

DOI: <https://dx.doi.org/10.18203/2320-1770.ijrcog20263999>

Original Research Article

Post-operative analgesic effect of wound infiltration with bupivacaine versus mixture of bupivacaine and tramadol in caesarean section under spinal anaesthesia: a randomized double-blind interventional controlled study

Mahesh Kumar^{1*}, Trishala Jain²

¹Department of Neuroanaesthesia, Christian Medical College, Vellore, Tamil Nadu, India

²Department of Anesthesiology, SMS Medical College, Jaipur, Rajasthan, India

Received: 08 September 2026

Revised: 11 October 2026

Accepted: 12 October 2026

*Correspondence:

Dr. Mahesh Kumar,

E-mail: messisharma24@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: Caesarean section is among the most frequently performed obstetric surgical procedures worldwide. Effective postoperative analgesia is crucial for promoting maternal comfort and facilitating recovery. Multimodal analgesic approaches are commonly used to optimize pain control, and wound infiltration is considered a simple, safe, and effective technique. This study aimed to assess and compare the postoperative analgesic efficacy of wound infiltration using a combination of bupivacaine and tramadol with that of bupivacaine alone following caesarean delivery.

Methods: This prospective, randomised, double-blind trial was conducted at Sawai Man Singh Medical College and Attached Hospitals, Jaipur, India, from February 2021 to [Month 2021] (CTRI/2021/02/031140). Sixty parturients aged 18–35 years, ASA physical status I–II, undergoing caesarean section under spinal anaesthesia were randomised into two groups of 30. Group T received wound infiltration with tramadol 2 mg/kg mixed in 0.25% bupivacaine (total 20 ml), and Group B received 20 ml of 0.25% bupivacaine. The time to first rescue analgesia, Numerical Rating Scale (NRS) pain scores, diclofenac consumption over 24 hours, patient satisfaction and adverse effects were compared.

Results: The time to first rescue analgesia was significantly longer in Group T than in Group B (6.60 ± 1.61 vs. 3.21 ± 0.65 hours; $P < 0.001$). Total 24-hour diclofenac consumption was significantly lower in Group T (96.67 ± 26.60 vs. 184.00 ± 40.54 mg; mean difference 87.33 mg, 95% CI 69.61–105.05; $P < 0.001$). Patient satisfaction was higher in Group T ($P = 0.001$), and adverse effects were comparable between groups.

Conclusions: Subcutaneous wound infiltration with a combination of tramadol and bupivacaine following caesarean section prolongs the pain-free period and reduces postoperative analgesic requirements, thereby enhancing maternal comfort and satisfaction.

Keywords: Bupivacaine, Caesarean section, Post-operative, Tramadol, Wound infiltration

INTRODUCTION

Postoperative pain management is particularly important after caesarean section because mothers need to care for and breastfeed their newborns as soon as possible, thereby

promoting early mother-infant bonding.¹ Analgesic strategies should also be safe for breastfed neonates and may help reduce thromboembolic morbidity.² Despite these clinical goals, the prevalence of persistent postoperative pain remains high, with reported rates ranging from 25.5% to 80% following the procedure.²

Despite advances in the understanding of acute pain physiology, the development of opioid and non-opioid analgesics, and the introduction of novel drug-delivery techniques, postoperative pain management remains challenging.³ This persistence is largely attributed to significant inter-individual variability in pain sensitivity, which is influenced by complex factors including genetics, preoperative anxiety, and psychological history.¹

Because of the complications associated with general anaesthesia, regional anaesthesia is now commonly used for caesarean section. It also facilitates postoperative analgesia through the administration of neuraxial opioids.^{1,4} Nevertheless, the various analgesic techniques evaluated in previous studies have distinct benefits and limitations. For instance, although neuraxial morphine provides effective analgesia, its frequent adverse effects, particularly nausea, vomiting, and pruritus, may limit its tolerability in the immediate postoperative period.¹

No single technique has been established as the gold standard for managing pain after caesarean section. Current approaches include opioids, supplemental non-opioid analgesics, peripheral nerve blocks, and other adjunctive techniques.

Accordingly, this study aimed to compare the analgesic efficacy of wound infiltration with bupivacaine alone versus a combination of bupivacaine and tramadol in women undergoing caesarean section under spinal anaesthesia. The primary outcome was the time to the first request for rescue analgesia. Secondary outcomes included total analgesic consumption and the incidence of adverse effects.

METHODS

Study type

This was a prospective, randomised, double-blind, parallel-group, active-controlled trial.

Study place and period

The study was conducted in the Obstetrics and Gynaecology operation theatre, Department of Anaesthesiology, Sawai Man Singh (SMS) Medical College and Attached Hospitals, Jaipur, Rajasthan, India, from February 2021 to May 2021.

Selection criteria

Inclusion criteria: Parturients aged 18–35 years, height 145–165 cm, weight 40–70 kg, undergoing caesarean section under spinal anaesthesia, who gave written informed consent.

Exclusion criteria: refusal to participate; uncooperative patients; immunocompromised patients; severe cardiopulmonary, renal or hepatic disease; pre-eclampsia

or eclampsia; morbid obesity; bleeding or coagulation disorders; known allergy to any study drug; and sepsis, bacteraemia or skin infection at the incision site.

Procedure

Randomisation and blinding. Sixty patients were randomly allocated into two groups of 30 using computer-generated random numbers. Allocation was concealed in sequentially numbered, sealed, opaque envelopes prepared by a neutral observer not involved in the study. The same observer opened each envelope and prepared the study drug in a pre-coded 20 ml syringe. Both solutions were clear, colourless and of identical volume. The anaesthesiologist who prepared the syringes was not involved in administering anaesthesia or collecting data. Patients were told that an analgesic would be given but were not told which drug. Postoperative assessments were performed by an anaesthesiologist or ward nurse unaware of group allocation.

Study groups

The study group included Group T (n=30) who were given tramadol 2 mg/kg mixed in 0.25% bupivacaine, to a total volume of 20 ml and group B (n=30) who were given 0.25% bupivacaine, 20 ml.

Pre-anaesthetic evaluation. All patients were assessed the day before surgery. Assessment covered medical, surgical, anaesthetic, drug and allergy history; general and airway examination; vital signs; and systemic examination. Investigations included haemoglobin, total and differential leucocyte counts, platelet count, bleeding and clotting time, blood sugar, liver and renal function tests, and electrocardiogram. Patients were taught the 11-point Numerical Rating Scale (NRS), where 0=no pain and 10=worst imaginable pain (6), and were kept fasting overnight. As per institutional protocol, all patients received oral ranitidine 150 mg the night before surgery, and intravenous ranitidine 50 mg and metoclopramide 10 mg before anaesthesia.

Anaesthesia and surgery. In the operation theatre, standard monitoring was applied: electrocardiogram, non-invasive blood pressure and pulse oximetry. Baseline heart rate, systolic, diastolic and mean arterial pressure, respiratory rate and SpO₂ were recorded. An 18G intravenous cannula was secured and Ringer's lactate 10 ml/kg was given as preload. Under aseptic precautions, lumbar puncture was performed in the sitting position at the L3–L4 interspace with a 25G Quincke spinal needle. Subarachnoid block was established with 2.0–2.2 ml of 0.5% hyperbaric bupivacaine. After delivery of the baby, all patients received intravenous fentanyl 1–1.5 µg/kg and midazolam 1–2 mg. All surgeries were performed by the same experienced obstetrician.

Wound infiltration. At skin closure, the operating obstetrician infiltrated the study solution subcutaneously

along both edges of the incision, distributing it evenly along the length of the wound. The wound was covered with sterile gauze and a bandage. The time of infiltration was taken as time 0 for all postoperative measurements.

Postoperative assessment. Pain was assessed with the NRS on arrival in the recovery room (0 min), at 15 and 30 minutes, and at 1, 2, 3, 4, 6, 12 and 24 hours. Intravenous diclofenac sodium 75 mg was given as rescue analgesia whenever the NRS score was ≥ 3 . Intravenous ondansetron 0.1 mg/kg was given for nausea.

Heart rate, systolic, diastolic and mean arterial pressure, and SpO₂ were recorded at the same time points. Patients were monitored for nausea, vomiting, shivering, headache, pruritus and respiratory depression. Hypotension was defined as mean arterial pressure <60 mmHg and bradycardia as heart rate <60 beats/min. Duration of surgery and perioperative complications (haemorrhage, bradycardia, hypotension, hypertension) were recorded. At 24 hours, patients rated the quality of pain relief as excellent (4), very good (3), good (2) or poor (1).

Outcomes.

The primary outcome was the time to first rescue analgesia, measured from wound infiltration to the first dose of diclofenac.

Secondary outcomes were: change in haemodynamic variables from baseline, incidence of adverse effects, total diclofenac consumption in the first 24 hours, postoperative NRS scores, patient satisfaction

Ethical approval

The study was approved by the Institutional Ethics Committee of SMS Medical College and Attached Hospitals, Jaipur (approval No. 21/MC/EC/2020, dated 11 June 2020). It was prospectively registered with the Clinical Trials Registry–India (CTRI/2021/02/031140) on 9 February 2021, before enrolment of the first patient on 15 February 2021. Written informed consent was obtained from all participants in their vernacular language.

Statistical analysis

The sample size was calculated from the study by Sachidananda et al.¹³ Assuming an expected difference in mean duration of analgesia of 194 minutes (SD 233.84 minutes), with 95% confidence and 80% power, 30 patients were required in each group.

Data were entered in Microsoft Excel and analysed using SPSS version 17. Quantitative variables were expressed as mean $\pm$ standard deviation and compared using the unpaired Student's t-test or the Mann–Whitney U test, as appropriate. Qualitative variables were expressed as numbers and percentages and compared using the chi-

square test or Fisher's exact test. A P value <0.05 was considered statistically significant.

RESULT

Sixty patients were enrolled, and all completed the study. No, statistically significant differences were noted between-groups with regards to age, weight, height, preoperative vital signs-including systolic blood pressure, diastolic blood pressure, mean arterial pressure, pulse rate, respiratory rate, and peripheral oxygen saturation-or duration of surgery. Hence both the randomised groups were distributed similarly (Table 1).

Table 1: Baseline demographic and clinical characteristics.

Parameters	Group T Mean ($\pm$ SD)	Group B Mean ($\pm$ SD)	P value
Age (years)	25.67 (2.44)	24.40 (2.03)	0.159
Weight (kg)	61.17 (5.58)	60.47 (5.04)	0.551
Height (cm)	158.07 (4.23)	159.87 (7.44)	0.148
SBP (mmHg)	121.10 (9.77)	118.70 (7.47)	0.289
DBP (mmHg)	78.23 (7.39)	76.83 (5.83)	0.418
MAP (mmHg)	92.29 (7.26)	90.70 (5.74)	0.350
Pulse (bpm)	94.10 (10.27)	92.29 (6.27)	0.250
RR (per min)	13.80 (1.24)	14.10 (0.92)	0.352
SpO ₂ (%)	99.27 (0.74)	99.33 (0.66)	0.714
Mean duration of surgery (min)	42.47 (3.88)	43.63 (4.75)	0.302
Age (years)	25.67 (2.44)	24.40 (2.03)	0.159
Weight (kg)	61.17 (5.58)	60.47 (5.04)	0.551

The mean time to the first request for rescue analgesia (Diclofenac Sodium) was statistically significant and longer in Group T (396.10 minutes) than in Group B (192.33 minutes). Total diclofenac consumption during the first 24 hours was also significantly lower in Group T (96.67 mg) than in Group B (184.00). This was also statistically significant in our study. The mean difference, calculated as Group B minus Group T, was 87.33 mg. (Table.2) Patient satisfaction was significantly higher in Group T than in Group B (Table 3). The incidence of adverse effects was comparable between the two groups, with no statistically significant difference (Table 4).

Table 2: Primary and secondary analgesic outcomes.

Parameters	Group T Mean (±SD)	Group B Mean (±SD)	Mean Difference (95% CI)	P value
Mean time to first rescue analgesic (min)	396.10± 96.87	192.33± 38.93	-203.77 (-241.92 to -165.62)	<0.001
Mean analgesic dose consumption (mg)	96.67± 26.60	184.00± 40.54	87.33 (69.61 to 105.05)	<0.001

Table 3: Primary and secondary analgesic outcomes.

Satisfaction score	Group T (N)	Group T (%)	Group B (N)	Group B (%)
Score 1 (Poor)	1	3.33	10	33.33
Score 2 (Good)	20	66.67	19	63.33
Score 3 (Very Good)	9	30.00	1	3.33
Score 4 (Excellent)	0	-	0	-
Total	30	100.00	30	100.00

Result: P=0.001

Table 4: Percentage of side effects in the two groups.

Side effect	Group T (N)	Group T (%)	Group B (N)	Group B (%)	P value
Nausea	3	10.00	5	16.67	0.704
Vomiting	2	6.67	4	13.33	0.667
Shivering	6	20.00	10	33.33	0.381

Table 5: Percentage of side effects in the two groups.

Side effect	Group T (N)	Group T (%)	Group B (N)	Group B (%)	P value
Nausea	3	10.00	5	16.67	0.704
Vomiting	2	6.67	4	13.33	0.667
Shivering	6	20.00	10	33.33	0.381

DISCUSSION

Caesarean section is the most commonly performed major surgical procedure among women of reproductive age.⁴ Effective post-caesarean analgesia is essential for facilitating rapid maternal recovery and breastfeeding initiation. Early skin-to-skin contact is important for neonatal thermoregulation and maternal-infant bonding.¹

Adequate postoperative pain control can be achieved with a multimodal analgesic approach. However, resource-limited settings may have limited opioid supplies, patient-controlled analgesia services, and infusion pumps. Therefore, wound infiltration combined with systemic nonsteroidal anti-inflammatory drugs offers a practical strategy for managing post-caesarean pain.^{1,6}

Bupivacaine is a long-acting amide local anesthetic.⁷ It blocks nerve impulses by raising the nerve's threshold and slowing signal transmission. It is broken down in the liver by CYP450 enzymes through N-dealkylation and hydroxylation. Subcutaneous bupivacaine has been used for pain relief in caesarean sections. Wound infiltration with bupivacaine may lower interleukin-10 and increase substance P.^{8,9} Local anesthetics given subcutaneously can also inhibit bacterial growth.^{5,10}

Clinical studies have demonstrated that wound infiltration with conventional local anesthetics, such as bupivacaine and ropivacaine, can reduce the severity of pain during the immediate postoperative period following caesarean delivery under general anesthesia. These findings suggest that parenteral analgesics and local anesthetic infiltration may constitute appropriate postoperative pain-management strategies, particularly when regional anesthesia is contraindicated.^{7,11,12}

Subcutaneous infiltration of the wound with a combination of tramadol and bupivacaine may prolong the pain-free interval, reduce postoperative analgesic requirements following caesarean section, and improve patient satisfaction. Our study reinforces the results by Sachidananda et al.¹³ Pain scores differed significantly between groups at 3, 4, 6 and 12 hours, but not in a consistent direction. Scores were lower in Group T at 3 and 12 hours and lower in Group B at 4 and 6 hours, most likely reflecting the earlier administration of rescue diclofenac in Group B. As all patients received rescue analgesia at NRS≥3, pain scores were constrained by the rescue protocol, and time to first rescue analgesia is the more informative measure of analgesic duration.

In the present trial, the combination of tramadol and bupivacaine significantly prolonged the time to the first request for rescue analgesia. Our study shows that adding tramadol to bupivacaine for local infiltration prolonged postoperative analgesia compared with bupivacaine alone. Patients in Group T (Tramadol+Bupivacaine) requested rescue analgesia after 6.60 ± 1.61 hours, compared with 3.21 ± 0.65 hours in Group B (Bupivacaine alone), representing a prolongation of approximately 3.40 hours (203.77 minutes) in the combination group. This difference was statistically significant (95% CI -4.03 to -2.76 hours)

Total diclofenac consumption during the first 24 hours was also significantly lower in Group T than in Group B: 96.67 ± 26.60 mg versus 184.00 ± 40.54 mg, respectively. Thus, the combination reduced diclofenac requirements by 87.33 mg, or approximately 47%, with a 95% confidence interval of 69.61 to 105.05.

This reduction may reflect a synergistic analgesic effect between tramadol and bupivacaine, resulting in more prolonged postoperative pain relief, and supports the findings of Sachidananda et al.¹³

Unlike our study, Milkias et al found no difference in rescue analgesic use between groups. This may be partly attributable to their use of preoperative dexamethasone, a long-acting glucocorticoid that can itself reduce postoperative pain. Waldron et al. reported that a single perioperative dose of IV dexamethasone has a small but statistically significant analgesic benefit.¹⁴ No patient in our study received perioperative glucocorticoids, so the observed difference in postoperative analgesia can be attributed more confidently to the difference in infiltration mixtures.

In addition, unlike Milkias et al and Sachidananda et al, who used both tramadol and diclofenac as rescue analgesics, we restricted rescue analgesia to diclofenac alone. This avoided confounding from postoperative tramadol and allowed the observed analgesic benefit to be attributed to intraoperative tramadol infiltration.^{11,13}

In the present study, wound infiltration with tramadol 2 mg/kg combined with bupivacaine maintained mean NRS scores below 4 at all-time points in both groups. The present trial did not demonstrate a statistically significant difference in nausea or vomiting between groups.

These findings indicate that the addition of tramadol produced not only statistically significant but also clinically meaningful improvements in the duration of postoperative analgesia and rescue analgesic requirement.

Consistent with the findings of Sachidananda et al, patients who received the tramadol-bupivacaine combination experienced a longer time to first rescue analgesia, lower total analgesic consumption, and higher satisfaction scores than those who received bupivacaine alone.¹³ Although

adverse effects such as nausea, vomiting, and shivering were numerically less frequent in Group T, these differences were not statistically significant in the present study. Importantly, the analgesic benefits were achieved without an apparent increase in adverse effects or drug cost, supporting wound infiltration with tramadol and bupivacaine as a simple, economical, and clinically useful component of multimodal analgesia after caesarean delivery.⁴

CONCLUSIONS

In women undergoing caesarean delivery under spinal anaesthesia, wound infiltration with a tramadol-bupivacaine mixture prolonged the duration of postoperative analgesia, delaying the first request for rescue analgesia by approximately 3.4 hours, and reduced 24-hour diclofenac consumption by nearly half compared with bupivacaine alone, without a significant increase in adverse effects. Given its simplicity and low cost, the addition of tramadol to bupivacaine for wound infiltration is a practical component of multimodal post-caesarean analgesia, particularly in resource-limited settings.

This study has some limitations. It was conducted at a single centre with a modest sample size, and follow-up was limited to 24 hours. As there was no group receiving intravenous tramadol, a contribution from systemic absorption rather than a purely local effect cannot be excluded. The optimal concentration and volume of the infiltration mixture were not evaluated, and the study was not powered to detect differences in adverse effects

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. The Ethics Committee of S.M.S. College and attached hospitals, Jaipur, issued approval 21/MC/EC/2020. After approval from the ethics committee, the study was registered with the Clinical Trials Registry India (CTRI); registration number CTRI/2021/02/031140.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Stevens J, Schmied V, Burns E, Dahlen H. Immediate or early skin-to-skin contact after a caesarean section: a review of the literature. *Matern Child Nutr.* 2014;10(4):456-73.
2. Abate SM, Mergia G, Nega S, Basu B, Tadesse M. Efficacy and safety of wound infiltration modalities for postoperative pain management after cesarean section: a systematic review and network meta-analysis protocol. *Syst Rev.* 2022;11(1):194.

3. Dominguez JE, Habib AS. Prophylaxis and treatment of the side-effects of neuraxial morphine analgesia following cesarean delivery. *Curr Opin Anaesthesiol.* 2013;26(3):288-95.
4. Bauchat JR, Weiniger CF, Sultan P, Habib AS, Ando K, Kowalczyk JJ, et al. Society for Obstetric Anesthesia and Perinatology consensus statement: monitoring recommendations for prevention and detection of respiratory depression associated with administration of neuraxial morphine for cesarean delivery analgesia. *Anesth Analg.* 2019;129(2):458-74.
5. Gadsden J, Hart S, Santos AC. Post-cesarean delivery analgesia. *Anesth Analg.* 2005;101(5 Suppl):S62-9.
6. Boonstra AM, Stewart RE, Köke AJA, Oosterwijk RFA, Swaan JL, Schreurs KMG, et al. Cut-off points for mild, moderate, and severe pain on the numeric rating scale for pain in patients with chronic musculoskeletal pain: variability and influence of sex and catastrophizing. *Front Psychol.* 2016;7:1466.
7. Johnson SM, Saint John BE, Dine AP. Local anesthetics as antimicrobial agents: a review. *Surg Infect (Larchmt).* 2008;9(2):205-13.
8. Carvalho B, Lemmens HJ, Ting V, Angst MS. Postoperative subcutaneous instillation of low-dose ketorolac but not hydromorphone reduces wound exudate concentrations of interleukin-6 and interleukin-10 and improves analgesia following cesarean delivery. *J Pain.* 2013;14(1):48-56.
9. Fiorelli A, Izzo AC, Frongillo EM, Del Prete A, Liguori G, Di Costanzo E, et al. Efficacy of wound analgesia for controlling post-thoracotomy pain: a randomized double-blind study. *Eur J Cardiothorac Surg.* 2016;49(1):339-47.
10. Bamigboye AA, Hofmeyr GJ. Local anaesthetic wound infiltration and abdominal nerves block during caesarean section for postoperative pain relief. *Cochrane Database Syst Rev.* 2009;(3):CD006954.
11. Milkias M, Mekonnen S, Getachew H, Mulugeta H, Ahmed S, Kebede M, et al. Analgesic effectiveness of wound infiltration with bupivacaine versus a mixture of bupivacaine and tramadol for postoperative pain management among parturients undergoing elective cesarean section under spinal anesthesia: a randomized controlled trial. *PLoS One.* 2025;20(11):e0336372.
12. Webster L, Rauck RL. Atypical opioids and their effect on respiratory drive. *J Opioid Manag.* 2021;17(7):109-18. doi:10.5055/jom.2021.0648.
13. Sachidananda R, Joshi V, Shaikh S, Umesh G, Mrudula T, Marutheesh M. Comparison of analgesic efficacy of wound infiltration with bupivacaine versus mixture of bupivacaine and tramadol for postoperative pain relief in caesarean section under spinal anaesthesia: a double-blind randomized trial. *J Obstet Anaesth Crit Care.* 2017;7(2):85.
14. Waldron NH, Jones CA, Gan TJ, Allen TK, Habib AS. Impact of perioperative dexamethasone on postoperative analgesia and side-effects: systematic review and meta-analysis. *Br J Anaesth.* 2013;110(2):191-200.

Cite this article as: Kumar M, Jain T. Post-operative analgesic effect of wound infiltration with bupivacaine versus mixture of bupivacaine and tramadol in caesarean section under spinal anaesthesia: a randomized double-blind interventional controlled study. *Int J Reprod Contracept Obstet Gynecol* 2026;15:4496-501.