Original Research Article

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To compare the effect of intrathecal buprenorphine versus buprenorphine in the transversus abdominis plane block on post-operative nausea and vomiting among subjects undergoing elective cesarean section: A randomized comparative study

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Abstract

Introduction: Post-operative nausea and vomiting (PONV) remain a significant clinical challenge following cesarean delivery, particularly when neuraxial opioids are used. Intrathecal opioids activate central chemoreceptor trigger zones and disrupt gastric motility, contributing to high PONV incidence (30–80%). The transversus abdominis plane (TAP) block offers peripheral analgesia without central opioid-related adverse effects. This study compares the efficacy of intrathecal buprenorphine versus buprenorphine administered through TAP block on PONV incidence and post-operative analgesia in cesarean delivery.

Methods: A randomized comparative study enrolled 60 parturients undergoing elective cesarean section (CS) under spinal anesthesia. Group SB ($n = 30$) received intrathecal buprenorphine, while Group TB ($n = 30$) received ultrasound-guided TAP block with buprenorphine. Primary outcomes included PONV scores using the Likert scale, vomiting episodes, and rescue antiemetic requirements. Secondary outcomes measured pain severity (Visual Analog Scale [VAS] scores), time to first analgesic request, and opioid consumption over 24 h. Statistical analysis of categorical and continuous variables were done using descriptive statistics, and compared between groups using independent sample t-tests and Chi-square tests.

Results: Group TB demonstrated significantly superior outcomes: PONV scores were markedly lower at 4, 6, and 12 h ($P < 0.0001$); fewer vomiting episodes ($P = 0.007$); reduced rescue antiemetic requirement (10% vs. 46.6%, $P = 0.004$); prolonged analgesic duration (423.9 ± 66.5 vs. 348.8 ± 46.4 min, $P = 0.0001$); and decreased paracetamol consumption (43.8 ± 4.4 vs. 48.8 ± 7.4 g/kg, $P = 0.002$). Early VAS scores (4–6 h) were significantly lower in Group TB ($P = 0.0001$), up to 24 h.

Conclusion: TAP blocks with buprenorphine provide superior post-operative analgesia with substantially reduced PONV compared to intrathecal buprenorphine, this approach is particularly beneficial for women at high risk of PONV and those requiring early mobilization. Incorporating TAP blocks into multimodal analgesia regimens for CS can enhance patient comfort and lead to better clinical outcomes.

Keywords: Buprenorphine, Cesarean section, Nerve block, Post-operative nausea and vomiting, Spinal anesthesia

Introduction

Cesarean section (CS) is a prevalent surgical procedure globally, and ensuring effective post-operative analgesia is crucial for enhancing maternal comfort, facilitating early ambulation, and promoting overall recovery.[1] Neuraxial anesthesia, particularly spinal anesthesia with intrathecal opioids, remains the standard for analgesia in cesarean deliveries. However, side effects, such as post-operative nausea and vomiting (PONV) continue to pose significant clinical challenges, impacting maternal satisfaction and recovery quality.

Intrathecal buprenorphine, a semisynthetic opioid, has gained popularity as an adjunct to local anesthetics in spinal anesthesia due to its prolonged analgesic effects and lower risk of respiratory depression.[2] Despite its benefits, intrathecal buprenorphine is associated with side effects, such as pruritus, sedation, and PONV, which remain a concern.[3,4]

The transversus abdominis plane (TAP) block has emerged as an effective regional analgesic technique for post-operative pain management after lower abdominal surgeries, including CS.[5] This block targets the nerves supplying the anterior abdominal wall, providing somatic analgesia without systemic opioid-related side effects. Ultrasound-guided TAP blocks have enhanced accuracy, safety, and efficacy, making it an attractive opioid-sparing analgesic modality.[6]

Studies suggest that buprenorphine in TAP blocks may offer prolonged analgesia with reduced opioid-related adverse events, but data are limited.[7] PONV remains a significant issue after CS, with an incidence of 30–80% depending on anesthetic technique, opioid use, and patient risk factors. Neuraxial opioids, including buprenorphine, contribute to higher PONV rates due to their action on central chemoreceptor trigger zones (CTZs) and delayed gastric emptying.[8]

This randomized comparative study aims to evaluate and compare the effects of intrathecal buprenorphine versus buprenorphine administered in the TAP block on the incidence of PONV among women undergoing elective CS.

Methods

This prospective randomized, double-blind controlled trial was conducted from June 2025 to September 2025 at a tertiary care hospital after obtaining ethical approval (BMCRI/EC/2025, dated June 27, 2025) the study included 60 patients aged between 18 and 45 years, ASA physical status II, posted for elective cesarean section under spinal anesthesia, after obtaining informed written consent. Refusal to give consent, age below 18 years, allergy to local anesthetics or opioids, bleeding diathesis, presence of skin lesions or wound at the proposed block site were excluded from the study. The study was conducted in accordance with the Declaration of Helsinki (2013) and Good Clinical Practice guidelines and the manuscript follows CONSORT guidelines.

All patients underwent a comprehensive pre-anesthesia evaluation on the day before study enrolment. The day of surgery, patients' fasting status and informed consent were re-verified. Upon arrival in the operating room, standard monitoring modalities (electrocardiography, pulse oximetry, non-invasive blood pressure) were applied and intravenous access was secured with an 18G intravenous cannula and fluid pre-load with 500 mL Ringer lactate, Basal parameters were recorded.

Randomization and allocation concealment involved serially numbered, sealed envelopes with group assignments determined by computer-generated sequences in a 1:1 ratio. Prepared using the online software www.randomization.com by the primary investigator. Spinal Buprenorphine group (Group SB) received spinal anesthesia with intrathecal hyperbaric bupivacaine combined with buprenorphine. Followed by ultrasound-guided bilateral TAP block with Local anesthetic and Normal saline. TAP Buprenorphine group

(Group TB) received spinal anesthesia with hyperbaric bupivacaine and normal saline intrathecally, followed by ultrasound-guided bilateral TAP block with Local anesthetic and buprenorphine.

Under aseptic conditions, patients were positioned sitting or in lateral decubitus. After local skin infiltration, dural puncture was performed at the L3–L4 interspace with a 25G Quincke spinal needle. Cerebrospinal fluid return was confirmed, then Group SB received 1.8 mL of 0.5% hyperbaric bupivacaine with 0.2 mL (60 mcg) of buprenorphine intrathecally. Group TB received 1.8 mL of 0.5% hyperbaric bupivacaine with 0.2 mL of normal saline intrathecally. Following surgical completion, Group SB received ultrasound-guided bilateral TAP blocks with 15 mL 0.25% Bupivacaine with 0.1 mL Normal saline on each side, and Group TB received ultrasound-guided bilateral TAP blocks with 15 mL 0.25% Bupivacaine 30 mcg (0.1 mL) buprenorphine on each side.

A bilateral ultrasound-guided TAP block was performed using a GE Healthcare Venue 40 portable ultrasound machine with a high-frequency linear probe of 8–12 MHz. The ultrasound probe was placed in the midaxillary line, midway between the inferior costal margin and the iliac crest, to visualize the external oblique, internal oblique, and transversus abdominis muscles, along with the transversus abdominis fascia. A 23-gauge Spinal needle was directed under continuous in-plane ultrasound visualization between the internal oblique and transversus abdominis muscle into the posterior aspect of the fascial plane. After negative aspiration for blood, the allocated solution was injected on each side under ultrasound guidance.

Patients were monitored post-operatively for 24 h for incidence and severity of PONV. The primary outcome was the incidence of PONV within 24 h post-operatively. PONV was defined as one or more episodes of vomiting, marked nausea defined by a numerical rating scale >4, or the requirement for rescue antiemetics. Severity was assessed using the Likert scale (0–10) at pre-defined time points: 0, 2, 4, 12, and 24 h post-operatively.

Post-operative pain (assessed by Visual Analog Scale [VAS]), treated when VAS >4 with injection Paracetamol 15 mg/kg and was reassessed after 30 min, if the pain persisted injection Tramadol 1.5 mg/kg was administered. Need for additional analgesics, number of rescue analgesics, and total dose administered were recorded. Patients were regularly assessed for these parameters until completion of the 24-h post-operative period.

Adverse effects were monitored, including Hypotension (Mean arterial pressure [MAP] decrease >20% from baseline) was managed with IV fluids and/or ephedrine 5 mg boluses. Bradycardia (heart rate [HR] <60 bpm) was treated with IV atropine 0.5 mg. Other monitoring included SpO_2, Baby APGAR 1 min and 5 min, and any unexpected adverse events during the post-operative period.

Randomization with allocation concealment ensured unbiased assignment of participants to groups. The standardized anesthetic and post-operative care protocols minimized confounding variables across groups. Data collection was conducted by trained personnel blinded to group allocation to reduce observer bias; this methodology adheres to standard clinical trial guidelines for randomized controlled trials in anesthesiology, ensuring validity and reproducibility of findings.

Data analysis was conducted using IBM SPSS Statistics Version 29.0. Categorical and continuous variables were summarized using descriptive statistics, which include frequency, percentage, and mean with standard deviation. Continuous variables were compared between groups using independent sample t-tests, while categorical data were analyzed using Chi-square tests (or Fisher's Exact test for small cell frequencies). A probability value (*P*-value) of 0.05 was considered statistically significant.

Results

Sixty patients were enrolled for this study; participants were equally randomized to receive Buprenorphine either through spinal or TAP block [Figure 1]. Both groups were comparable in terms of demographics (age, sex, weight, and height) with no significant differences, as summarized in Table 1.

The comparative analysis between Group SB and Group TB demonstrated significant differences across various post-operative parameters related analgesia [Table 2]. The Group TB demonstrated significantly prolonged time to first analgesic request (423.9 ± 66.5 min vs. 348.8 ± 46.4 min, $P = 0.0001$). Paracetamol consumption was notably higher in the SB group, with 76.6% requiring four doses compared to none in the TB group ($P = 0.0001$). VAS pain scores showed significant differences at 4 and 6 h ($P = 0.0001$), with no significant differences at 12 and 24 h, indicating comparable late post-operative analgesia between groups.

In addition, the parameters related to nausea and vomiting [Table 3] in the study found that PONV scores demonstrated superior outcomes in the TB group. At 4 h, PONV scores were significantly lower in TB (0 vs. 3.8 ± 1.4, $P < 0.0001$). At 6 h,

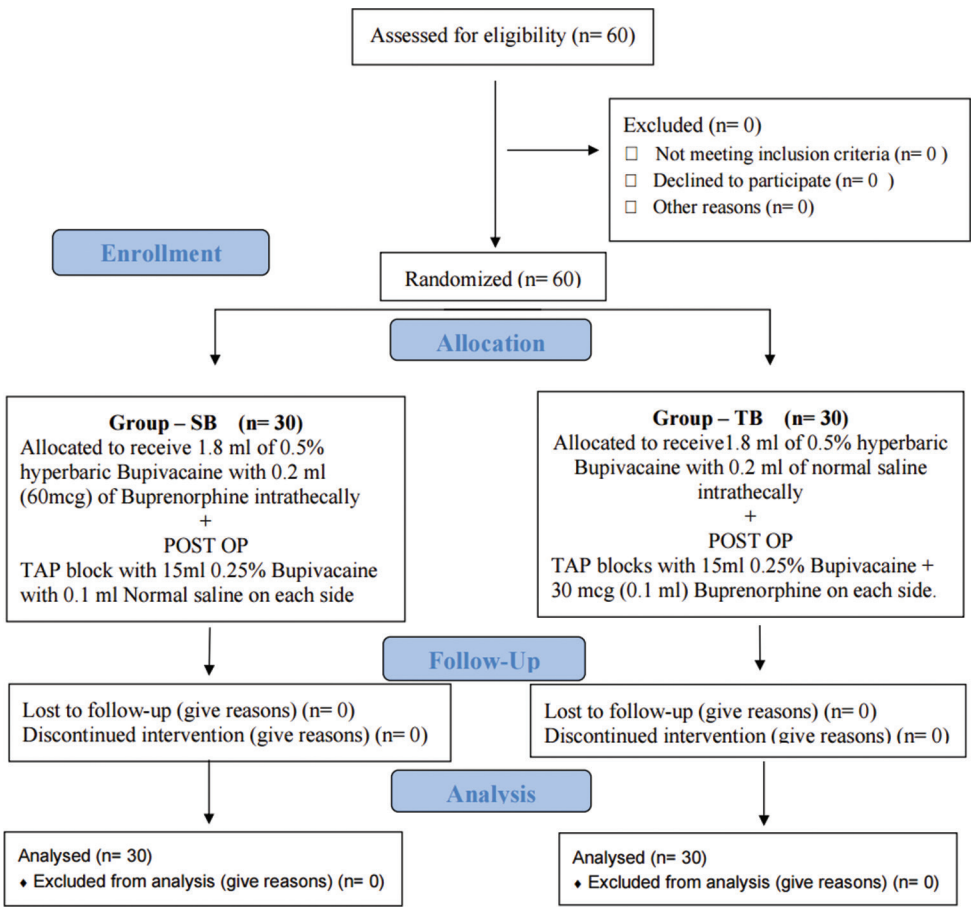

Figure 1: Consolidated standards of reporting trials flow diagram for participant enrolment. Group-SB (Spinal Buprenorphine) Group-TB (TAP Buprenorphine), *n* = number of patients

Table 1: Comparison of patient's demographics and Total duration of surgery

Parameters	Group SB (*n*=30)	Group TB (*n*=30)	*P*-value
Age (mean±SD)	27.8±8.4	29.7±7.5	0.36
Height (mean±SD)	154.7±6.9	155.0±7.0	0.87
Weight (mean±SD)	66.2±7.6	65.4±9.7	0.72
BMI	29.6±4.7	28.8±5.8	0.56
Total duration of surgery (Mean±SD)	60.8±6.4	58.9±6.5	0.26

Data expressed as mean (SD) SD: Standard deviation, *n*: Number of patients. For continuous variables, a t-test was used, BMI: Body mass index

Table 2: Comparison of analgesic characteristics between groups

Parameters	Group SB (*n*=30)	Group TB (*n*=30)	*P*-value
Time to first analgesic request (min)	348.8±46.4	423.9±66.5	0.0001
Paracetamol requirement in the first 24 h			
2 doses	0	8	0.0001
3 doses	7	22	
4 doses	23	0	
Mean paracetamol consumed in first 24 h (g/kg)	48.8±7.4	43.8±4.4	0.002
Number of patients needing tramadol in first 24 h (%)	17 (56.6)	9 (30)	0.035
Mean tramadol consumed in mg/kg	5.8±1.4	4.2±1.3	0.0001
VAS (h)			
4	3.8±0.3	1.8±0.4	0.0001
6	5.3±0.4	3.8±0.5	0.0001
12	6.1±0.7	6.0±0.4	0.564
24	5.8±0.4	5.7±0.3	0.249

Data expressed as mean (SD). SD: Standard deviation, *n*: Number of patients. Independent t-test for the mean difference between both groups. *$P<0.05$ was considered significant, VAS: Visual Analog Scale

TB group scores remained significantly lower (0.8 ± 0.3 vs. 2.2 ± 0.8, $P < 0.0001$). Vomiting episodes were fewer in the TB group, with 90% experiencing no vomiting compared to 53.3% in the SB group ($P = 0.007$) and rescue antiemetic requirements favored the TB group, with only 10% requiring rescue medication versus 46.6% in the SB group ($P = 0.004$).

Table 3: Comparison of post-operative nausea and vomiting characteristics between groups

Parameters	Group SB (*n*=30)	Group TB (*n*=30)	*P*-value
PONV score using Likert scale (mean at different hours)			
4	3.8±1.4	0	<0.0001
6	2.2±0.8	0.8±0.3	<0.0001
12	0.7±0.3	0	0.0002
24	0	0	1.0
Number of vomiting episodes			
0	16	27	0.007
1	9	2	
2	5	1	
Rescue antiemetic given in first 24 h (%)	14 (46.6)	3 (10)	0.004
Number of antiemetic doses (%)			
0	16	27	0.003
1	11	3	
2	4	0	

Data expressed as mean (SD). SD: Standard deviation, *n*: Number of patients. Independent t-test for the mean difference between both groups. *$P<0.05$ was considered significant, PONV: Post-operative nausea and vomiting

In the data of HR [Figure 2] and MAP [Figure 3], there was no significant difference between the groups; similar levels were comparable from baseline till 24 h post-operatively.

No significant other adverse effects were observed intraoperatively or post-operatively in either group.

Discussion

The present study demonstrated significant differences in PONV incidence and analgesic

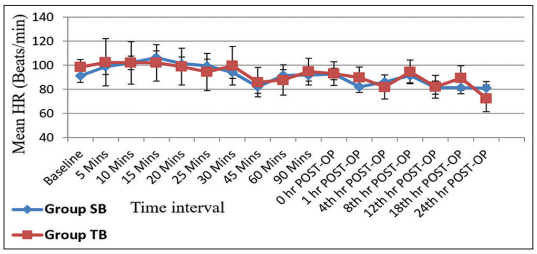

Figure 2: Changes in heart rate in the two studied groups, PO: Post-operative

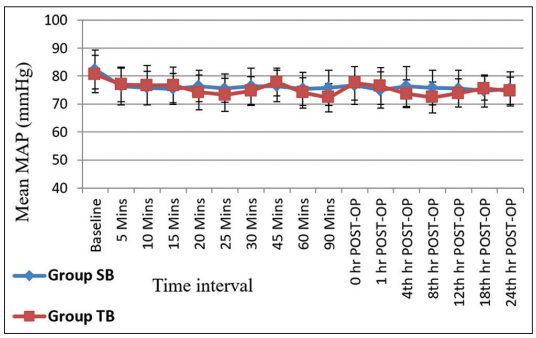

Figure 3: Changes in the mean arterial blood pressure in the two studied groups. PO: Post-operative

efficacy between intrathecal buprenorphine (Group SB) and buprenorphine administered through TAP block (Group TB) in women undergoing elective CS.[9]

The significantly longer time to first analgesic requirement in Group TB compared to Group SB reflects the sustained analgesic benefit of buprenorphine in TAP blocks. This finding is similar to a recent study, which demonstrated that perineural buprenorphine prolonged the duration of regional analgesia through activation of peripheral opioid receptors and potential antihyperalgesic effects,[10] similarly, buprenorphine was used as an adjuvant to levobupivacaine in TAP blocks, providing a mean duration of analgesia exceeding 688 min, significantly longer than local anesthetic alone.[11]

Our study revealed lower mean paracetamol consumption and reduced tramadol requirements in the TAP block group, consistent with the opioid-sparing multimodal analgesia regimen increasingly advocated for cesarean delivery. A retrospective cohort study analyzing 130,946 cesarean deliveries under general anesthesia in US hospitals found that opioid-sparing multimodal analgesia utilization remained suboptimal at only 8.5% despite proven benefits, emphasizing the need for greater adoption of such protocols. The incorporation of peripheral nerve blocks with buprenorphine represents a practical strategy to reduce systemic opioid exposure while maintaining adequate analgesia.[9]

VAS scores at 4 and 6 h post-operatively were significantly lower in Group TB compared to Group SB, indicating superior early post-operative pain control. Interestingly, VAS scores converged at 12 and 24 h, suggesting that while intrathecal buprenorphine provides initial analgesia, its benefits diminish more rapidly than TAP block with buprenorphine. This temporal pattern aligns with pharmacokinetic considerations: Intrathecal buprenorphine's central effects may be counteracted by activation of opioid receptor-like 1 (ORL-1) receptors, which can attenuate analgesia and contribute to side effects, whereas peripheral administration in TAP blocks avoids this central receptor interaction.[12]

The most significant finding of this study is the significant reduction in PONV in the TB group. PONV scores using the Likert scale were significantly lower at 4, 6, and 12 h in Group TB, compared with Group SB. Furthermore, only a few patients in Group TB required rescue antiemetics compared to Group SB, and the number of vomiting episodes was significantly lower in the TAP block group. These findings are consistent with the established understanding that neuraxial opioids, including buprenorphine, exert emetogenic effects through multiple mechanisms. Intrathecal opioids access the central nervous system directly, activating the CTZ in the area postrema and disrupting the vomiting center in the medulla. In addition, opioids delay gastric emptying and increase vestibular sensitivity, further contributing to PONV.[13] Van den Bosch *et al*.,[14] reported in their implementation that a study using intrathecal

morphine for cesarean delivery demonstrated an improved quality of recovery, but significantly increased pruritus, proving the well-documented adverse effect profile of neuraxial opioids.

A recent meta-analysis by Demilew *et al*.[13] examining intraoperative nausea and vomiting during CS under spinal anesthesia found a pooled prevalence of 36% (95% CI: 31–41%), emphasizing that PONV remains a significant clinical challenge in this population. While our study did not specifically analyze these subgroups, the consistently lower PONV rates in Group TB suggest that peripheral opioid administration effectively reduced centrally mediated emetogenic pathways.

Buprenorphine administered peripherally activates local mu-opioid receptors, providing sustained analgesia while avoiding the CTZ and other central structures responsible for nausea and vomiting.[15-17] This peripheral mechanism explains the markedly lower PONV incidence observed in our TAP block group.

Buprenorphine possesses unique pharmacological properties that distinguish it from other opioids. As a partial mu-opioid receptor agonist with high receptor affinity but lower intrinsic activity, buprenorphine exhibits a ceiling effect for respiratory depression while maintaining analgesic efficacy. In addition, buprenorphine acts as an antagonist at kappa and delta-opioid receptors, potentially reducing dysphoria and constipation, and functions as a full agonist at ORL-1 receptors.[17]

Intrathecal buprenorphine's hydrophobic nature enables rostral spread and central nervous system penetration, activating CTZ and gastrointestinal centers, causing PONV. ORL-1 receptor activation produces antianalgesic effects. Conversely, TAP blocks target peripheral opioid receptors on sensory nerve terminals, providing prolonged analgesia without systemic absorption or central penetration, thereby minimizing opioid side effects while modulating pain sensitization independently of central mechanisms.[11]

The Procedure-Specific Post-operative Pain Management guidelines for cesarean delivery, updated in 2021 and endorsed by multiple international anesthesiology societies, recommend multimodal analgesia incorporating neuraxial morphine, regular acetaminophen and NSAIDs, and consideration of TAP blocks, particularly when neuraxial morphine is contraindicated or not used. Our study provides evidence supporting TAP blocks with buprenorphine as a viable alternative to intrathecal opioids, offering comparable or superior analgesia with significantly reduced PONV.[18]

Our study's findings should be considered in the context of certain limitations. First, the study had a sample size of 60, while adequate for detecting the observed differences in primary outcomes, may limit the generalizability of findings to broader populations. Additionally, the study was conducted at a single center, and practice patterns, patient demographics, and surgical techniques may vary across institutions.

Conclusion

The ultrasound-guided TAP block with buprenorphine offers a superior alternative to intrathecal buprenorphine, exhibiting, a significantly lower incidence of PONV, reduced opioid requirements, decreased need for rescue antiemetics, prolonged duration of analgesia, this approach is particularly beneficial for women at high risk of PONV and those requiring early mobilization. Incorporating TAP blocks into multimodal analgesia regimens for CS can enhance patient comfort and lead to better clinical outcomes.

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Conflicts of Interest

There are no conflicts of interest.

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