 for subjects without ropivacaine, ropivacaine 0.25%, and ropivacaine 0.375% are 2.80 and 2.25, respectively. The average NRS score at T3 for subjects without ropivacaine, ropivacaine 0.25%, and ropivacaine 0.375% are 2.10 and 2.15, respectively. The average NRS score at T4 for subjects without ropivacaine, ropivacaine 0.25%, and ropivacaine 0.375% are 1.05 and 1.00, respectively. Based on the Mann-Whitney analysis, the NRS data at T1, T2, T3, and T4 for the ropivacaine 0.25% and ropivacaine 0.375% groups show no significant differences between the groups, with p-value > 0.05.

In Table 6, it is observed that 10 patients in the cohort devoid of ropivacaine did not necessitate supplementary analgesia, while 17 patients in the cohort receiving ropivacaine 0.25% also did not require additional analgesic intervention, and 18 patients in the cohort administered ropivacaine 0.375% exhibited no need for rescue analgesia. The Chi-square analysis indicates that the data concerning supplementary analgesia across the groups lacking ropivacaine, those receiving ropivacaine 0.25%, and those receiving ropivacaine 0.375% reveal a statistically significant disparity among the groups, characterized by a p-value of less than 0.05.

In Table 7, the p-values are as follows: the p-value at T1 for the group without ropivacaine, ropivacaine 0.25%, and ropivacaine 0.375% is 0.221. The p-value at T2 for these groups is 0.022. The p-value at T3 for the groups is 0.081. Finally, the p-value at T4 is 0.000. Based on the Mann-Whitney analysis, it was found that the data at T1, T3, and T4 for the groups without ropivacaine, ropivacaine 0.25%, and ropivacaine 0.375% (p=0.221, p=0.081, p=0.000) show no significant differences between the groups. However, at T2, there is a significant difference with a p-value of 0.022.

In Table 8, it is observed that 10 patients in the cohort devoid of ropivacaine did not necessitate supplementary analgesia, whereas 17 patients in the cohort administered ropivacaine 0.25% did not necessitate supplementary analgesia. According to the Chi-square statistical analysis, the findings regarding supplementary analgesia in the cohorts lacking ropivacaine and those incorporating ropivacaine 0.25% exhibit a statistically significant distinction between the groups, with a p-value less than 0.05.

In Table 9, it is observed that a total of 10 patients in the cohort devoid of ropivacaine did not necessitate supplementary analgesia, whereas 18 patients in the cohort administered ropivacaine 0.375% did not require additional analgesic intervention. The Chi-square analysis indicates that the findings regarding supplementary analgesia in the cohorts lacking ropivacaine and those receiving ropivacaine 0.375% exhibit a statistically significant difference, with a p-value of less than 0.05.

In Table 10, it is observed that 17 patients did not necessitate supplementary analgesia when administered ropivacaine 0.25%, whereas 18 patients did not necessitate supplementary analgesia when administered ropivacaine 0.375%. According to the Chi-square analysis, the findings regarding supplementary analgesia in the cohorts receiving ropivacaine 0.25% and ropivacaine 0.375% indicate that there exists no statistically significant difference between the groups, with a p-value exceeding 0.05.

Table 1. Sample characteristics

Characteristics	Group			p-value
	Without Ropivacaine	Ropivacaine 0.25%	Ropivacaine 0.375%	
Age (year)	28.4±7.14	32.4±5.17	31.9±5.54	0.086*
BMI (kg/m^2)	24.4±5.70	26.7±4.39	26.5±4.26	0.249*
Gravida				
1st pregnancy	3(15%)	7(35%)	2(10%)	
2nd pregnancy	9(45%)	7(35%)	9(45%)	0.385**
3rd pregnancy	5(25%)	4(20%)	8(40%)	
4th pregnancy	3(15%)	2(10%)	1(5%)	
Gestational Age				
37-38 weeks	7(35%)	2(10%)	4(20%)	
38-39 weeks	10(50%	17(85%)	13(65%)	0.206**
39-40 weeks	3(15%)	1(5%)	3(15%)	

Table 2. Pain analysis

Time	Mean pain level			*p-value
	Without Ropivacaine	Ropivacaine 0.25%	Ropivacaine 0.375%	
NRS T1	2.65	2.20	2.20	0.017
NRS T2	3.65	2.80	2.25	0.001
NRS T3	2.60	2.10	2.15	0.005
NRS T4	1.60	1.05	1.00	0.001

Table 3. Comparison of pain scores between ropivacaine 0.25% and without ropivacaine

Time	Mean pain level		*p-value
	Without Ropivacaine	Ropivacaine 0.25%	
NRS T1	2.65	2.20	0.018
NRS T2	3.65	2.80	0.002
NRS T3	2.60	2.10	0.006
NRS T4	1.60	1.05	0.000

Table 4. Comparison of pain scores between ropivacaine 0.375% and without ropivacaine

Time	Mean pain level		*p-value
	Without Ropivacaine		
NRS T1	2.65	2.20	0.018
NRS T2	3.65	2.25	0.001
NRS T3	2.60	2.15	0.016
NRS T4	1.60	1.00	0.001

Table 5. Comparison of pain scores between ropivacaine 0.375% and ropivacaine 0.25%

Time	Mean pain level		*p-value
	Ropivacaine 0.25%	Ropivacaine 0.375%	
NRS T1	2.20	2.20	1.000
NRS T2	2.80	2.25	0.080
NRS T3	2.10	2.15	0.637
NRS T4	1.05	1.00	0.317

Table 6. Analysis of additional analgesia

Additional Analgesia	Without Ropivacaine	Ropivacaine 0.25%	Ropivacaine 0.375%	*p-value
No	10	17	18	0,006
Yes	10	3	2	

Table 7. Comparison of additional analgesia requirements for ropivacaine 0.25%, 0.375%, and without ropivacaine based on time

Time	Without Ropivacaine	Ropivacaine 0.25%	Ropivacaine 0.375%	*p-value
T1 No	19	20	20	0.221
T1 Yes	1	0	0	
T2 No	12	17	18	0.022
T2 Yes	8	3	2	
T3 No	19	20	20	0.081
T3 Yes	1	0	0	
T4 No	20	20	20	0.000
T4 Yes	0	0	0	

Table 8. Comparison of additional analgesia requirements for ropivacaine 0.25% and without ropivacaine

Additional Analgesia	Without Ropivacaime	Ropivacaine 0.25%	*p-value
No	10	17	0.018
Yes	10	3	

Table 9. Comparison of additional analgesia requirements for ropivacaine 0.375% and without ropivacaine

Additional Analgesia	Without Ropivacaime	Ropivacaine 0.375%	*p-value
No	10	18	0,006
Yes	10	2	

Table 10. Comparison of additional analgesia requirements for ropivacaine 0.25% and ropivacaine 0.375%

Additional Analgesia	Ropivacaine 0.25%	Ropivacaine 0.375%	*p-value
No	17	18	0,6333
Yes	3	2	

DISCUSSION

Analysis of pain scores based on observation times T1, T2, T3, and T4 shows a significant difference (p=0.017; p=0.001; p=0.005; p=0.001) among the three groups. The comparison of pain scores between the ropivacaine group and the non-ropivacaine group is very significant, but the pain scores between the 0.25% ropivacaine group and the 0.375% ropivacaine group are not significantly different, although the research findings show that the pain score for 0.375% ropivacaine usage is lower compared to the other groups.

The study by Jalil et al. found no significant difference between the groups receiving 0.2% and 0.5% ropivacaine at T1, T2, T3, and T4.[15] This result is quite different from our study, where a significant relationship was found at T2. This difference may be due to physiological differences among each subject, and possibly the number of surgeries previously performed using similar anesthetic modalities.

Another study by Simamora et al. found a significant difference between the administration of infiltration with 0.75% ropivacaine 150 mg and the combination of 1% lidocaine and 10 mg dexamethasone regarding the NRS values at hours 2, 6, 12, and 24.[16] This aligns with our study, which also found a significant reduction in NRS values in the ropivacaine group.

There is a significant difference at T1, T2, T3, and T4 between the non-ropivacaine group and the 0.25% ropivacaine group (p=0.018; p=0.001; p=0.006; p=0.001). Likewise, the 0.375% group shows significant differences compared to the non-ropivacaine group with p-value <0.005 (p=0.018; p=0.001; p=0.016; p=0.001), but no significant difference exists between the 0.25% ropivacaine group and the 0.375% ropivacaine group with p-value >0.05. In the study conducted by Kim et al., significant differences were found at T1, T2, T3, and T4 between the non-ropivacaine group and the 0.375% and 0.25% ropivacaine groups (p<0.05). Their study also noted that NRS scores for patients given 0.375% ropivacaine were much lower at T2 and T3 compared to patients given 0.25% ropivacaine.[17] This result is quite different from what we found, as we did not observe significant differences among treatment groups at T1 and T3. This discrepancy may be explained by variations in how each patient responds to pain stimuli and their pain tolerance.

The investigation conducted by Moya et al. concluded that there were no statistically significant differences between the cohorts administered 0.375% and 0.75% ropivacaine.[18] This finding aligns with the research conducted by Miao et al., which indicated the absence of significant disparities in pain levels quantified by the NRS among groups receiving 0.1% and 0.15% ropivacaine. Notably, the NRS scores were lower in patients who were administered ropivacaine in conjunction with sufentanil. Nevertheless, this particular administration did not yield satisfactory analgesic outcomes during the procedure of uterine massage.[19]

In the context of cesarean deliveries, anesthetic agents can exert significant effects on both the expectant mother and the developing fetus. Ropivacaine is classified as an L-amide anesthetic, exhibiting structural and pharmacodynamic similarities to bupivacaine. Ropivacaine offers the distinct advantage of facilitating differentiated sensory and motor blockade while demonstrating reduced toxicity to both the cardiovascular and central nervous systems.[20] Furthermore, ropivacaine's duration of sensory and motor blockade is comparatively shorter due to its lower affinity for plasma proteins.

In the analysis of additional analgesia, it was noted that at T4, no samples received additional analgesia in any of the treatment groups. At T1, a bolus of 1 mcg/kg body weight fentanyl was administered in the non-ropivacaine group for 1 sample (5%), while in the 0.25% and 0.375% ropivacaine groups, there were 0 samples (0.00%). At T2, additional analgesic fentanyl was administered at a dose of 1 mcg/kg body weight to 8 samples (40%) in the non-ropivacaine group, 3 samples (15%) in the 0.25% ropivacaine group, and 2 samples (10%) in the 0.375% ropivacaine group. At T3, a bolus of 1 mcg/kg body weight fentanyl was given in the non-ropivacaine group for 1 sample (5%), while in the 0.25% and 0.375% groups, there were 0 samples (0.00%).

This phenomenon can be elucidated by the observation that the duration effect of ropivacaine commenced to diminish approximately 4-8 hours after infiltration, concomitantly with the reduction of the analgesic properties of paracetamol and ketorolac from both pharmacodynamic and pharmacokinetic perspectives. The investigation conducted by Garcia et al. revealed that 12 patients (11.1%) did not necessitate analgesics at T2. Among the remaining patients, 1 g of intravenous paracetamol was effectively administered as the initial analgesic to 74 patients (68.5%), while 15 patients required an additional 2 g of intravenous metamizole (13.9%), 2 patients necessitated 50 mg of intravenous dexketoprofen (1.9%), and 5 patients required more potent analgesia in the form of opioid medications (4.6%; specifically, 3 patients received 100 mg of intravenous tramadol, 1 patient received 1 g of intravenous paracetamol alongside 100 mg of tramadol, and 1 patient received 2 mg of morphine chloride via subcutaneous administration).[21] This outcome diverges from our findings, where merely around 8 samples necessitated supplementary analgesia at T2.

Several limitations should be acknowledged. The modest sample size and recruitment from a limited number of centers within a single region may constrain external validity. Postoperative

pain intensity was measured using the NRS, a validated patient-reported outcome; however, it remains inherently subjective and may be affected by inter-individual differences and situational factors. Moreover, outcomes were assessed only up to 24 hours postoperatively; thus, longer-term analgesic efficacy and clinically meaningful recovery endpoints (e.g., mobilization, maternal functional recovery, breastfeeding-related comfort, patient satisfaction, and length of stay) were not evaluated. Although the postoperative analgesic regimen was standardized, residual heterogeneity in perioperative factors and individual pharmacodynamic responses could have influenced rescue analgesic requirements. These considerations warrant cautious interpretation of the findings and support the need for adequately powered, multicenter trials with extended follow-up and broader outcome measures.

CONCLUSION

Local anesthetic wound infiltration using ropivacaine, at both 0.25% and 0.375% concentrations, effectively reduces postoperative pain scores and the need for additional analgesia following cesarean section when compared to no infiltration. Although ropivacaine 0.375% demonstrated numerically lower pain scores and reduced rescue analgesic requirements, particularly at 6 hours postoperatively, these differences were not statistically significant when compared to ropivacaine 0.25%. Both concentrations showed comparable safety profiles without significant differences in adverse effects.

Based on these findings, the authors recommend the use of ropivacaine wound infiltration as part of a multimodal analgesia strategy following cesarean section, with the 0.25% concentration being a reasonable and effective option due to its similar efficacy and potentially lower drug exposure. Future research is recommended to involve larger sample sizes, multicenter designs, and longer follow-up periods to evaluate long-term pain outcomes, functional recovery, and cost-effectiveness, as well as to explore optimal dosing strategies for local anesthetic infiltration in cesarean delivery.

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