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Comparative Effectiveness of Ultrasound-Guided TAP Block and Surgical Site Infiltration on Post-Cesarean Pain Control and Early Breastfeeding

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ABSTRACT

Background: Post-Cesarean pain management remains challenging, potentially affecting maternal recovery, infant care, and breastfeeding success. While both transversus abdominis plane (TAP) block and surgical site infiltration are established analgesic techniques, their comparative impact on early postoperative outcomes and breastfeeding initiation remains incompletely understood. **Objective:** This study aimed to compare the efficacy of TAP block versus wound infiltration for post-Cesarean analgesia.

Patients and methods: A prospective, randomized study was conducted involving 194 women undergoing Cesarean delivery with spinal anesthesia at a single academic center. Participants were randomized to receive either an ultrasound-guided bilateral TAP block with 20 mL of 0.25% bupivacaine per side (n=97) or surgical site infiltration with 30 mL of 0.25% bupivacaine (n=97). Pain intensity, supplemental analgesic consumption, adverse effects, and breastfeeding initiation times were assessed over 24 hours postoperatively.

Results: Median pain scores remained consistently low in the TAP block group (range: 1.61-1.73) compared to progressively increasing scores in the infiltration group, reaching 7.06 at 24 hours ($p<0.001$). Notably, 82.5% of TAP block recipients required no supplemental analgesics, contrasting with universal analgesic requirements in the infiltration group. Hematoma formation was significantly less frequent with TAP block (4.1% versus 23.7%, $p<0.001$). Early breastfeeding initiation (within 6 hours) was achieved by 55.7% of TAP block recipients compared to 8.2% in the infiltration group ($p<0.001$). Neither group required opioid rescue analgesia. **Conclusion:** Ultrasound-guided TAP block provides superior postoperative pain control compared to surgical site infiltration following Cesarean delivery, characterized by sustained analgesic efficacy, minimal supplemental analgesic requirements, and reduced complications. The technique's association with earlier breastfeeding initiation suggests benefits extending beyond pain control, supporting its integration into enhanced recovery protocols for Cesarean delivery.

Keywords: Post-Cesarean analgesia, Ultrasound-guided TAP block, Surgical site infiltration, Postoperative recovery, Early breastfeeding.

INTRODUCTION

Cesarean delivery (CD) is a commonly performed surgery worldwide, often accompanied by significant postoperative pain. Effective pain management is essential to improve maternal recovery, facilitate early mobilization, enhance patient satisfaction, and support mother-infant bonding [1]. Traditional pain management strategies involve multimodal analgesia, combining systemic and regional analgesics [2]. Two prominent regional techniques for pain relief after CD include the TAP block and direct wound infiltration with local anesthetics [3].

TAP blocks are ultrasound-guided regional techniques that target the thoracolumbar nerves supplying the anterior abdominal wall. Interruption of nerve signals through TAP block has emerged as a promising method for controlling post-surgical pain and reducing opioid requirements following abdominal operations, with encouraging results in Cesarean deliveries. Local infiltration offers a different approach by delivering anesthetic directly to the incision site for focused pain management. However, existing research has not definitively established which technique provides better pain control after Cesarean delivery, as current evidence shows variable outcomes [4-6].

Despite that both techniques are showing potential as opioid-sparing strategies, studies comparing TAP blocks with wound infiltration often yield conflicting results due to variations in methodology, patient demographics, anesthetic dosages, and outcome measures. Furthermore, these studies frequently emphasize short-term pain outcomes rather than patient-centered factors like quality of life and satisfaction [7, 8]. Given these considerations, this randomized controlled trial aimed to compare the efficacy of TAP block versus wound infiltration for post-Cesarean analgesia. The study evaluated pain scores, analgesic requirements, adverse effects, and breastfeeding outcomes to provide comprehensive insights into the benefits and limitations of each technique. By addressing these aspects, the study seeks to inform clinical practices and enhance postoperative care for women undergoing Cesarean delivery.

SUBJECTS AND METHODS

Study design: This randomized controlled trial was conducted at Aswan University Hospital through the period from Jan, 2022 to June, 2024.

Study population: A total of 194 women scheduled for CD under spinal anesthesia were enrolled in the study. Participants were between 18 and 45 years of age and classified as American Society of Anesthesiologists (ASA) physical status I or II.

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Exclusion criteria: Contraindications to regional anesthesia, pre-existing chronic pain conditions, history of recent opioid exposure, significant psychiatric disorders, and known allergies to local anesthetics.

Randomization and blinding: A computerized random allocation system assigned 194 participants equally between the study groups. One group underwent TAP block intervention, while the other received wound infiltration (97 patients per group). To maintain randomization integrity, an independent statistician prepared opaque envelopes, numbered in sequence, containing concealed group assignments. The study maintained double-blinding, with both patients and outcome evaluators unaware of treatment allocation.

Anesthetic technique: All participants received standardized spinal anesthesia administered at the L3-L4 or L4-L5 intervertebral space using a 25-gauge spinal needle. The anesthetic solution consisted of hyperbaric bupivacaine (12-15 mg) combined with fentanyl (10-25 mcg). Standard monitoring included continuous electrocardiography, non-invasive blood pressure measurement, and pulse oximetry.

Interventions

TAP block group: Following delivery and before abdominal closure, bilateral TAP blocks were performed under ultrasound guidance using a high-frequency linear transducer (6-13 MHz). Using an in-plane technique with a 22-gauge needle, 20 mL of 0.25% bupivacaine was injected into the fascial plane between the internal oblique and transversus abdominis muscles on each side. The spread of local anesthetic was confirmed by ultrasound visualization.

Wound infiltration group: After fascial closure but before skin closure, 30 mL of 0.25% bupivacaine was infiltrated into the subcutaneous tissues along the length of the surgical incision. The infiltration was performed using a systematic technique to ensure uniform distribution of the local anesthetic.

Outcome measurements: Pain intensity was assessed using a numerical rating scale (NRS) ranging from 0 (no pain) to 10 (worst imaginable pain) at 2, 4, 12, and 24 hours postoperatively. The requirement for additional analgesics was recorded, including the time to first analgesic request and total analgesic consumption during the first 24 hours.

Secondary outcomes included:

The incidence of adverse effects particularly hematoma formation, the timing of breastfeeding initiation and the need for opioid analgesia.

Patients were assessed by trained research personnel who were blinded to group allocation. All adverse events were documented, including the development of hematoma, infection, or other complications.

Sample size: Sample size calculation was based on detecting a difference in pain scores, with a power of 80% and a significance level of 0.05. Based on a previous study [8] showing mean pain scores of 1.8 ± 1.3 in the TAP block group and 2.24 ± 0.8 in the wound infiltration group, 97 participants per group were required.

Ethical approval: The study protocol was approved by The Institutional Review Board of Aswan University Hospital (NCT 03498/18), and written informed consents were obtained from all participants. Throughout its implementation, the study complied with the Helsinki Declaration.

Statistical analysis

Data were analyzed using SPSS version 29. We assessed the distribution pattern of continuous variables using the Kolmogorov-Smirnov test. For data not following normal distribution, we reported central tendency as a median with an interquartile range and was conducted between-group comparisons using non-parametric testing (Mann-Whitney U). For categorical variables, we presented data as numbers and percentages, analyzing differences between groups with Chi-square analysis. Statistical significance was established at $p \leq 0.05$, with values below 0.001 indicating statistical significance.

RESULTS

A total of 194 patients were included in the study, with 97 patients randomized to each group. The demographic characteristics showed a small but statistically significant difference in age between the TAP block group (29.3 ± 4.76 years) and the wound infiltration group (31.21 ± 5.41 years) ($p = 0.015$).

Postoperative pain scores showed significant differences between the groups after the initial 2-hour period. While pain scores at 2 hours were comparable between groups (TAP: 1.73 ± 0.73 vs wound infiltration: 2.02 ± 0.97, $p = 0.062$), the TAP block group demonstrated significantly lower pain scores at all subsequent time points. The TAP block group maintained consistently low pain scores throughout the 24 hours (ranging from 1.61 to 1.67), whereas the wound infiltration group showed progressively increasing pain scores, reaching 7.06 ± 0.767 at 24 hours ($p < 0.001$) (Table 1 and figures 1& 2).

Table (1): Postoperative pain scores

Time Point	TAP Block Group (N=97)	Wound Infiltration Group (N=97)	P-value
2 Hours	1.73 ± 0.73	2.02 ± 0.97	0.062
4 Hours	1.67 ± 0.68	4.56 ± 0.82	<0.001
12 Hours	1.61 ± 0.65	4.60 ± 0.78	<0.001
24 Hours	1.65 ± 0.64	7.06 ± 0.767	<0.001

Values are presented as mean ± SD.

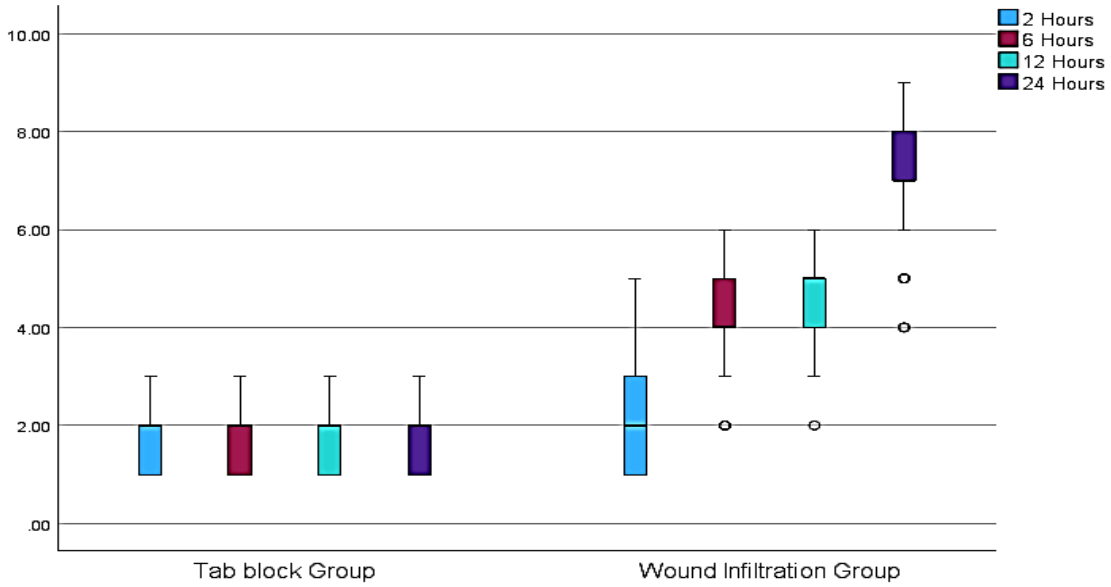

Figure (1): Comparison between the two groups according to pain score during 24 Hours.

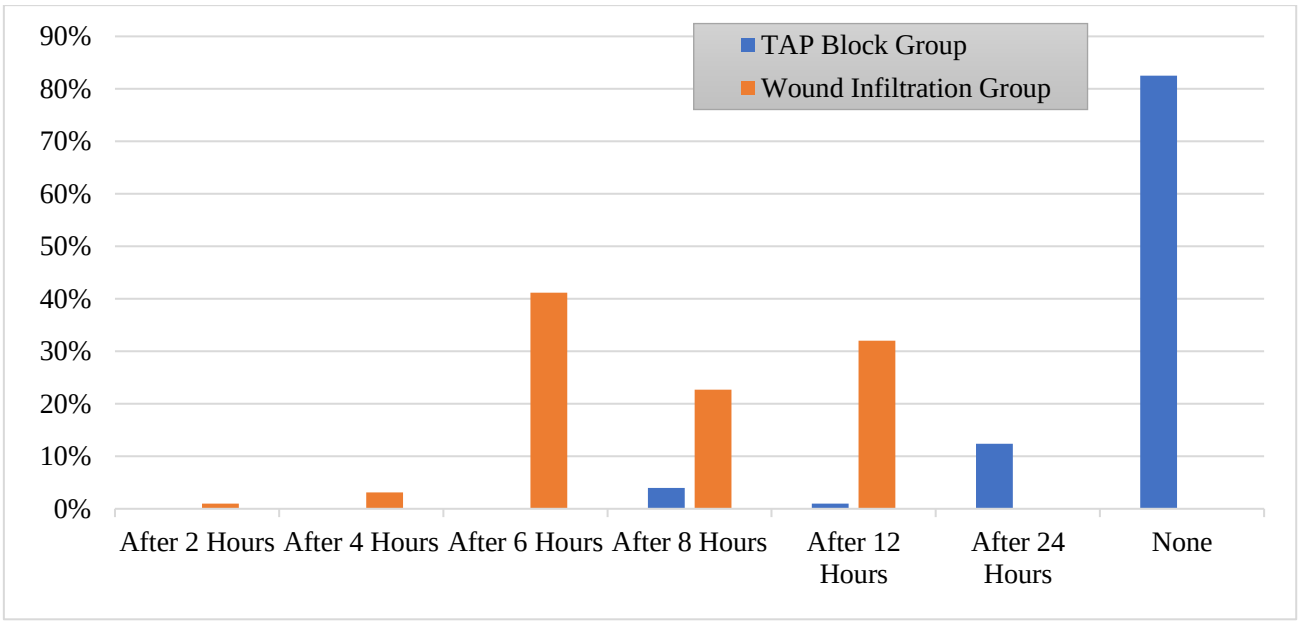

Figure (2): Comparison between the two groups according to pain score.

Neither group required opioid analgesics during the 24-hour observation period. However, there were marked differences in the need for non-opioid analgesics. In the TAP block group, 82.5% of patients required no additional analgesics, with only 12.4% needing analgesics after 24 hours. In contrast, all patients in the wound infiltration group required analgesics, with the majority (41.2%) requiring their first dose at 6 hours post-surgery, followed by 32% at 12 hours. The incidence of adverse effects differed significantly between groups. Hematoma formation was observed in 23.7% of patients in the wound infiltration group compared to only 4.1% in the TAP block group ($p < 0.001$) (Table 2, figure 3). Breastfeeding initiation patterns showed significant differences between the groups ($p < 0.001$). In the TAP block group, early initiation was more common, with 9.3% of mothers starting at 2 hours and 34% at 6 hours post-surgery. The wound infiltration group showed delayed initiation, with the majority starting after 12 hours (36.1%) or 24 hours (29.9%) post-surgery (Table 2, figure 4).

Table (2): Secondary outcomes

Outcome	TAP Block Group (N=97)	Wound Infiltration Group (N=97)	P-value
First Analgesic Requirement			<0.001
After 2 Hours	0 (0%)	1 (1%)	
After 4 Hours	0 (0%)	3 (3.1%)	
After 6 Hours	0 (0%)	40 (41.2%)	
After 8 Hours	4 (4.1%)	22 (22.7%)	
After 12 Hours	1 (1%)	31 (32%)	
After 24 Hours	12 (12.4%)	0 (0%)	
None	80 (82.5%)	0 (0%)	
Adverse Effects			<0.001
Hematoma	4 (4.1%)	23 (23.7%)	
None	93 (95.9%)	74 (76.3%)	
Breastfeeding Initiation			<0.001
After 2 hours	9 (9.3%)	0 (0%)	
After 4 Hours	12 (12.4%)	0 (0%)	
After 6 Hours	33 (34%)	8 (8.2%)	
After 8 Hours	20 (20.6%)	10 (10.3%)	
After 12 Hours	22 (22.7%)	35 (36.1%)	
After 18 Hours	0 (0%)	15 (15.5%)	
After 24 Hours	1 (1%)	29 (29.9%)	

Values are presented as n (%).

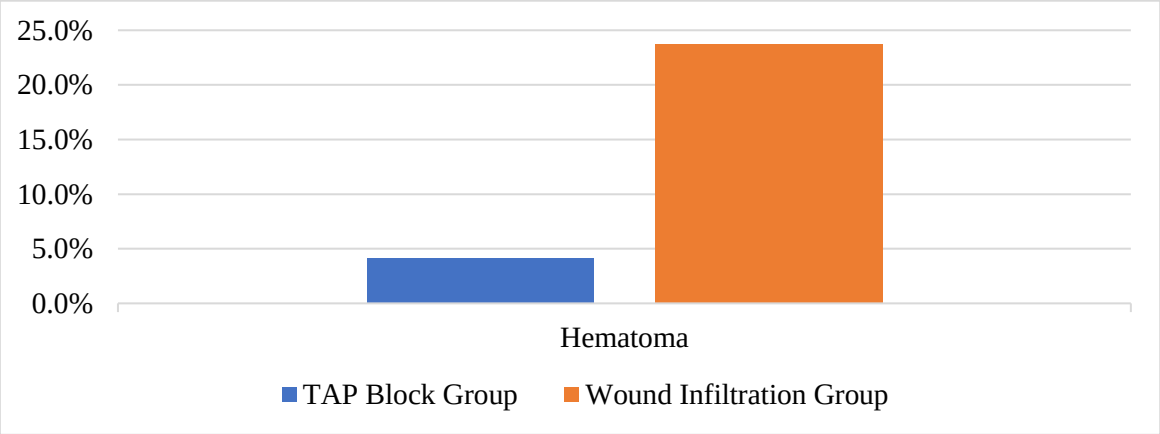

Figure (3): Comparison between the two groups according to adverse effect.

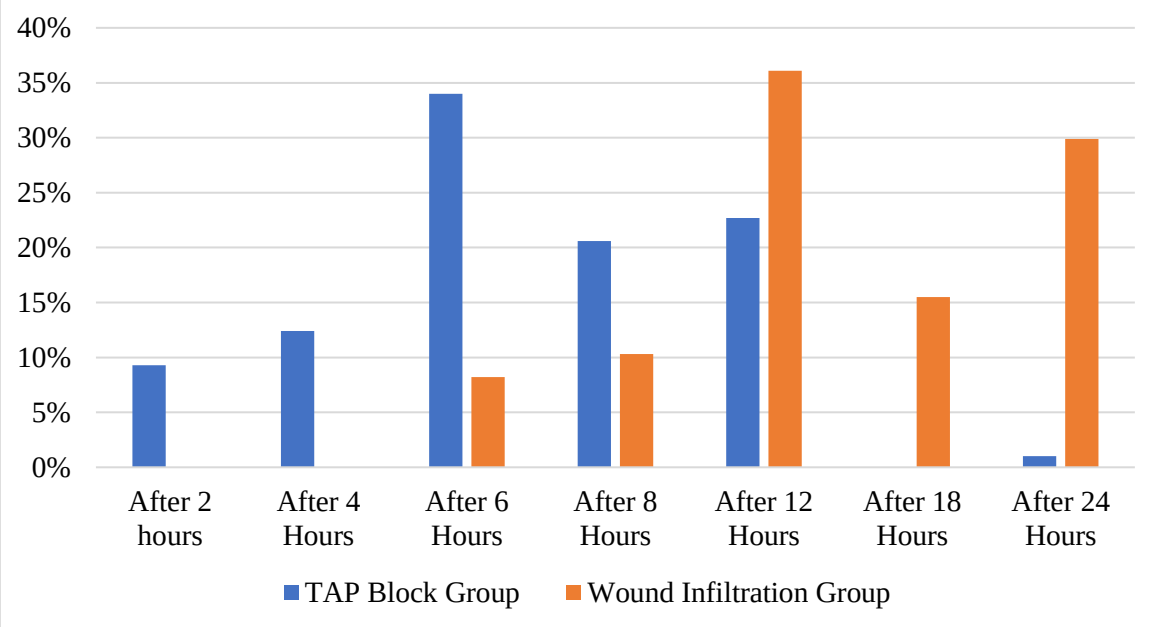

Figure (4): Comparison between the two groups according to breastfeeding.

DISCUSSION

This randomized controlled trial compared the efficacy of TAP block versus wound infiltration for post-Cesarean analgesia, examining pain scores, analgesic requirements, adverse effects, and breastfeeding outcomes. Our findings demonstrate several significant advantages of TAP block over wound infiltration for post-Cesarean pain management, aligning with and extending previous research in this area.

Initial post-surgical pain levels were similar between groups at the 2-hour assessment point. However, marked differences emerged thereafter, with patients receiving TAP block experiencing consistently superior pain control at subsequent measurement intervals (4, 12, and 24 hours after surgery). The TAP block group maintained consistently low pain scores (ranging from 1.61 to 1.73) throughout the 24 hours, whereas the wound infiltration group showed a progressive increase in pain scores, reaching 7.06 at 24 hours. Our results support the findings of **Guo *et al.*** [9], whose research demonstrated that TAP block led to reduced pain scores compared to wound infiltration at both 8 and 24 hours following surgery, while showing comparable efficacy during the first hour post-procedure. Similarly, **Aydogmus *et al.*** [10] reported superior pain control with TAP block compared to wound infiltration. **Görkem *et al.*** [11] observed that TAP block provided better early pain relief and reduced analgesic consumption within 12 hours post-surgery, while wound infiltration showed promise in reducing opioid use. The sustained analgesic effect can be attributed to the TAP block's mechanism of action, which involves depositing local anesthetic in a neurovascular plane containing the thoracolumbar nerves that supply the anterolateral abdominal wall [4].

In contrast, a meta-analysis of 2,906 participants by **Grape *et al.*** [12] found moderate-level evidence that TAP block and wound infiltration provide similar postoperative analgesia after Cesarean section. The analysis reported no significant differences in pain scores at 2, 12, and 24 hours postoperatively between the two techniques. Furthermore, two studies found no significant difference in postoperative pain scores between TAP block and wound infiltration at 24 hours [7, 8]. The marked difference in analgesic requirements between groups provided compelling evidence for the TAP block's superiority. In our study, 82.5% of TAP block patients required no additional analgesics during the first 24 hours, compared to the 100% analgesic requirement in the wound infiltration group. This finding surpasses the results reported by **Kumar *et al.*** [13] who found a significant reduction in analgesic requirements with TAP blocks. The enhanced effectiveness observed in our study might be attributed to our precise ultrasound-guided technique and optimal local anesthetic volume, factors highlighted by **Sultan *et al.*** [3] as crucial for TAP block success. However, another study reported no significant difference between TAP block and continuous local anesthetic infiltration wound catheter in terms of morphine consumption, pain scores, and patient satisfaction [14]. Additionally, a systematic review and meta-analysis by **Riemma *et al.*** [15], which synthesized data from five RCTs involving a total of 268 participants, demonstrated that cumulative opioid consumption at 24 hours was not significantly different between the TAP block and wound infiltration groups. Secondary outcomes, including adverse effects, gastrointestinal reactions, and sedation levels, also showed similar incidences across both modalities.

Regarding safety profiles, our study revealed significantly lower rates of hematoma formation in the TAP block group (4.1%) compared to the wound infiltration group (23.7%). The higher incidence of hematoma in wound infiltration can be explained by direct tissue trauma and multiple needle passes required for adequate local anesthetic spread, whereas the ultrasound-guided TAP block allows for more precise medication delivery with minimal tissue disruption. A study by **Tawfik *et al.*** [7] found that both techniques were generally safe, with low incidences of side effects reported.

A novel contribution of our study was the comprehensive assessment of breastfeeding outcomes. The TAP block group demonstrated remarkably earlier breastfeeding initiation, with 21.7% of mothers beginning within 4 hours and 34% by 6 hours post-surgery. In contrast, most wound infiltration group mothers started after 12 hours (36.1%) or 24 hours (29.9%). This finding builds upon **Hooda *et al.*** [16] work highlighting the importance of optimal pain control in facilitating early breastfeeding, though they did not specifically compare these two techniques.

Both techniques effectively spared opioid use are consistent with **Sultan *et al.*** [3] highlighting their role in postoperative analgesia after CD and reinforcing opioid-sparing strategies in obstetric practice.

Several mechanisms might explain the TAP block's superior performance. The use of ultrasound guidance enhances the precision of the injection, allowing for accurate placement of the anesthetic and reducing the risk of complications. Second, the TAP block targets the sensory nerves (T6–L1) that innervate the skin, muscles, and parietal peritoneum of the anterior abdominal wall providing broader coverage than wound infiltration, which primarily affects superficial nerve endings. By depositing the anesthetic in this fascial plane, the TAP block effectively interrupts the transmission of pain signals from the abdominal wall to the central nervous system, resulting in significant postoperative pain relief [12, 17].

Our findings had important clinical implications. The superior pain control, reduced analgesic requirements, and earlier breastfeeding initiation with TAP blocks suggest this technique should be considered a preferred option for post-Cesarean analgesia. The safety profile and complete avoidance of opioids further

strengthen this recommendation. However, implementation requires consideration of factors such as operator expertise, equipment availability, and cost-effectiveness.

LIMITATIONS: The single-center design and 24-hour follow-up period. Future research should examine longer-term outcomes, including chronic pain development and breastfeeding duration. Additionally, cost-effectiveness analyses would provide valuable information for healthcare systems considering the widespread implementation of TAP blocks.

CONCLUSION

This randomized controlled trial demonstrated the superior efficacy of TAP block compared to wound infiltration for post-Cesarean analgesia. TAP block provided more effective and sustained pain control throughout the 24-hour postoperative period, with significantly lower pain scores and markedly reduced analgesic requirements. The technique was associated with a lower incidence of complications, particularly hematoma formation, and facilitated earlier initiation of breastfeeding. The absence of opioid requirements in both groups supports the effectiveness of these regional techniques as part of a multimodal analgesic strategy. However, the TAP block group showed clear advantages in terms of sustained pain control and reduced need for supplemental analgesics, with 82.5% of patients requiring no additional pain medication. These findings suggest that ultrasound-guided TAP block should be considered as a preferred analgesic technique following Cesarean delivery, particularly in settings where early maternal recovery and breastfeeding initiation are prioritized. Future research should focus on long-term outcomes and cost-effectiveness analysis to further support the widespread implementation of this technique in routine clinical practice.

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