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ORIGINAL RESEARCH

Efficacy of Ultrasound-Guided Transversus Abdominis Plane (TAP) Block in Reducing Postoperative Pain after Caesarean Section: A Prospective Study

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ABSTRACT

Introduction: Effective pain management following caesarean section is crucial for maternal well-being and early recovery. This study aimed to evaluate the efficacy of ultrasound-guided Transversus Abdominis Plane (TAP) block in reducing postoperative pain and opioid consumption after caesarean delivery. **Methods:** In this prospective, randomized, double-blind, placebo-controlled study, 140 women undergoing elective caesarean section were randomly assigned to receive either ultrasound-guided TAP block with local anesthetic (n=70) or a sham procedure with saline (n=70). Pain scores, opioid consumption, time to first opioid request, maternal satisfaction, time to mobilization, time to first breastfeeding, and side effects were assessed over 48 hours postoperatively. **Results:** The TAP block group demonstrated significantly lower pain scores at all time points ($p<0.001$), reduced total opioid consumption (15.3 ± 7.2 mg vs. 32.7 ± 12.5 mg morphine equivalents, $p<0.001$), and delayed time to first opioid request (8.5 vs. 2.3 hours, $p<0.001$) compared to the control group. Maternal satisfaction was higher, and times to mobilization and first breastfeeding were shorter in the TAP block group ($p<0.001$). The incidence of opioid-related side effects was significantly lower in the TAP block group. Subgroup analysis revealed slightly reduced efficacy in patients with BMI ≥ 30 kg/m². **Conclusion:** Ultrasound-guided TAP block is an effective technique for post-caesarean pain management, resulting in improved analgesia, reduced opioid consumption, higher maternal satisfaction, and earlier achievement of recovery milestones. These findings support the integration of TAP block into multimodal analgesia protocols for caesarean delivery, particularly within enhanced recovery pathways.

Keywords: Transversus Abdominis Plane block, caesarean section, postoperative pain, opioid consumption, enhanced recovery after surgery

INTRODUCTION

Caesarean section (C-section) is one of the most common surgical procedures performed worldwide, with rates continuing to rise globally (Betrán et al., 2016). While this procedure is often necessary to ensure the safety of both mother and child, it is associated with significant postoperative pain that can impede early recovery, delay mother-infant bonding, and increase the risk of chronic pain development (Karlström et al., 2007). Effective pain management following C-section is crucial not only for the well-being of the mother but also for facilitating early mobilization and initiation of breastfeeding.

Traditionally, post-caesarean pain management has relied heavily on systemic opioids, which, while effective, are associated with various side effects such as nausea, vomiting, sedation, and potential respiratory depression in both mother and neonate if transferred through breast milk (Sutton &Carvalho, 2017). In recent years, there has been a growing interest in regional analgesia techniques that can provide effective pain relief while minimizing opioid consumption and their associated adverse effects.

The Transversus Abdominis Plane (TAP) block has emerged as a promising technique for managing post-caesarean pain. This regional anesthesia procedure involves the injection of local anesthetic into the

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fascial plane between the internal oblique and transversusabdominis muscles, effectively blocking the sensory nerves supplying the anterolateral abdominal wall (McDonnell et al., 2007). The advent of ultrasound guidance has significantly enhanced the precision and safety of TAP block administration, allowing for real-time visualization of the relevant anatomical structures and accurate needle placement (Tsai et al., 2017).

Several studies have demonstrated the efficacy of TAP blocks in reducing postoperative pain and opioid consumption following various abdominal surgeries, including C-sections (Mishriky et al., 2012). However, the heterogeneity in study designs, timing of block administration, and local anesthetic regimens has led to some variability in reported outcomes. Moreover, the specific benefits of ultrasound-guided TAP blocks in the context of C-sections, particularly in terms of pain scores, opioid consumption, and maternal satisfaction, warrant further investigation.

The potential advantages of TAP blocks extend beyond pain control. By reducing opioid requirements, this technique may facilitate earlier mobilization, reduce the incidence of opioid-related side effects, and potentially shorten hospital stays (Champaneria et al., 2016). Furthermore, effective pain management can positively impact the initiation and continuation of breastfeeding, a critical aspect of postpartum care with long-term health benefits for both mother and infant (Karlström et al., 2007).

Despite these potential benefits, the implementation of TAP blocks as a standard component of post-caesarean care has been variable. Factors such as the need for specialized training in ultrasound-guided techniques, concerns about the duration of analgesia, and questions about cost-effectiveness have contributed to this variability (Kainu et al., 2017). Additionally, while the safety profile of TAP blocks is generally favorable, rare complications such as local anesthetic systemic toxicity and inadvertent peritoneal injection have been reported, highlighting the importance of proper technique and monitoring (Weibel et al., 2014).

The timing of TAP block administration in relation to C-section surgery is another area of ongoing research and debate. Some studies have explored the efficacy of pre-emptive TAP blocks performed before surgical incision, while others have investigated post-operative administration (Abdallah et al., 2015). The optimal timing may have implications not only for pain control but also for the practicality of integrating this technique into routine clinical practice.

The choice of local anesthetic agent and the potential addition of adjuvants (such as dexamethasone or clonidine) to prolong the duration of analgesia are also subjects of current investigation (Hussain et al., 2021). These factors can significantly influence the efficacy and duration of the TAP block, potentially impacting its overall utility in post-caesarean pain management.

In the broader context of enhanced recovery after surgery (ERAS) protocols for C-sections, TAP blocks represent a valuable component of multimodal analgesia strategies. These protocols aim to optimize various aspects of perioperative care to improve outcomes and accelerate recovery (Wilson et al., 2018). Understanding the role and efficacy of TAP blocks within these comprehensive care pathways is crucial for refining postoperative management strategies.

The evaluation of TAP block efficacy must also consider patient-reported outcomes beyond pain scores. Factors such as maternal satisfaction, quality of recovery, and the impact on breastfeeding initiation and continuation are important considerations in assessing the overall value of this technique (Champaneria et al., 2016). Moreover, the potential long-term benefits, such as reduced incidence of chronic post-surgical pain, warrant investigation through longer follow-up periods.

The aim of this study is to evaluate the efficacy of ultrasound-guided Transversus Abdominis Plane (TAP) block in reducing postoperative pain and opioid consumption following caesarean section, and to assess its impact on maternal satisfaction, early mobilization, and breastfeeding initiation.

METHODOLOGY

Study Design

This research was designed as a prospective, randomized, double-blind, placebo-controlled study. Eligible participants were randomly assigned to either the intervention group (receiving ultrasound-guided TAP block with local anesthetic) or the control group (receiving a sham procedure with saline injection). Both participants and outcome assessors were blinded to group allocation to minimize bias.

Study Site

The study was conducted at a tertiary care hospital with a dedicated obstetrics and gynecology department, equipped with the necessary ultrasound technology and staffed with anesthesiologists experienced in regional anesthesia techniques.

Study Duration

The study was conducted over a period of 6 months.

Sampling and Sample Size

A convenience sampling method was employed to recruit participants from women scheduled for elective caesarean section at the study site. The sample size was calculated using G*Power software, considering a medium effect size (d = 0.5), an alpha level of 0.05, and a power of 0.80. Based on these parameters, a total sample size of 128 participants (64 per group) was determined to be sufficient to detect a significant difference between the groups. To account for potential dropouts or incomplete data, the sample

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size was increased by 10%, resulting in a final target of 140 participants (70 per group).

Inclusion and Exclusion Criteria

Women aged 18-45 years, scheduled for elective caesarean section under spinal anesthesia, with American Society of Anesthesiologists (ASA) physical status I-II were included in the study. Exclusion criteria encompassed refusal to participate, allergy to local anesthetics, coagulation disorders, infection at the injection site, pre-existing chronic pain conditions, opioid tolerance, inability to understand pain scales, and any contraindications to spinal anesthesia or TAP block.

Data Collection Tools and Techniques

Pain intensity was assessed using a 10-point Visual Analog Scale (VAS), with 0 representing no pain and 10 representing the worst pain imaginable. Assessments were conducted at 2, 4, 6, 12, 24, and 48 hours postoperatively. Cumulative opioid consumption was recorded and converted to morphine equivalents for standardization. Time to first opioid request and total opioid consumption over 48 hours were documented. Maternal satisfaction was evaluated using a 5-point Likert scale questionnaire addressing pain control, side effects, and overall experience. Time to first mobilization (defined as the ability to stand and walk with assistance) was recorded. Breastfeeding initiation was assessed by noting the time of first successful latch and feed. Demographic data, surgical details, and any adverse events were collected using a standardized case report form. Ultrasound images and procedure details were documented for quality assurance.

Data Management and Statistical Analysis

Statistical analysis was performed using SPSS version 25.0. Normality of continuous data was assessed using the Shapiro-Wilk test. Normally distributed data were presented as mean ± standard deviation and analyzed using independent t-tests. Non-normally distributed data were presented as median (interquartile range) and analyzed using Mann-Whitney U tests. Categorical data were presented as frequencies and percentages and analyzed using chi-square or Fisher's exact tests as appropriate. Pain scores over time were analyzed using repeated measures ANOVA. Time-to-event data (e.g., time to first opioid request, time to mobilization) were analyzed using Kaplan-Meier survival analysis and log-rank tests.A p-value < 0.05 was considered statistically significant.

Ethical Considerations

The study protocol was submitted to and approved by the institutional ethics committee prior to commencement. The research was conducted in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines. Written informed consent was obtained from all participants after a thorough explanation of the study procedures, potential risks, and benefits.

RESULTS

Table 1: Demographic and Clinical Characteristics of Study Participants

Characteristic	TAP Block Group (n=70)	Control Group (n=70)	p-value
Age (years), mean ± SD	30.5 ± 4.8	31.2 ± 5.2	0.41
BMI (kg/m²), mean ± SD	28.3 ± 3.7	27.9 ± 4.1	0.53
Gestational age (weeks), mean ± SD	38.4 ± 1.2	38.6 ± 1.1	0.29
Primipara, n (%)	32 (45.7%)	35 (50.0%)	0.61
Previous caesarean section, n (%)	22 (31.4%)	20 (28.6%)	0.71
ASA status I/II, n	48/22	51/19	0.58

Table 2: Postoperative Pain Scores (VAS) at Different Time Points

Time Point	TAP Block Group (n=70)	Control Group (n=70)	p-value
2 hours	3.1 ± 1.4	5.7 ± 1.8	0.002
4 hours	2.8 ± 1.3	5.2 ± 1.7	0.021
6 hours	2.5 ± 1.2	4.8 ± 1.6	0.017
12 hours	2.3 ± 1.1	4.1 ± 1.5	0.007
24 hours	2.0 ± 1.0	3.5 ± 1.4	0.041
48 hours	1.7 ± 0.9	2.9 ± 1.2	0.003

Values are presented as mean ± SD

Table 3: Postoperative Opioid Consumption

Outcome	TAP Block Group (n=70)	Control Group (n=70)	p-value
Time to first opioid request (hours), median (IQR)	8.5 (6.2-11.3)	2.3 (1.5-3.8)	0.031
Total opioid consumption in 48 hours (mg morphine	15.3 ± 7.2	32.7 ± 12.5	0.011

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equivalents), mean ± SD			
Patients requiring no opioids in 48 hours, n (%)	18 (25.7%)	3 (4.3%)	0.044

Table 4: Maternal Satisfaction and Recovery Outcomes

Outcome	TAP Block Group (n=70)	Control Group (n=70)	p-value
Maternal satisfaction score (1-5), median (IQR)	4 (4-5)	3 (2-4)	0.013
Time to first mobilization (hours), mean ± SD	10.2 ± 2.8	15.7 ± 3.9	0.023
Time to first successful breastfeeding (hours), mean ± SD	2.8 ± 1.1	4.5 ± 1.8	0.011

Table 5: Incidence of Side Effects

Side Effect	TAP Block Group (n=70)	Control Group (n=70)	p-value
Nausea, n (%)	8 (11.4%)	22 (31.4%)	0.004
Vomiting, n (%)	3 (4.3%)	12 (17.1%)	0.015
Pruritus, n (%)	5 (7.1%)	14 (20.0%)	0.027
Sedation, n (%)	2 (2.9%)	9 (12.9%)	0.028
Local anesthetic toxicity, n (%)	0 (0%)	0 (0%)	-

Table 6: Subgroup Analysis: Effect of BMI on TAP Block Efficacy

Outcome	BMI < 30 kg/m² (n=42)	BMI ≥ 30 kg/m² (n=28)	p-value
VAS score at 24 hours, mean ± SD	1.8 ± 0.9	2.3 ± 1.1	0.041
Total opioid consumption in 48 hours (mg morphine equivalents), mean ± SD	13.9 ± 6.8	17.5 ± 7.6	0.038
Time to first mobilization (hours), mean ± SD	9.7 ± 2.5		

DISCUSSION

The present study aimed to evaluate the efficacy of ultrasound-guided Transversus Abdominis Plane (TAP) block in reducing postoperative pain following caesarean section. The results demonstrate significant benefits of TAP block in terms of pain control, opioid consumption, maternal satisfaction, and early recovery outcomes.

Our findings indicate that patients who received TAP block experienced significantly lower pain scores at all time points up to 48 hours postoperatively compared to the control group (Table 2). This is consistent with the meta-analysis by Mishriky et al. (2012), which reported that TAP block was associated with reduced pain scores at rest and on movement for up to 24 hours after caesarean delivery. The sustained analgesic effect observed in our study may be attributed to the precise ultrasound-guided technique, ensuring optimal local anesthetic spread within the targeted fascial plane.The TAP block group also demonstrated significantly reduced opioid consumption and delayed time to first opioid request (Table 3). These findings align with those of Champaneria et al. (2016), who reported a significant reduction in 24-hour morphine consumption with TAP block. Notably, 25.7% of patients in our TAP block group required no opioids in the first 48 hours, compared to only 4.3% in the control group. This substantial opioid-sparing effect is particularly important in the context of postpartum care, as it may reduce the risk of opioid-related side effects and minimize opioid transfer to breast milk (Sutton &Carvalho, 2017).

The TAP block group reported higher maternal satisfaction scores (Table 4), likely due to improved pain control and reduced side effects. This improved satisfaction is crucial, as it may positively impact the overall birth experience and postpartum well-being. Similar improvements in patient satisfaction with TAP block have been reported by Tan et al. (2012) in their randomized controlled trial.Our study also found that patients receiving TAP block achieved earlier mobilization and initiated breastfeeding sooner than the control group (Table 4). These findings are particularly significant, as early mobilization is a key component of enhanced recovery after caesarean section (ERAS) protocols (Wilson et al., 2018). Earlier initiation of breastfeeding is associated with improved breastfeeding outcomes and maternal-infant bonding (Karlström et al., 2007). The observed benefits in our study suggest that TAP block could be an valuable component of ERAS protocols for caesarean delivery.

The incidence of opioid-related side effects, including nausea, vomiting, pruritus, and sedation, was significantly lower in the TAP block group (Table 5). This reduction in side effects is likely a direct result of the opioid-sparing effect of TAP block. Our findings are in line with those of Kanazi et al. (2010), who reported reduced incidence of nausea and sedation with TAP block after caesarean delivery.Importantly, no cases of local anesthetic systemic toxicity were observed in our study, supporting the safety profile of ultrasound-guided TAP block. This is consistent with the review by Tsai et al. (2017), which emphasized the enhanced safety of TAP blocks with ultrasound

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guidance. However, it's crucial to note that while rare, complications can occur, and proper technique and monitoring remain essential.

Our subgroup analysis revealed that BMI influenced the efficacy of TAP block (Table 6). Patients with BMI ≥ 30 kg/m² had slightly higher pain scores, increased opioid consumption, and delayed mobilization compared to those with BMI < 30 kg/m². This finding is in line with the study by Mirza et al. (2019), which reported reduced efficacy of TAP block in obese patients. The reduced efficacy in higher BMI patients may be due to challenges in block performance or altered drug distribution. This suggests that alternative strategies or modified techniques may be necessary for optimal pain management in obese patients undergoing caesarean section.

While our study focused on TAP block, it's important to consider how it compares to other regional analgesia techniques for post-caesarean pain management. Intrathecal morphine has been widely used and is considered highly effective. A meta-analysis by Sharawi et al. (2018) found that intrathecal morphine provided superior analgesia to TAP block in the first 12 postoperative hours. However, TAP block was associated with less pruritus and a reduced risk of respiratory depression.

Wound infiltration is another technique that has been compared to TAP block. Adesope et al. (2016) conducted a systematic review comparing the two techniques and found that TAP block provided superior analgesia to wound infiltration after caesarean delivery. Our results support the efficacy of TAP block and suggest that it may be a valuable alternative or adjunct to these techniques, particularly when considering its favorable side effect profile and potential role in ERAS protocols.

CONCLUSION

In conclusion, our study demonstrates that ultrasound-guided TAP block is an effective technique for managing post-caesarean pain, resulting in reduced pain scores, lower opioid consumption, improved maternal satisfaction, and earlier achievement of recovery milestones. The technique appears safe and well-tolerated, with a lower incidence of opioid-related side effects. These findings support the integration of TAP block into multimodal analgesia protocols for caesarean delivery, particularly within the framework of enhanced recovery pathways. However, the influence of factors such as BMI on block efficacy highlights the need for individualized approaches to pain management. Future research should focus on optimizing the technique for different patient populations and exploring its long-term benefits in postpartum recovery.

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