

ARSI UNIVERSITY, COLLEGE OF HEALTH SCIENCE,
DEPARTMENT OF ANESTHESIA



EFFECTIVENESS OF ULTRASOUND-GUIDED TRANSVERSUS
ABDOMINIS PLANE BLOCK VS INTRATHECAL MORPHINE
COMBINED WITH BUPIVACAINE FOR POSTOPERATIVE PAIN
MANAGEMENT IN CESAREAN SECTION: A PROSPECTIVE
COHORT STUDY.

Investigator: Haile Demissie (BSc Anesthesia)

Principal advisor: Tahir Aman (Assistant Professor of Anesthesia)

Co-advisor: Ephrem Nigussie (MSc Anesthesia)

: Fate Aman (MSc Anesthesia)

A Thesis Submitted to Arsi University College of Health Sciences
Department of Anesthesia, in Partial Fulfillment of the requirements of the
Master of Science's Degree in Advanced Clinical Anesthesia.

November 2025

Asella, Oromia, Ethiopia

ARSI UNIVERSITY COLLEGE OF HEALTH SCIENCES

DEPARTMENT OF ANESTHESIA

Name of Investigator		Haile Demissie (BSc Anesthesia, Arsi University) Phone: +215 930 7596 27 E-mail: hai21dem@gmail.com
Advisors	Principal	Tahir Aman (Assistant Professor of Anesthesia, Arsi University) Phone: +251 910 0486 36 E-mail: tahirastu@gmail.com
	Co-advisor	1. Ephrem Nigussie (MSc Anesthesia, Arsi University) Phone: +251 940 8163 30 E-mail: ephremnigussie@gmail.com 2. Fate Aman (MSc Anesthesia, Arsi University) Phone: +251 995 0908 21 E-mail: fateaman15@gmail.com
Title of the Research		Effectiveness of ultrasound-guided transversus abdominis plane block vs. intrathecal morphine combined with bupivacaine for postoperative pain management in caesarean section: a prospective cohort study.
Duration		June to September 2025
Study Area		Asella Referral and Teaching Hospital
Total Cost		30,349.00 ETB

November 2025
Asella, Oromia, Ethiopia

ABSTRACT

Background: Postoperative pain following caesarean section is often severe, affecting up to 93% of parturients. It influences maternal outcomes which has an impact on clinical challenge. Ultrasound-guided transverse abdominis plane block and Intrathecal morphine are widely used. However, there is ongoing debate regarding their relative effectiveness, and limited comparative evidence exists in resource-limited setting. This study provides evidence to guide practice, policy, and improve maternal recovery in resource-limited settings.

Objective: To compare effectiveness of Ultrasound-guided transverse abdominis plane block and Intrathecal morphine for postoperative analgesia in parturients undergoing caesarean section.

Methods: A prospective cohort study was conducted at Asella Referral and Teaching Hospital from June 1 to September 30, 2025. Systematic random sampling was employed to select parturients undergoing cesarean section. Pain score using numerical rating score, time to first analgesia request, total analgesic consumption, and postoperative outcomes were assessed. Chi-squares, independent t-test, Mann-Whitney test, logistic regression, Linear mixed model, and survival analysis by SPSS v.25, with significance set at $p < 0.05$.

Results: 98 participants (49 per group) were included in the study. Both groups had comparable baseline characteristics ($p > 0.05$). Postoperative pain intensity was significantly lower in parturients who received intrathecal morphine (mean difference: 0.86, $p < 0.001$), peaked at 12 hours. It also provides superior analgesic adequacy during movement (OR: 3.65, 95% CI: 2.56-5.24, $p < 0.001$) and a longer time to first analgesia request (median: 7 vs. 5 hours, $p < 0.001$). Analgesic consumption and postoperative outcomes, including side effects and functional recovery, were comparable.

Conclusion: Intrathecal morphine provides a lower pain score and a prolonged first analgesia request than Ultrasound-guided transverse abdominis plane block. However, both of them had relatively comparable postoperative analgesia consumption, side effects

and safety profiles. Future multicenter randomized control studies are recommended to guide national practice.

Key words: Intrathecal morphine, transverse abdominis plane block, cesarean section, postoperative analgesia

ACKNOWLEDGEMENT

Deepest gratitude goes to Arsi University, Department of Anesthesia, postgraduate programs for the opportunity to engage in conducting and providing the resources and environment necessary for this research thesis. It's my pleasure to express my sincere gratitude to Mr Tahir Aman (my principal advisor), Mr Ephrem Nigussie (co-advisor), and Mrs Fate Aman (co-advisor) for their valuable guidance, support, and encouragement throughout the thesis. In addition, I would like to thank Mr Kabtamu Tolossie (Assistant Professor of Biostatistics, Arsi University) for his valuable comments during analysis.

Table of Contents

ABSTRACT.....	i
ACKNOWLEDGEMENT	iii
ABBREVIATIONS AND ACRONYMS	viii
1. INTRODUCTION.....	1
1.1. Background	1
1.2. Statement of the problem	4
1.3. Significance of the study	6
2. LITERATURE REVIEW	7
2.1. Mechanism and effect of ITM.....	7
2.2. TAPB and Ultrasound guidance for TAPB.....	9
2.3. Comparative studies of ITM and USG-TAPB for post CS pain.....	9
2.4. Hypothesis.....	13
2.5. Conceptual framework	14
3. OBJECTIVES.....	15
3.1. General objective.....	15
3.2. Specific objectives.....	15
4. METHODS AND MATERIALS	16
4.1. Study area.....	16
4.2. Study design and period	16
4.3. Source and study population	16
4.3.1. Source population.....	16
4.3.2. Study population.....	17
4.4. Inclusion and exclusion criteria.....	17
4.5. Sample size determination and Sampling technique.....	17
4.5.1. Sample size determination.....	17
4.5.2. Sampling procedures	18
4.6. Study variables	19
4.6.1. Dependent variables	19
4.6.2. Independent variables	19
4.7. Operational definition	19

4.8. Data collection procedures	21
4.9. Data analysis procedures	23
4.10. Data quality assurance.....	24
4.11. Ethical consideration	24
4.12. Dissemination plan.....	25
5. RESULT	26
5.1. Socio-demographic and baseline characteristics.....	26
5.2. Anesthesia and surgical-related factors.....	28
5.3. Postoperative pain scores (NRS).....	29
5.4. Time to First Analgesia Request	33
5.5. Analgesic adequacy between groups.....	34
5.6. Postoperative Analgesia Consumption.....	35
5.7. Postoperative Outcomes and Safety	36
6. DISCUSSION.....	39
7. STRENGTHS AND LIMITATIONS OF THE STUDY	43
8. CONCLUSION	44
9. RECOMMENDATIONS.....	44
10. REFERENCES	45
11. ANNEXES	51

List of Tables

Table 1: Socio-demographic and baseline characteristics of study participants.....	26
Table 2: Environmental factors.....	27
Table 3: Intraoperative anesthetic and surgical characteristics of study participants	28
Table 4: Pairwise differences of pain at rest and Movement Pain (USG-TAP vs. ITM) .	30
Table 5: Pairwise comparison of mean NRS scores between ITM and USG-TAPB	30
Table 6: Estimated marginal means of NRS scores by group across postoperative time points (Group x Time interaction).	31
Table 7: Fixed effects for NRS scores across group, time, and condition.....	32
Table 8: Association Between Analgesic Technique and Adequate Pain Control (Pain Score ≤ 3).....	35
Table 9: Comparison of discharge and ambulation times between ITM and TAPB	37

List of Figures

Figure 1: Conceptual frame work	14
Figure 2: Type of surgical incision by group.....	Error! Bookmark not defined.
Figure 3: Mean NRS scores over 48 h postoperative period by group (ITM vs TAP) and condition (rest vs. movement).....	32
Figure 4: Kaplan–Meier Curves for Time to First Analgesia Request in ITM vs. USG-TAPB.	34
Figure 5: Overall postoperative pain severity.....	35
Figure 6: Total analgesia doses (Diclofenac equivalent) between ITM and USG-TAPB	36
Figure 7: Distribution of patient satisfaction ratings by treatment group.	38

ABBREVIATIONS AND ACRONYMS

ARTH	Asella Referral and Teaching Hospital
CS	Caesarean section
DVT	Deep vein thrombosis
ITM	Intrathecal morphine
LA	Local analgesia
NRS	Numerical rating score
PONV	Post-operative nausea and vomiting
RCT	Randomized controlled trial
SA	: Spinal anesthesia
SPSS	Statistical product and service solution
TAP	Transverse abdominis plane
TAPB	Transverse abdominis plane block
USG	Ultrasound guided

1. INTRODUCTION

1.1. Background

Caesarean section (CS) is a common surgical procedure performed, and its prevalence is increasing worldwide. It is mainly performed to save the fetus and the life of the mother in a complicated pregnancy (1,2). The global rate has been increasing and has reached 29.5% in some African countries, including Ethiopia (1,3–5).

Postoperative pain affects over 85% of women undergoing CS (6). When inadequately managed, this pain can hinder early rehabilitation and recovery, leading to increased patient morbidity, dissatisfaction, more extended hospital stays, and a higher risk of developing chronic pain(7–9). In addition, it may minimize the early interaction of the mother with the child. Therefore, effective post-CS pain management can improve the health outcomes of the mother, breastfeeding, and infant weight gain (10).

Multimodal analgesia is implemented during surgery and the postoperative period to provide adequate pain management. Opioids, regional analgesic techniques, and other systemic medications were used to relieve this pain. Systemic opioids are mainly used to achieve multimodal analgesia (11). Despite multimodal analgesia being standard, its effectiveness in parturient mothers is limited. This is due to its potential for placental transfer and later excretion into breast milk (12–14).

Effective postoperative analgesia can decreases the total and variety of analgesic drugs used to control pain. This is by increasing the duration of analgesia and prolongs the time to analgesia request (11). In addition it enhances maternal satisfaction through improving postoperative safety profiles such as early mobilization; resume oral intake, and reducing overall postoperative complications associated with inadequate pain management (15,16).

Different adjuvants are used to augment the effects of spinal anesthesia (SA) and to enhance postoperative analgesia. Neuraxial opioids is one of the adjuvants used with SA to provide adequate analgesia after surgery for many hours after CS. Different opioids like fentanyl, pethidine, morphine, and tramadol can be used to enhance postoperative

analgesia. Neuraxial opioids provide an extended analgesic effect and significantly reduce systemic opioid requirements for up to 48 hours postoperatively (2,17,18).

Intrathecal morphine (ITM) can be used as an adjunct to local anesthesia or as a sole analgesia for postoperative pain management (14,19). It's hydrophilic nature delays the rate of decline in cerebrospinal fluid concentration (20,21). It acts on μ -receptors in the spinal cord to provide analgesia. It doesn't affect motor or sympathetic functions (9,22). Previously, it is considered the gold standard in post-CS pain management due to its potency and prolonged duration of action. However a recent study suggested that it shouldn't be standardized for every parturient and needs to be individualized (16). Other techniques that limit the negative effects of ITM have become a popular in recent years (5,23,24).

Regional anesthesia is the commonly used technique for CS, which has the advantage of its good quality and longer duration of analgesia. Peripheral nerve blockade at terminal nerve branches requires careful attention to ensure analgesia during the perioperative period. Recent advances in the utilization of ultrasound for regional nerve block have led to significant improvements in achieving successful pain control (24).

To address postoperative surgical-related pain of the lower abdomen, from regional analgesia, Ultrasound-guided transversus abdominis plane block (USG-TAPB) is utilized nowadays (5,25). It provides somatic analgesia for lower abdominal incision (25,26). These targets aim to block the nerves, mainly the lower thoracic and upper lumbar branches that run between these two muscles. Sometimes, it flows back toward the paravertebral space and covers the visceral pain when the volume of local anesthetics used is high (10,27). These had its own effects on the rate of absorption and increase the likelihood of systemic toxicity. Local anesthetic toxicity has an estimate of 0.03% following peripheral nerve blocks (28). The reduced concentration of plasma α_1 -acid glycoprotein increases the risk in parturients (29).

The USG-TAP block is a feasible post CS analgesia technique, mainly in patients contraindicated for Intrathecal opioids. It has an additional benefit of reducing postoperative opioid consumption and related side effects (30). Numerous studies have

examined the effectiveness of USG-TAPB and ITM. Their comparison across studies show inconsistencies and leaves open the question of better analgesic techniques after CS.

Previously, ITM was taken as a standard analgesic technique, but recent studies have traced out the beneficial effect of USG-TAPB. To our knowledge, there is one that has been conducted to compare ITM and TAPB for postoperative pain management in Ethiopia without incorporating ultrasound to conduct TAPB. So, our study intends to examine the effects ITM and USG-TAPB on postoperative pain management after CS and providing additional evidence that strengthens the existing knowledge or provides a new insight.

1.2. Statement of the problem

Pain is one of the most undesirable outcomes of CS. Moderate to severe acute pain after CS affects approximately 93% of parturients (9). In most cases, it persists beyond 24 hours, sometimes for up to 2 months (9,25,31). The chance of progression to chronic pain is increased by 2.5 (32). This evidence underscores the urgent need for more effective, locally validated analgesic strategies. Despite guidelines, studies from developing countries, including those conducted in Ethiopia, highlight a critical problem (6,9,33).

Inadequate pain management after CS had different impacts on the mother and the newborn baby, by reducing early interaction. It increases the risk of postpartum depression, thromboembolism and delays functional recovery in parturients. The effects of outcomes and increases in resource utilization are significant for healthcare systems (18,27,31).

Ideal analgesia for CS is efficacious without compromising child care, as well as reducing the risk of breast milk transfer of the drugs. Systemic analgesic techniques are less likely to be recommended nowadays due to their limited adequacy in pain control and increased side effects, especially in CS (8,9,12). Irrespective of the route, opioids can mostly have adverse effects like nausea, vomiting, pruritus, sedation, respiratory depression, and hyperalgesia. ITM can produce extensive post-CS analgesia for several hours (5,14). This necessitates strict close follow-up to identify and manage complications early. Consequently, other alternative analgesia techniques are essential to reduce or replace opioid consumption (19,26,34)

USG-TAPB has demonstrated prolonged analgesic effects and minimal side effects. Existing evidence on its benefit after CS is inconsistent with that for ITM. While some studies report it enhances postoperative pain control after CS, others show no significant additional analgesic effect (12,22,34). This controversy presents a critical knowledge gap, warranting further investigation to determine the effectiveness of USG-TAPB for postoperative analgesia after CS.

Moreover, majority of these studies have been conducted in developed countries (21,25,26), resulting in scarce evidence from developing countries, including sub-Saharan Africa. This geographic and contextual gap underscores the need for further studies to assess the effectiveness of USG-TAPB compared with ITM in resource-limited settings. Despite global guidelines, studies in Ethiopia consistently report a high prevalence of untreated or poorly managed postoperative pain following CS, with some women experiencing persistent or chronic pain in the postpartum period. So, this study could address a critical gap in evidence and practice by evaluating context-specific, effective analgesic strategies for post-cesarean pain in Ethiopian women undergoing CS.

By incorporating USG, the study seeks to improve block precision and consistency, contributing to the growing body of evidence, and inform local clinical practice. It aims to compare the effectiveness and safety of both techniques in parturients undergoing CS at ARTH.

1.3. Significance of the study

Effective pain management is a rudimentary human right and a cornerstone of quality surgical care. The study is important to provide locally relevant evidence on the comparative effectiveness of USG-TAPB and ITM which can inform clinical practice, policy and hospital protocols in resource limited setting. The findings of this study are essential to multiple stakeholders to address postoperative pain after CS.

For policymakers, it helps in developing evidence-based guidelines and locally relevant protocols to optimize postoperative pain management after CS. It has the potential to influence institutional protocols and health strategies in improving outcomes for mothers across similar resource limited settings. Hospitals may benefit through reduced complications, shorter length of stays, and more efficient care delivery that promote effective resource utilization.

For parturients undergoing CS, the study aims to improve pain relief with fewer side effects, facilitate early mobilization, enhancing recovery, and support mother-to-infant bonding and increasing maternal satisfaction. For anesthetists, it offers comparative evidence on the effectiveness of USG-TAPB versus ITM and support in making informed decisions especially in resource-limited settings. Additionally, the study contributes to the limited research on postoperative pain management after CS in developing countries and acts as evidence for further studies. It contributes to the growing body of evidence, and informs local clinical practice.

2. LITERATURE REVIEW

Effective pain management following CS is essential for improving maternal outcomes, facilitating early mobility, and enhancing overall recovery. One of the key strategies to address postoperative pain is the provision of regional anesthesia and analgesia. This involves adding an adjuvant to local analgesia during SA and performing peripheral nerve blocks. ITM and USG-TAPB are commonly used to provide analgesia for lower abdominal surgeries such as CS. This literature review aims to compare the effectiveness of USG-TAPB and ITM to manage postoperative pain after CS, considering their mechanisms, benefits, and clinical outcomes.

2.1. Mechanism and effect of ITM

Intrathecal morphine may be administered as a standalone analgesic or as an adjuvant to local anesthetics. In CS procedures, it is often combined with local anesthesia to enhance intraoperative analgesia and extend pain relief into the postoperative period. ITM provides analgesia for up to 24 hours postoperatively and is a cost-efficient method for managing postoperative pain (22,35,36).

Its efficacy and duration of action are associated with the amount of drug given. A variety of doses can be utilized with a range of 75mcg to 500mcg. But it may be used as low as 25mcg in conjunction with local anesthetics (5,11,14,25). This can have a significant impact in mitigating postoperative pain after CS for prolonged hours. High-dose ITM increases the time to first analgesia request. A recent meta-analysis that compares different doses of ITM shows that the average time to first analgesia request was extended (MD, 4.49 hours [95% CI, 1.85-7.13]; $p < 0.001$) in the high dose group when compared with the low dose (37). The pain score was significantly low at 12 hours and moderate at 24 hours after the procedure(18,37,38).

ITM significantly reduces the total dose and variety of systemic medications required for postoperative pain management, including intravenous opioids. Meta-analysis of RCT shows that, patients receiving ITM required 45% less systemic opioid analgesia when compared to placebos (OR: 0.55, 95% CI: 0.40–0.76, $p < 0.001$) (39). Additionally, the

use of ITM decreases the risk of postoperative deep vein thrombosis (DVT) and coagulation abnormalities, possibly due to improved early mobility. This analgesic approach also reduces the risk of lower limb weakness and numbness, facilitating earlier ambulation (11,37).

Maternal satisfaction among parturients undergoing CS with adjuvant ITM remains high (27). A narrative review by Kaye et al. shows that the satisfaction score averages 8.9 ± 1.1 on a 10-point scale with $p < 0.001$ when compared to conventional opioid regimens (36).

Although it looks like the most significant technique for postoperative pain management in CS, it is not without adverse effects. Systemic absorption of morphine can lead to nausea, vomiting, pruritus, and itching. It may also be associated with respiratory depression, which requires close follow-up until 24 hours postoperatively. Mostly, it can happen between 2 and 24 hours after administration of the drug (40,41).

Serious respiratory depression with or without somnolence can occur with significantly high doses of 900mcg. A meta-analysis conducted on 4400 mothers undergoing CS shows that adjuvant ITM to local anesthetics was associated with an increased respiratory depression incidence (p-value <0.05) (40). A case series and systematic review by Koning et al. on adverse effects recommends 50-100mcg of ITM as an optimal dose (41). In addition, other studies revealed that beyond 100-200 mcg, the quality of analgesia is not changed, but it increases the risk of adverse effects (12,42). However, previous meta-analyses of randomized controlled trials show that the risk of systemic side effects was not linear with the dose of ITM (39).

Despite side effects associated with ITM, a recent review shows the complications were short-lived and manageable [OR 3.85 (95% CI 2.40 – 6.15)] (36). These controversies contributed to the decline in the use of perioperative opioids for pain management and an increase in the use of regional nerve blocks.

2.2. TAPB and Ultrasound guidance for TAPB

USG-TAP block after CS is increasingly utilized for postoperative pain management. This is usually administered as a multimodal analgesia in conjunction with other systemic analgesics. Its practice is widely used when opioids are contraindicated or intrathecal adjuvants like morphine cannot be given to the patient. Majorly, it is used to decrease the opioid requirements and increase post CS pain management (12,23,42,43).

The effectiveness of TAPB is improved as a result of advanced techniques of using USG. Previously, landmark techniques were used to provide a prolonged duration of analgesia. But, it is associated with inadvertent penetration of the peritoneum and incorrect needle position in 24% and 18% respectively (44). Using a USG block can reduce these side effects and doses used for block (25,45–47). In addition, it prolongs the duration of analgesia (48).

The optimal drugs used for TAP block are 0.25% bupivacaine and 0.375% ropivacaine (44). They have a comparable analgesic efficacy with reduced pain score during 24 hours in ropivacaine. 0.5% of bupivacaine provides the desired quality of block under USG. Since this needs a high volume of local anesthetics, it reaches the toxic level. To reduce the effects associated with this, 0.2-0.25% can be utilized.

Total volume of the drug used varies from 15ml to 30ml of 0.25% bupivacaine on either side of the abdomen (27,45,49,50). It has a favorable onset of action and reaches peak effect within 10 minutes (mean, SD of 22.5 ± 12.5 minutes)(45). The maximum serum concentration persists longer, in the range of 240-555 minutes (43). The duration is extended as the dose of local anesthetics is increased, which is further prolonged with the use of adjuvants like dexamethasone (5,19).

2.3. Comparative studies of ITM and USG-TAPB for post CS pain

Comparison of the analgesic efficacy of USG-TAPB and ITM shows that they are inconsistent with each other. Both ITM and USG-TAPB have a comparable analgesic efficacy in the early postoperative time until 6 hours at rest, during cough, and on movement and within the first 24 hours during postoperative time (34,50). The intensity

of pain on VAS and NRS is significantly reduced in parturients managed with ITM, even after the addition of adjuvant TAP (10,21,27,51). But an RCT conducted by Kwikiriza et al. shows USG-TAPB has a superior analgesic efficacy over ITM with reduced pain intensity within 24 hours (5) as supported by a meta-analysis conducted by Yang et al (21).

An RCT conducted in Uganda to compare NRS for ITM and USG-TAPB among women undergoing CS shows only a significant difference at 24 hours at rest (2.9 vs. 2.3, $p = 0.01$) and coughing (3.9 vs. 3.4, $p = 0.02$). But, a locally conducted study shows a significant difference with a superiority of ITM at multiple time points in both at rest and on movement (27). Despite this, a study conducted in Tunisia revealed an insignificant difference between the two groups (50).

An observational study conducted in Indonesia shows the mean duration of time before analgesia request is 600.45 ± 68.901 minutes in ITM and 438.18 ± 46.867 minutes in TAP block ($p < 0.05$) (25). In addition, a local study conducted by Jemal et al. shows that the time to first analgesia request in patients with ITM is prolonged (360 minutes vs. 240 minutes, $p\text{-value}=0.004$) when compared with the TAP block (27). However, study conducted in Tunisia by Ben Marzouk and his colleagues reported that there is a no significant difference between groups (9 hours in ITM vs. 7 hours in TAP $P=0.12$) (50).

Some studies compared postoperative analgesia consumption between ITM and TAPB. A recent RCT conducted in Indonesia on postoperative opioid consumption shows a significant difference with superiority of ITM ($38.64 \pm 16.775 \mu\text{g}$) while USG-TAP block ($50.00 \pm 18.898 \mu\text{g}$) with a p value of 0.043 (25), which is supported by a local study (median morphine consumption 5 mg in ITM and 10 mg in TAPB, $p < 0.001$) (27).

A locally conducted RCT on a single center shows a significantly different result in their analgesic adequacy, in which 62.6% and 37.4% reported pain score ≤ 3 in ITM and TAP group, respectively (OR: 1.96, 95% CI: 1.34-2.57, $p = 0.001$) (27). But, a meta-analysis from others reveals that there is no significant difference between the ITM and TAP at rest and on movement (5,21,50).

Postoperative need for rescue medication for pain management was different among studies. Many studies reported that both groups demonstrate a relatively similar need for postoperative rescue medication. A study conducted in Tunisia shows breakthrough pain was occurred in 36% of mothers who received USG-TAP versus 32% in the ITM group ($p=0.19$) (50). But other studies reported that breakthrough pain was significantly different (5,7). Despite this, numerous results show that ITM has an advantage over USG-TAPB in reducing total rescue medications after CS (21,25,30,43). Addition of ITM to local analgesia during SA is superior to USG-TAPB in reducing postoperative pain. It helps to minimize the cost utilized to buying rescue medications and has a significant role in patient satisfaction (26,27,34).

An increasing rate of complications is associated with ITM. Decreased tone of the lower extremity and urinary retention are increased in comparison with USG-TAPB. It is due to the neuraxial blockade associated with the ITM. The majority of parturients develop pruritus, PONV, and respiratory depression (21,41,49). But some studies reported that the adverse effects were insignificant in both groups (5,22,26,50). Administration of adjuvant ITM to bupivacaine is also associated with a higher rate of motor block than TAPB (12).

Patient received USG-TAPB for their postoperative analgesia, which reduces the risk of side effects related to opioids. A meta-analysis conducted in 2021 shows pruritus (95% CI: 1.17-8.26; $p = 0.02$) and PONV (95% CI: 1.92-4.87, $p < 0.001$) were higher in the ITM group (21). Even if the potential side effects of USG-TAPB are subtle when compared with ITM, the major adverse effect is seizure after its administration. However, the incidence rate is as low as 2.7% with TAP conducted by using USG (7,10,42).

Patient satisfaction with postop pain management is high and comparable effects of both techniques (23,45). Overall maternal satisfaction was relatively similar in both groups ($p=0.94$), although it was 58% in the USG-TAP group vs. 60% in the ITM group (50). A meta-analysis conducted in 2017 shows USG-TAP has a higher patient satisfaction score in more than 60% of patients by reducing adverse effects when compared with ITM (12). However, a locally conducted study at Dilla University shows the superiority of ITM over TAP in satisfying the mothers with their post CS analgesia (27).

In summary, the reviewed literature compares the effectiveness of the ITM and USG-TAPB block with variable outcomes. Most studies favor the superiority of ITM for postoperative pain management following CS. However, the USG-TAP block also offers comparable pain control with limited side effects, which is particularly useful when ITM is contraindicated. Despite mixed results regarding superiority, both techniques are effective and used widely.

2.4. Hypothesis

Null Hypothesis (H_0)

- Ultrasound-guided TAP block provides postoperative pain relief equivalent to adjuvant ITM with bupivacaine in patients undergoing caesarean section.

Alternative hypothesis (H_A)

- Ultrasound-guided TAP block provides significantly different postoperative pain relief compared to adjuvant ITM with bupivacaine in patients undergoing CS.

2.5. Conceptual framework

Multiple factors can influence the severity and presence of postoperative pain. The conceptual framework was adapted from a study conducted by Sisay Ebistu (AAU repository), and other contributing factors were derived from literature and depicted in the Figure 1 below (4,21,25,27).

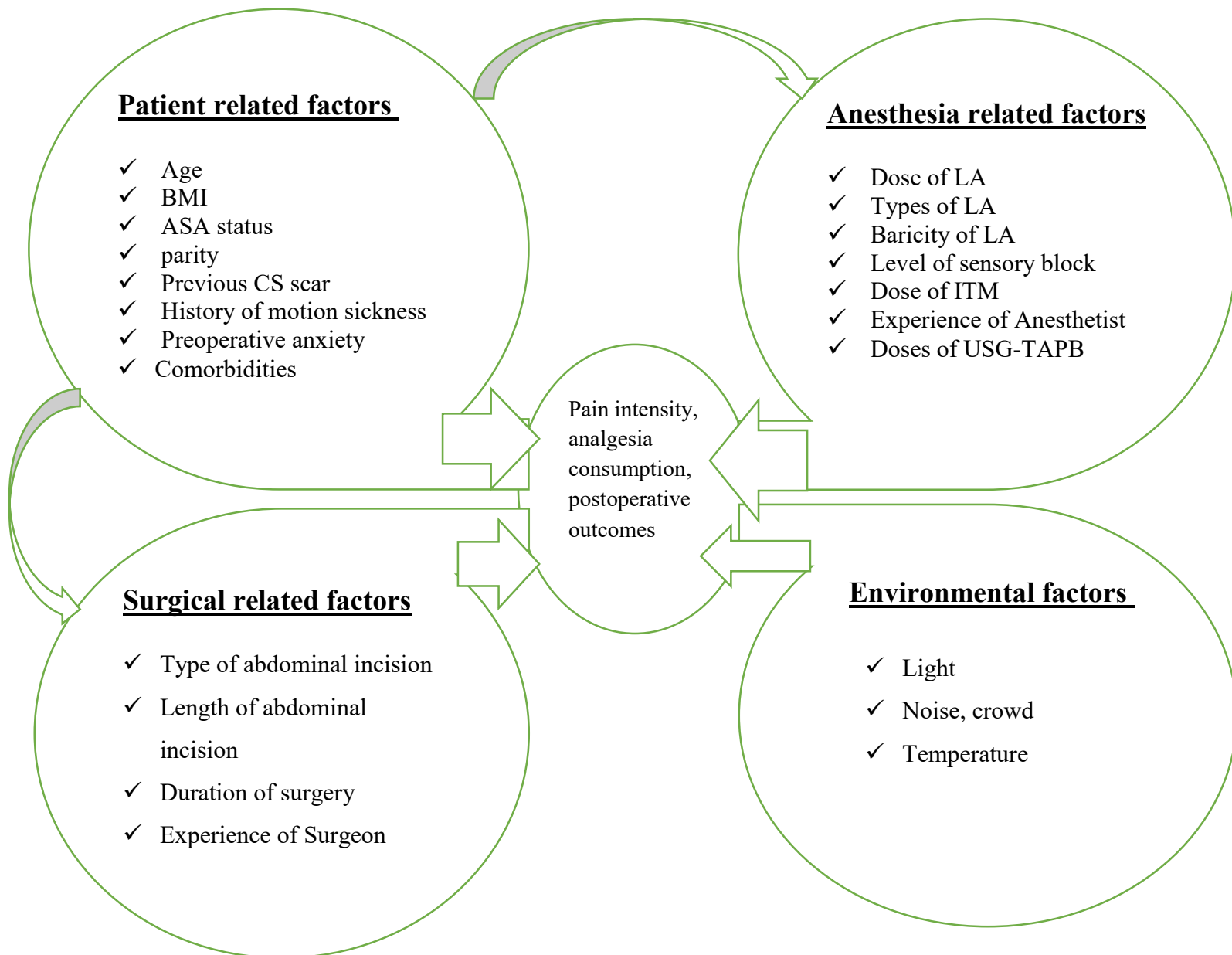


Figure 1: Conceptual frame work

3. OBJECTIVES

3.1. General objective

- To compare the effectiveness of Ultrasound-guided transversus abdominis plane block and intrathecal morphine with bupivacaine in managing postoperative pain among parturients undergoing cesarean section at ARTH between June and September 2025.

3.2. Specific objectives

- To compare the time to first analgesia request within 72 hours postoperatively between the two groups.
- To assess postoperative pain intensity using the NRS within 72 hours.
- To determine total postoperative analgesic consumption within 72 hours in both groups.
- To compare postoperative outcomes after CS between USG-TAP block and adjuvant ITM to bupivacaine within 72 hours.

4. METHODS AND MATERIALS

4.1. Study area

The study was conducted at Asella Referral and Teaching Hospital (ARTH), which is located in the Arsi zone, Asella town. ARTH serves 3.89 million people in the Arsi zone and receives referrals from neighboring zones. It was found in the Southeast of Addis Ababa, the capital of Ethiopia. ARTH provides a wide variety of services, including specialized care in Surgery, Obstetrics and Gynecology, Pediatrics, Anesthesia, Internal Medicine, Radiology, Oncology, Urology, Orthopedics, Emergency and critical care, and others. They have 5 functional operating rooms, which serve 75 patients per week, including elective and emergency obstetric surgical procedures.

One of the primary focuses of ARTH is zero tolerance for pain. They have a strong emphasis on addressing perioperative pain by incorporating USG to perform regional nerve blocks. These commitments to advanced pain management techniques make ARTH a suitable and relevant setting for this study. Their experience and infrastructure support the reliable implementation and evaluation of both USG-TAPB and ITM for postoperative pain management.

4.2. Study design and period

A prospective cohort study was conducted on parturient mothers who gave birth via caesarean section from June 1 to September 30, 2025. Due to the lack of institutional authorization from the national ethical review committee to conduct a randomized controlled trial, the study was adapted to a prospective cohort study design. So, the use of a cohort is methodologically appropriate for addressing research objectives.

4.3. Source and study population

4.3.1. Source population

All parturients underwent CS with spinal anesthesia at ARTH from June 1 to September 30, 2025.

4.3.2. Study population

All parturients who had a CS with SA, met the inclusion criteria, and receiving either ITM or USG-TAPB during the study period at ARTH.

4.3.3. Study Unit

Parturients who underwent CS during the study period, and data were actively collected from them.

4.4. Inclusion and exclusion criteria

Inclusion criteria

- All parturients undergoing CS under SA
- ASA II and III
- Parturient who received ITM or USG-TAPB

Exclusion criteria

- Parturient with a history of chronic pain.
- Parturient with cognitive impairment.
- Parturient who receive sedative medications.
- Parturient who refused to participate.
- Parturient who had a known respiratory problem.
- Parturient who received other adjuvants with ITM or USG-TAPB.
- Parturient who received both ITM and USG-TAPB.
- Parturient undergoing CS after labor analgesia.

4.5. Sample size determination and Sampling technique

4.5.1. Sample size determination

Our sample size was determined by using Epi Info 7.2.5.0 version. We took a 2-sided confidence interval of 95%, power 80% and a ratio of unexposed to exposed 1:1. Percent of outcome (34.2% in TAP block and 62.6% in ITM) and odds ratio (3.22) were taken from previous similar studies conducted by Jemal et al (27). The output of Fleiss with continuity correction, which gave us the largest sample size of 110, was taken.

Since the population size was 408 during our study period from situational analysis of last year of the same time, which is below 10,000, the correction formula was used.

$$Nf = n / (1 + n/N) = 110 / (1 + 110/408) = 86.6 \approx 87.$$

Where:

N = the number of total CS in the study area during study period

nf = final sampling size

To ensure the final sample sizes include enough participants, we accounted for a 10% non-response rate.

$$\text{Adjusted sample size} = n / 1 - 0.1 = 87 / 0.9 = 96.7 \approx 97.$$

To enhance statistical power and analytical balance, we take the round-up technique and add one more sample. This made an equal 49 samples in both groups, and leads our final sample size to 98.

4.5.2. Sampling procedures

The average number of CS surgeries performed at ARTH is 135 per month, with 102 parturients receiving either ITM or USG-TAPB, based on data from the same period last year. Since the data collection spanned four months, the total sample frame consists of 408 cases. A systematic random sampling technique was employed for the study. The interval for sampling (k) was calculated accordingly, and the first sample was selected using the lottery method.

$$k = \frac{N}{n} \text{ where, } N = \text{Total CS conducted and takes ITM or USG-TAP block during 4 months}$$

n = Sample size

$k = 408 / 98 = 4.1 \approx 4$ interval. Every fourth woman undergoing a cesarean section was included in the data collection. At the end of the analyses, the adequacy of the sample size was checked by G-Power, and it became 78.6% which is reasonable.

The initial participant was chosen through a lottery method from those who met the inclusion criteria. This helps us to make an unbiased selection of participants and ensure representativeness. If a selected participant is excluded due to unforeseen reasons, the next eligible case was enrolled. Data collection was extended until an adequate sample size is reached, if the case flow is below the same time as last year. If one group reached the required number, the remaining group was collected until it reached the required number by skipping to the next if it was not the needed case.

4.6. Study variables

4.6.1. Dependent variables

- NRS within 72 hours after a Caesarean section
- Time to first analgesia request within 72 hours
- Total postoperative analgesic consumption.
- Postoperative outcomes (side effects, recovery profiles and maternal satisfaction)

4.6.2. Independent variables

- Socio-demographic characteristics: Age, ASA status, BMI.
- Patient-related factors: Parity, previous cesarean delivery, preoperative anxiety, Co-morbidity, history of motion sickness
- Surgery-related factors: type of incision, size of incision, surgery duration, and experience of the surgeon.
- Anesthesia-related factors: Dose of local anesthetic, types of local anesthesia, baricity of local anesthetic, level of sensory block, dose of ITM, and experience of anesthetist.
- Environmental factors: light, noise, temperature, crowd.

4.7. Operational definition

- Intrathecal morphine: ITM is the administration of morphine into the subarachnoid space with local analgesia.

- Transverse abdominis plane block: administration of LA between the internal oblique and transverse abdominis muscles bilaterally.
- Postoperative analgesia: is the management of postoperative pain by using different approaches.
- Cesarean section: the type of surgical procedure used to give birth through incision of mothers abdomen.
- Rescue analgesia: the administration of pain medication to relieve severe pain when initial pain management is insufficient.
- Numerical pain rating scale: is a valid tool for assessing pain severity using attributable number labels that range from 0 to 10, in which “0” is no pain and “10” is the worst pain.
- Effectiveness of post CS pain management: it refers to the success in controlling postoperative pain ($\text{NRS} \leq 3$), facilitating early functional recovery, minimizing opioid use and side effects, and enhancing patient satisfaction.
- Analgesia consumption: overall dose and type of medication given to alleviate pain starting from the recovery room up to 72 hours.
- Post-operative outcomes: a composite of clinical and patient centered outcomes, including adverse effects (including PONV, respiratory depression, pruritus, urinary retention), functional recovery (time to oral intake, time to ambulate, duration of hospital stay), and patient satisfaction to evaluate overall safety until discharge.
- Respiratory depression: respiratory rate less than 10 breaths per minute or oxygen saturation less than 90% (27).
- Pain at rest: pain assessed while the parturient is rest on bed without movement or cough
- Pain on movement: the pain was assessed when the mother elevated from their pillow by their head and shoulder and/or asked to flex their hip and knee in the supine position (26,47).

4.8. Data collection procedures

Informed consent was obtained at the end of the procedure after being transferred from the operation suite and before being transferred to the ward. Every participant was informed of their right to decline participation at any time, and confidentiality was assured. The data collection process was conducted by three MSc students and three nurses. Supervision was done by one MSc anesthesia student and took place from June 1 to September 30, 2025. Before the commencement of data collection, all data collectors received a two-hour training session on the purpose of the study and detailed guidance on the data collection tool.

A structured questionnaire developed from different literatures and validated was used to collect data. Trained anesthetists, assigned specifically for data collection, gathered information through patient interviews and chart reviews. Study participants were started on follow-up at the end of surgery after the parturient was discharged and ensured that they received either USG-TAPB or ITM. They were blinded to which analgesic techniques were given to the study participants, and nurses are the main data collectors at the ward. Participants in each group were based on clinical practice rather than random allocation.

Data was collected by using software called the Kobo tool. Kobo Toolbox is well-suited for clinical data collection, offering a free and secure platform with customizable digital forms. It supports offline data entry and allows complex logic for clinical assessments, follow-ups, and patient records. The tool ensures data security through encryption and controlled access.

Study participants were followed and assessed immediately after surgery (0 hours) before being taken to the ward, at 2, 6, 12, 24, 36, 48, and 72 hours (adapted from Macias et al, 2022 (32)). The parturient was followed until the immediate follow-up time before discharge, and then the registration book and patient chart were reviewed after discharge. During each follow-up, the severity of pain using NRS both at rest and during movement, vital signs, and potential adverse effects were evaluated. Patient satisfaction was assessed immediately before discharge home.

A standardized perioperative management protocol was implemented at ARTH to ensure uniform anesthesia and perioperative care. During the preoperative phase, each parturient was evaluated to confirm the indication for CS and to review her medical, obstetric, allergic, and anesthesia history with a thorough physical examination and baseline investigations. After adequate explanation about the procedure, benefits, and possible risks of anesthesia, informed written consent for surgery and anesthesia was obtained.

Bilateral intravenous access was secured, and parturients were preloaded or co-loaded (in urgent cases) with 0.5–1 liter of normal saline or Ringer's lactate, unless contraindicated. Preoperative medications included ampicillin 2 g intravenously 30 minutes before skin incision and metoclopramide 10 mg intravenously. Standard ASA monitoring was attached upon transfer to the operating theatre table, and baseline vital signs were taken.

Spinal anesthesia was given under aseptic conditions with 0.5% hyperbaric bupivacaine 2–2.5 mL in between L3–L4 or L2–L3 interspace in the sitting position by using a 22–25G spinal needle. Small doses of morphine (75–100 µg), fentanyl (15–25 µg), Pethidine (15–25 mg), tramadol (15–25mg), or dexamethasone (2 mg) were added as an adjuvant. Intraoperative vital signs were recorded every 10 minutes. Following fetal delivery, oxytocin 10 IU IM and 30 IU in infusion or 400 µg misoprostol sublingually were given as needed to promote uterine contraction. Pethidine (25–50 mg) or tramadol (25–50 mg) was administered in cases of shivering. We took those who received morphine 100mcg.

Upon completion of the procedure, depending on the parturient's preference and affordability, bilateral USG-TAPB was given with 15–20 mL of 0.25% bupivacaine with or without adjuvant. We collected data from those who received 15ml of 0.25% bilaterally. Stable patients were directly transferred to the ward and monitored there. Pain intensity (NRS) was assessed postoperatively and followed for any complications.

Postoperative analgesia included 100 mg diclofenac suppository as standing medication, with 75 mg IM reserved for rescue analgesia. If pain persisted, ibuprofen 400 mg or paracetamol 1 g orally was administered as available, followed by tramadol 50 mg IV for uncontrolled pain. These medications were given up on request. Discharge was planned when the patient was hemodynamically stable, had adequate pain control ($\text{NRS} \leq 3$),

could ambulate, and tolerated oral intake. Before discharge, each mother received counseling and was scheduled for follow-up within 7–10 days. All perioperative and postoperative events were documented.

Postoperative analgesia consumption was collected with the actual drug given with specific routes and doses. As the institutional protocol puts diclofenac for postoperative pain management, to allow comparison, conversion was made to diclofenac 75mg IM. Paracetamol 1000mg PO converted to approximately equivalent to diclofenac 75mg IM, Ibuprofen 400mg to diclofenac 50mg IM and diclofenac 100mg suppository to 75mg IM (52,53). This conversion was based on the approximate analgesic efficacy in mild-to-moderate pain in acute settings, not identical pharmacologic potency or duration. Total analgesic consumption was calculated from the chart review after the patient was discharged.

4.9. Data analysis procedures

Data collected using Kobo Toolbox was first exported to the Excel (.xlsx) format; thereafter, EpiData (version 3.1) was used for data coding and cleaning before being transferred to SPSS version 25 for statistical analysis. The results were presented using text, tables, and graphs. Frequencies and percentages were used to summarize categorical data, while mean $\pm$ standard deviation (SD) and median and interquartile range (IQR) were used to describe normally and non-normally distributed numerical data, respectively. The normality of continuous variables was assessed using the Shapiro–Wilk test, and Levene’s test was used for homogeneity of variance. Stata 14.2 was used to plot a Kaplan–Meier graph for time to first analgesia request.

Comparisons of socio-demographic and clinical variables between study groups were conducted using the independent t-test and the Mann–Whitney U test for normally distributed and skewed data, respectively. For categorical variables, the Pearson's Chi-square test or Fisher’s exact test (as appropriate) was used.

Time-to-event outcome (time to first analgesia) was analyzed using the Kaplan–Meier survival function, and group differences were assessed with the log-rank test to see the

significance. The Cox proportional hazard model is used to see the effect of covariates. Multicollinearity among covariates was checked for by the Variance Inflation Factor (VIF) for all predictors, and Schoenfeld residuals were used for the proportional hazard assumption of time-dependent patterns.

A linear mixed-effects model was used to analyze repeated NRS pain scores measured at multiple postoperative time points to compare pain trajectories between ITM and USG-TAP block groups at rest and movement. The model included random intercepts to account for within-subject correlation and a fixed Group $\times$ Time interaction to assess differences in pain trends between the groups.

Model assumptions were examined before interpretation: residual normality was assessed using histograms, Q-Q plots, and the Shapiro-Wilk test, while homoscedasticity was checked with residual-versus-fitted value plots. Model adequacy and convergence were evaluated using Akaike information criteria (AIC) and Bayesian information criteria (BIC). A p-value of ≤ 0.05 is considered statistically significant for all tests.

4.10. Data quality assurance

Data was collected with a structured questionnaire, which was initially prepared in English and translated into Afan Oromo and Amharic and back to English. Completeness of the data was checked by the data collector and supervisor after collection. Every two days, the principal investigator was checked. Before the actual data collection, a pilot study was conducted with 5% of the actual sample size to test the feasibility of data collection procedures, methodology, and timing. The participants in the pilot study were not included in the final analysis because the questionnaire format was modified after that.

4.11. Ethical consideration

This study follows the ethical principles amended in the Helsinki declaration, which guides studies conducted on human participants (54). The study was approved by the Institutional Review Board of the College of Health Sciences at Arsi University (project

protocol number: CoHS/R/191/2025). A cooperation letter from ARTH was secured to confirm the support (Ref number: A/U/C/H/S/C/120/967/17). Every participant was given detailed information about the purpose of the study and informed consent was obtained by ensuring their autonomy and confidentiality.

4.12. Dissemination plan

The findings of the study will be submitted to the Department of Anesthesia, College of Health Sciences, Arsi University. The results will also be shared with the Department of Obstetrics and Gynecology at Arsi University after the defense, and finally, it will be submitted for publication in a reputable journal.

5. RESULT

The study included 98 parturients who underwent CS under spinal anesthesia. Of these, 49 (50%) received ITM as an adjuvant to bupivacaine, while the remaining 50% received USG-TAPB at the end of surgery. Detailed results are presented below.

5.1. Socio-demographic and baseline characteristics

The distributions of baseline characteristics of study participants are relatively similar between the two groups, as shown in **Error! Reference source not found.** below (all $p > 0.05$). Parturients who received ITM had a mean age of 30.1 ± 6.7 years, and those who received USG-TAPB had 30.2 ± 6.5 years ($p = 0.939$). Similarly, environmental factors were analysed, and the result shows that there is no significant difference between the two groups.

Table 1: Socio-demographic and baseline characteristics of study participants

Variable	ITM Group (n = 49)	USG-TAP Group (n = 49)	p-value
Age (years), mean $\pm$ SD	30.1 ± 6.7	30.2 ± 6.5	0.939
Weight (kg), mean $\pm$ SD	67.6 ± 10.7	67.5 ± 9.9	0.941
Height (cm), mean $\pm$ SD	162.2 ± 8.8	161.3 ± 8.9	0.964
BMI (kg/m^2), mean $\pm$ SD	22.3 ± 3.0	21.9 ± 2.8	0.854
Parity, median (IQR)	2 (1-2)	2 (1-3)	0.062
Gestational age (weeks), mean $\pm$ SD	38.9 ± 1.0	38.7 ± 0.9	0.671
Presence of comorbidity, n (%)	8 (16.3)	13 (26.5)	0.218
History of motion sickness, n (%)	9 (18.4)	8 (16.3)	0.790
Preoperative anxiety, n (%)	6 (12.2)	9 (18.4)	0.392

Previous CS scar, n (%)	25 (51.0)	22 (44.9)	0.544
Baseline pulse rate (beats/min), mean $\pm$ SD	89.2 $\pm$ 12.0	89.5 $\pm$ 14.8	0.928
Baseline diastolic BP (mmHg), mean $\pm$ SD	74.6 $\pm$ 8.4	76.2 $\pm$ 9.0	0.343
Baseline systolic BP (mmHg), mean $\pm$ SD	118.7 $\pm$ 11.0	123.0 $\pm$ 10.8	0.053
Baseline respiratory rate (breaths/min), mean $\pm$ SD	16.7 $\pm$ 3.0	16.7 $\pm$ 2.7	0.972

ITM: Intrathecal morphine, USG-TAP: Ultrasound guided Transversus Abdominis Plane, cm: centimeter, n (%): frequency (percentage), kg: kilogram, SD: Standard deviation, mmHg: millimeter mercury, IQR: Interquartile range

Table 2: Environmental factors

Category	Level	ITM (n = 49)	USG-TAPB (n = 49)	p-value
Room temperature	Too cold	11 (22.4%)	8 (16.3%)	0.934
	comfortable	36 (73.6%)	39 (79.7%)	
	Too hot	2 (4.0%)	1 (2.0%)	
Lighting	Too dim	5 (10.2%)	6 (12.2%)	0.823
	Adequate	43 (87.8%)	41 (83.8%)	
	Too bright	1 (2.0%)	2 (4.0%)	
Environmental comfort	Not at all	3 (6.1%)	4 (8.1%)	0.362
	Slightly	4 (8.1%)	2 (4.0%)	
	Moderately	28 (57.2%)	24 (49.0%)	

Significantly 14 (28.6%) 19 (38.9%)

ITM: Intrathecal morphine, USG-TAPB: Ultrasound guided Transversus Abdominis Plane Block, n (%): frequency (percentage)

5.2. Anesthesia and surgical-related factors

The proportion of sensory block level before skin incision was predominantly T4 in both groups (63.3%), with a slight domination of USG-TAPB in achieving T6 compared to ITM (14.3% vs. 2.0%, $p = 0.055$) before skin incision. The mean dose of bupivacaine used for spinal anesthesia was comparable in ITM and USG-TAP block (10.97 ± 0.57 mg vs. 11.06 ± 0.55 mg, $p = 0.399$, respectively), as were the mean length of skin incision and duration of surgery.

The distribution of surgeon experience varied slightly, with a higher proportion of R4 residents performing CS in parturients who received USG-TAPB, though this difference did not reach significance ($p = 0.091$). Intraoperative anesthetic and surgical variables didn't show a significant difference between the two groups and summarized in **Error! Reference source not found..**

Table 3: Intraoperative anesthetic and surgical characteristics of study participants

Category	Level / Measure	ITM (n = 49)	USG-TAP (n = 49)	p-value
Sensory block level before incision	T4	31 (63.3%)	31 (63.3%)	0.055
	T5	17 (34.7%)	11 (22.4%)	
	T6	1 (2.0%)	7 (14.3%)	
Motor block (Bromage scale at the end of surgery)	2	23 (46.9%)	23 (46.9%)	1.000
	3	26 (53.1%)	26 (53.1%)	
Sensory block level at	T4	1 (2.0%)	0 (0.0%)	0.062

the end of surgery	T5	4 (8.2%)	0 (0.0%)	
	T6	19 (38.8%)	23 (46.9%)	
	T7	14 (28.6%)	19 (38.8%)	
	T8	11 (22.4%)	7 (14.3%)	
Dose of spinal bupivacaine (mg)	-	10.97 ± 0.57	11.06 ± 0.55	0.399
Skin incision length (cm)	-	12.90 ± 1.40	12.57 ± 1.43	0.722
Duration of surgery (min), median (IQR)	-	54.0 (16.0)	57.0 (22.0)	0.455
Experience of an anesthetist performing USG-TAPB	Anesthesiologist	1 (2.0%)	1 (2.0%)	0.759
	MSc Staff	3 (6.1%)	5 (10.2%)	
	MSc Student	45 (91.8%)	43 (87.8%)	
Intraoperative analgesic/opioid use	Yes	7 (14.3%)	10 (20.4%)	0.424
Premedication given	Yes	27 (55.1%)	28 (57.1%)	0.839

n (%): frequency (percentage), T: Thoracic dermatome level, SD: Standard deviation, R: resident, IQR: Interquartile range

5.3. Postoperative pain scores (NRS)

Normality assumption for conducting a linear mixed model for NRS was checked from residuals by using visual and statistical methods. Normal Q-Q plots and histograms for both ITM and USG-TAP groups showed that residuals were approximately normally distributed. Shapiro–Wilk test yielded statistically significant results for both groups (ITM: $W = 0.973$, $p < .001$; USG-TAP: $W = 0.990$, $p < .001$), likely due to the large

sample size ($n > 600$). The assumption of normality was therefore considered adequately met for both ITM and USG-TAP groups.

Postoperative Pain Scores over Time and Condition

A linear mixed model with random intercepts of individual participants and fixed effects for the two groups, different time points, and their interactions (group x time) was used for repeated measures. Post hoc comparisons were done under estimated marginal means by using Bonferroni to adjust for type 1 error. Pain score increases over time was illustrated in the table 4 below.

Table 4: Pairwise differences of pain at rest and Movement Pain (USG-TAP vs. ITM)

Time (h)	At Rest		At movement	
	MD (ITM-USG_TAP)	p-value	MD(ITM-USG_TAP)	p-value
0	-0.224	0.211	-0.571	0.027*
2	-0.204	0.255	-0.327	0.205
6	-0.796	<0.001***	-1.551	<0.001***
12	-1.082	<0.001***	-1.653	<0.001***
24	-0.939	<0.001***	-1.469	<0.001***
36	-0.831	<0.001***	-1.154	<0.001***
48	-0.512	0.011*	-0.533	0.065

MD: mean difference, * p-value < 0.05 ** p-value < 0.01, *** p-value < 0.001

Postoperative pain scores (NRS) by group

The main effect of group indicated a statistically significant difference in NRS scores between parturients who received ITM and USG-TAP ($F(1, 242.4) = 77.48, p < .001$). The estimated marginal means of NRS for parturients who received adjuvant ITM and USG-TAP block were 1.53 and 2.39, respectively. On average, parturients who received adjuvant ITM had 0.86 points lower pain scores than those who received USG-TAP block (95% CI: -1.05 to -0.67, $p < .001$).

Table 5: Pairwise comparison of mean NRS scores between ITM and USG-TAPB

Pairwise Comparisons ^a							
(I)	Mean		Std.		95% CI for Difference		
Group	(J) Group	Difference (I-J)	Error	df	Sig.	Lower Bound	Upper Bound
ITM	USG-TAP	-.856*	.097	242.413	<0.001	-1.048	-.665

*. The mean difference is significant at the .05 level.

Postoperative pain trajectories between groups

The trends of postoperative pain for ITM and USG-TAP block were different. Immediately at the end of surgery (0 hours), the average NRS at rest ITM was 0.20 ± 0.87 and USG-TAP 0.60 ± 0.92 , representing the smallest difference (~ 0.4 points), and slightly higher scores during movement compared to rest, 0.57 ± 0.86 vs. 0.24 ± 0.88 (difference 0.33). The pain increased at 2 hours with ITM 1.38 and USG-TAP 1.64 (difference 0.26 points). Then, after the intensity of pain rose more and peaked at 12 hours with ITM 2.19 ± 0.87 ; USG-TAP: 3.56 ± 0.87 (difference 1.37) and movement: 3.66 ± 0.87 vs. rest: 2.09 ± 0.87 . In the late postoperative period, after 24 hours, it started to decline gradually and reached lower pain scores (mild pain); ITM: 1.30 ± 0.87 ; USG-TAP: 1.88 ± 0.87 , and at movement: 2.09 ± 0.87 vs. rest: 1.09 ± 0.87 at 48 hours.

Table 6: Estimated marginal means of NRS scores by group across postoperative time points (Group x Time interaction).

Group * Time ^a					
Group	Time	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
ITM	0hr	.204	.869	-5.113	5.521
	2hr	1.378	.869	-3.940	6.695
	6hr	1.929	.869	-3.389	7.246
	12hr	2.194	.869	-3.123	7.511
	24hr	1.837	.869	-3.481	7.154

	36hr	1.893	.869	-3.088	6.875
	48hr	1.304	.871	-2.138	4.746
USG-TAP	0hr	.602	.869	-4.715	5.919
	2hr	1.643	.869	-3.674	6.960
	6hr	3.102	.869	-2.215	8.419
	12hr	3.561	.869	-1.756	8.878
	24hr	3.041	.869	-2.276	8.358
	36hr	2.905	.869	-2.245	8.054
	48hr	1.879	.871	-1.585	5.342

a. Dependent Variable: NRS.

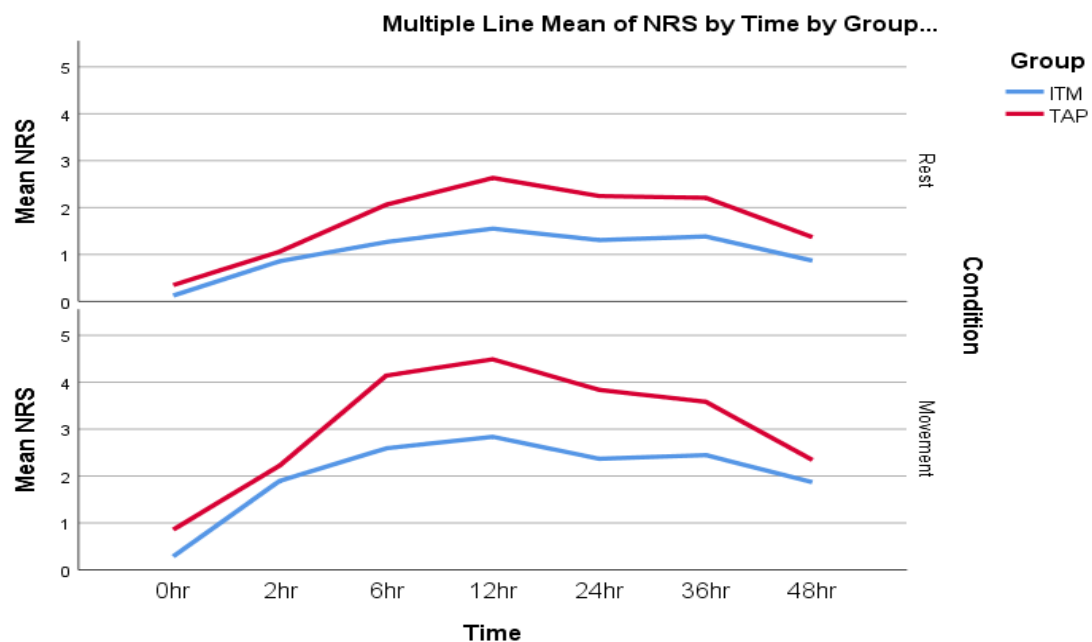


Figure 2: Mean NRS scores over 48 h postoperative period by group (ITM vs TAP) and condition (rest vs. movement).

Main effects of group, time, and condition, and their two-way interactions were significantly different as shown on **Error! Reference source not found..** These findings indicate that pain scores varied significantly over time, between groups, and between rest and movement, with differential trajectories depending on the combination of factors. However, the three-way interaction was not significant ($F=1.55$, $p=0.159$), suggesting that the joint influence of all three factors did not meaningfully alter pain trajectories beyond the two-way effects.

Table 7: Fixed effects for NRS scores across group, time, and condition.

Type III Tests of Fixed Effects^a				
	Numerator	Denominator		
Source	df	df	F	Sig.
Intercept	1	.000	5.207	1.000
Group	1	242.413	77.477	<.001
Time	6	789.871	70.456	<.001
Condition	1	882.960	1037.759	<.001
Time * Group	6	789.871	4.678	<.001
Condition * Group	1	882.960	24.346	<.001
Time * Condition	6	1087.397	16.996	<.001
Time * Condition * Group	6	1087.397	1.548	.159

a. Dependent Variable: NRS.

5.4. Time to First Analgesia Request

Time to first analgesia request demonstrated a clear difference between the parturient who received adjuvant ITM and USG-TAPB. In the ITM group, they started to request analgesia early at 3 hours vs. 2 hours in USG-TAP. 53.1% of parturients reached 6 hours without asking for analgesia, and 10.2% remained pain-free for 17 hours. In contrast to this, 26.5% reached 6 hours, and 10.2% of parturients who received USG-TAP remained pain-free for only 7 hours. The median survival time was approximately 5 hours (95% CI: 4.52-5.49) and 7 hours (95% CI: 5.97-8.03) among parturients who received USG-TAP and ITM, respectively. Parturients who received the USG-TAP block demonstrated earlier and steeper declines than ITM, as illustrated in **Error! Reference source not found.** below. Censoring occurred in both groups at 24, 36, and 48 hours.

These differences were statistically significant as confirmed by the log-rank test ($\chi^2 = 12.662$, $df = 1$, $p < 0.001$). This indicates that patients who received adjuvant ITM experienced significantly longer analgesia duration before requesting analgesia compared with those who received USG-TAP block. The effect of covariates was checked by incorporating treatment group and six covariates (parity, duration of surgery, dose of

spinal bupivacaine, intraoperative analgesic given, length of skin incision and previous CS scar). Using the Cox proportional hazards regression model, they did not achieve statistical significance overall ($\chi^2 = 7.348$, $df = 10$, $p = 0.692$).

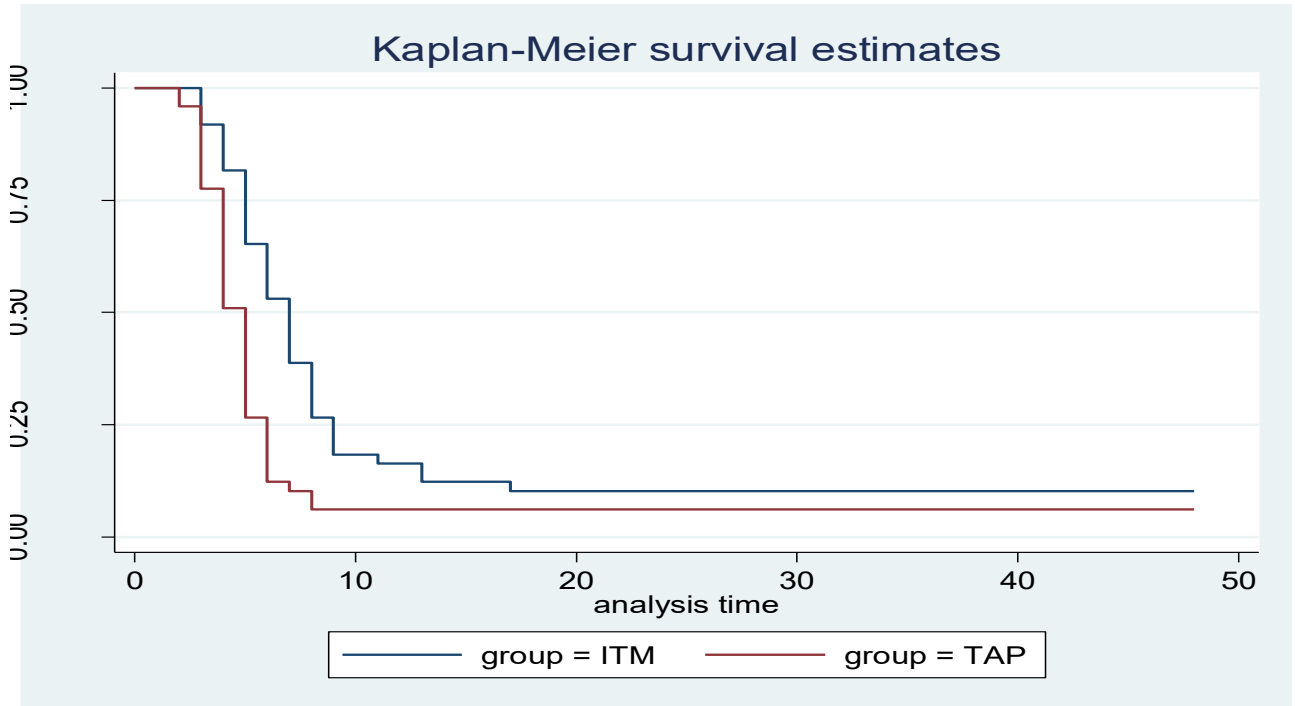


Figure 3: Kaplan–Meier Curves for Time to First Analgesia Request in ITM vs. USG-TAPB.

5.5. Analgesic adequacy between groups

Parturients who received adjuvant ITM had 2.23 times higher odds of achieving $NRS \leq 3$ (OR = 2.23, 95% CI: 0.77–6.49, $p = 0.140$). 50.4% of parturients in the ITM group had reported mild pain, whereas 49.4% in the USG-TAP group at rest. However, on movement, 59.4% and 40.6% parturients reported mild pain in the ITM and USG-TAP group, respectively. ITM provided significantly more adequate analgesia during movement (OR = 3.65, 95% CI: 2.56–5.24, $p < 0.001$) as shown in Table 8 below. 9.5% of parturients in the ITM group experienced moderate to severe pain, as 23.6% in the USG-TAP block. These finding reveals ITM can control pain during movement greater than those who received USG-TAP block.

Condition	OR (Exp(B))	95% CI for OR	p-value
At Rest	2.23	0.77 – 6.49	0.140
Movement	3.65	2.56 – 5.24	<0.001

Table 8: Association Between Analgesic Technique and Adequate Pain Control (Pain Score ≤ 3)

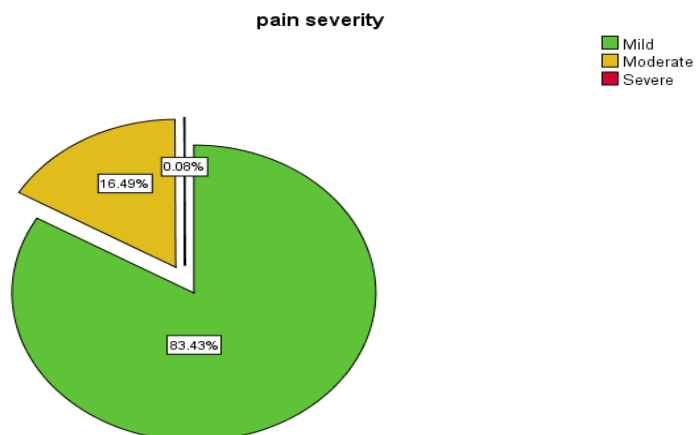


Figure 4: Overall postoperative pain severity.

5.6. Postoperative Analgesia Consumption

Postoperative analgesia consumption, expressed in diclofenac and its equivalent doses, the median total dose in the ITM group was 125 mg (IQR: 100–175 mg), and 150 mg (IQR: 100–200 mg) in the USG-TAP block. The USG-TAPB group demonstrated a higher mean rank (54.15) compared with the ITM group (44.85), suggesting a trend toward greater analgesic consumption. However, this difference was not statistically significant ($U = 972.500$, $Z = -1.638$, $p = 0.101$), indicating that overall analgesia requirements were comparable between groups. It was demonstrated by the box plot

Error! Reference source not found..

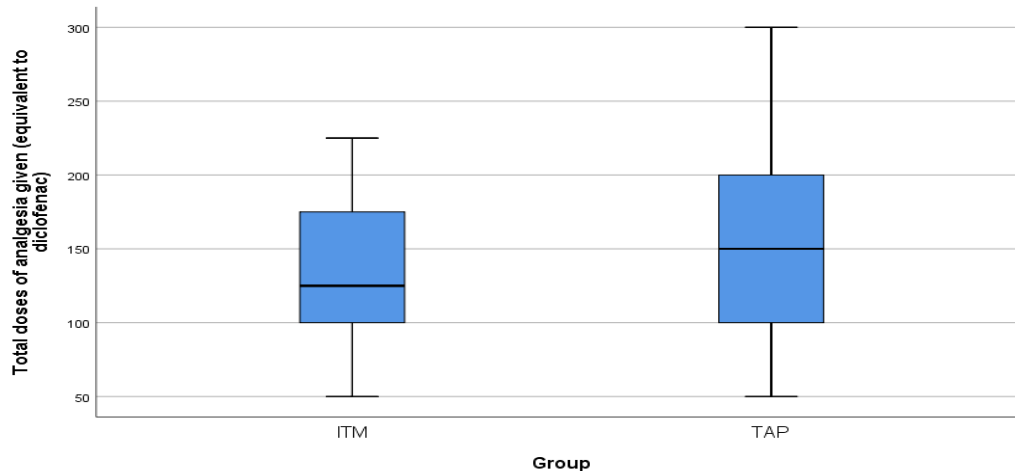


Figure 5: Total analgesia doses (Diclofenac equivalent) between ITM and USG-TAPB

5.7. Postoperative Outcomes and Safety

Parturients who received the USG-TAP block experienced twice as many cases of breakthrough pain compared with the ITM group (14 [28.6%] vs. 7 [14.3%]). These differences were not statistically significant (Pearson $\chi^2 = 2.970$, $p = 0.085$). The one-sided Fisher's test approached significance ($p = 0.069$), suggesting a trend toward increased breakthrough pain among the USG-TAP block. This aligns with the earlier findings of shorter analgesia duration and higher postoperative analgesic consumption in the USG-TAPB group.

In terms of safety and side effects, one patient in the ITM group (1.02%) developed mild, transient respiratory depression during the immediate postoperative period. Postoperative urinary retention was observed in 4 ITM patients (8.2%) compared with 1 USG-TAP parturient (2.0%), ($\chi^2 = 1.897$, $p = 0.362$). Although the ITM group showed a slightly higher incidence, the overall rate was low, indicating that complications were uncommon in both groups.

PONV occurred primarily in the early hours following surgery. At 0 hours, 3(6.1%) participants in those who received ITM and 1(2.0%) who received USG-TAPB experienced PONV, while at 2 hours, 1 additional ITM patient (2.0%) reported symptoms. No further cases were observed beyond 2 hours in either group. Additionally,

mild pruritus was reported in 1 ITM parturient (2.0%) during the early postoperative phase at 2 hrs. These findings suggest that adverse events were generally limited, transient, and largely confined to the immediate postoperative period.

Functional Recovery

Postoperative oral intake was resumed at a median of 9.0 hours (IQR: 7.0–11.0) in both groups, in which the difference was not statistically significant ($U = 1141.000$, $Z = -0.426$, $p = 0.670$). Parturient in USG-TAP group had a slightly earlier intake than ITM (mean rank 48.3 vs. 50.7). This indicates they have comparable gastrointestinal recovery.

Ambulation during the postoperative time periods occurred at a mean of 12.02 ± 3.43 hours and 12.78 ± 3.32 hours in ITM and USG-TAP groups, respectively ($t(96) = -1.107$, $p = 0.271$), as shown in **Error! Reference source not found.** Length of hospital discharge was 45.7 ± 13.3 hours in the ITM group and 46.5 ± 10.7 hours in the USG-TAP block group ($t(96) = -0.327$, $p = 0.745$). Overall, there was no significant difference in recovery parameters between ITM and USG-TAPB, indicating both techniques support early mobilization consistent with ERAS principles

Table 9: Comparison of discharge and ambulation times between ITM and TAPB

	t	df	Sig. (2-tailed)	Mean Difference	Std. Error	95% CI Lower	95% CI Upper
Length of stay (hours)	-.327	96	0.745	-0.796	2.436	-5.632	4.040
Ambulation after surgery (hours)	-1.107	96	0.271	-0.755	.682	-2.109	.598

Patient satisfaction

Both ITM and USG-TAP block groups have a comparable, overall high satisfaction rate, with ITM at 95.9% and USG-TAP block at 91.8 % ($\chi^2 = 0.710$, $p = 0.678$). Ordinal logistic regression revealed a significant effect of analgesic technique on patient satisfaction (Estimate = -0.969 , $p = 0.013$). Parturients receiving adjuvant ITM to bupivacaine had 62% lower odds of reporting lower satisfaction levels (dissatisfaction) compared to those who received USG-TAPB (OR = 0.38, 95% CI: 0.18–0.81). These

indicate that ITM is associated with significantly higher patient satisfaction levels. Willingness to repeat the same analgesia technique was high in both groups with no statistically significant difference (ITM: 85.7% USG-TAP block: 73.5%) ($\chi^2 = 2.271$, $p = 0.321$). These findings suggest overall acceptability of both techniques, with a modest preference for ITM.

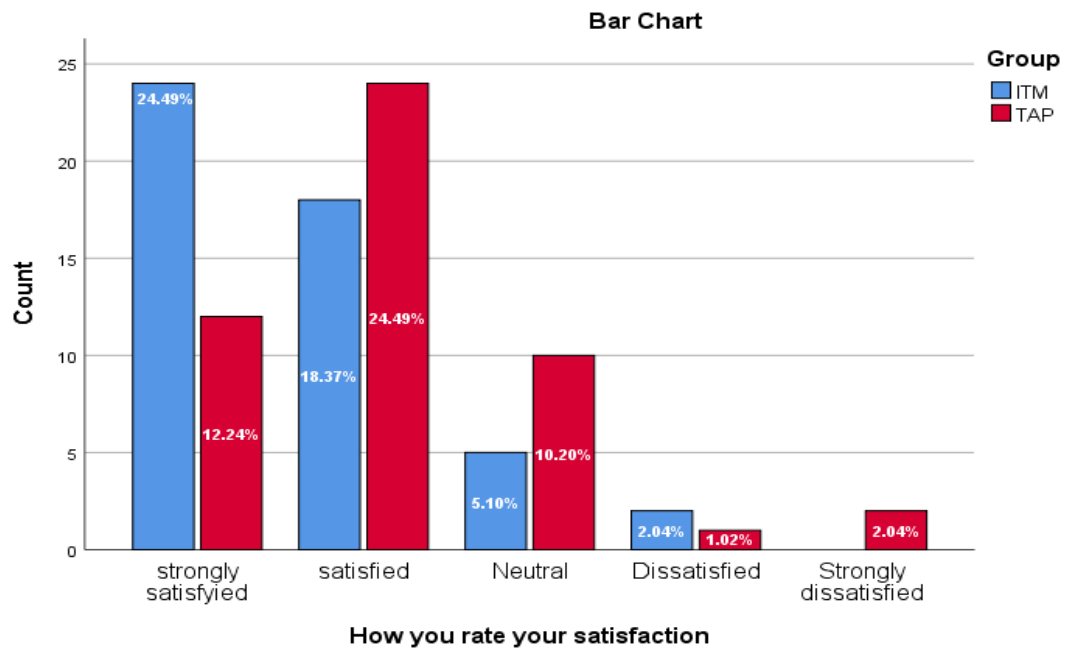


Figure 6: Distribution of patient satisfaction ratings by treatment group.

6. DISCUSSION

This study compared the effectiveness of adjuvant ITM to bupivacaine with USG-TAP block in 98 parturients undergoing CS. The results revealed that both techniques provided effective postoperative pain management strategies, with ITM being superior. ITM was associated with lower pain scores, longer analgesia duration, reduced breakthrough pain, and higher satisfaction levels compared with USG-TAP. Post-operative outcomes were comparable in both groups; however, with limited overall complications in the USG-TAPB group.

In our study, ITM and USG-TAPB reduced the prevalence of moderate to severe pain to less than 20%. Despite this, previous studies conducted in Ethiopia have reported a high incidence of moderate to severe pain within the first 24 hours after CS, which demonstrated predominantly low to moderate pain levels (6,33). Studies from developing countries also present the high prevalence of moderate to severe pain, which shows a huge difference from our study (9,31).

These discrepancies may come from a lack of prioritization to address postoperative pain management, as well as limited exercise of nerve blocks and the use of adjuvants for spinal anesthesia. These studies emphasize the need for balanced analgesia with minimal complications. The decline in percentage in our study is due to the implementation the two techniques to address postoperative pain after CS. These percentages were decreased further if the WHO guidelines for pain management were strictly followed.

Our study shows that parturients who received ITM have significantly lower pain scores (NRS) than those who received USG-TAP block. The largest differences were observed at 12 hours. This is in line with other studies that show superior and more sustained analgesia with ITM compared to USG-TAP block after CS (5,21,27,55). The superiority of ITM comes from the nature of involving both somatic and visceral pain control at the spinal nerve roots.

However, a study conducted by Ben Marzouk et al. found that pain scores between the TAP and ITM were comparable and supported by other systematic reviews and meta-analyses (21,50). A systematic review and meta-analysis by Yang et al. reports comparable postoperative NRS when studies from developing countries are included (21). This is due to the variability of results from studies conducted in developing countries. It was a study conducted by Kwikiriza et al., which reported that both techniques provide similar postoperative pain relief and superiority of TAP at 24 hours (5). These studies limit the inferiority of the TAP block for postoperative pain management. These arise from the block techniques (posterior approach) that results in a backward flow of local anesthetic towards the paravertebral spaces.

In our study, pain at movement is well controlled in the ITM groups. But Champaneria et al. said that ITM has no more added benefit to control pain at rest and on movement when compared with USG-TAPB (2). This discrepancy arises from approaches to manage postoperative pain management. In their study they gave analgesia on a twice daily basis without parturient request. But in our setup analgesia is given once the mothers request for analgesia or after she complains a pain.

Most studies were focused on early postoperative time periods within 24 hours after surgery. Our study followed participants beyond 24 hours until 72 hours. The result shows that ITM reduces pain score at 48 hours compared to USG-TAPB, which is significant at rest, with comparable results on movement. The reverse is true for the study conducted by McMorro et al. But, meta-analysis done by Mishriky et al concluded the difference is not significant at rest and on movement (26,34). The difference is due to the nature of study design, in which we are only following without devised protocol to intervene. Despite the lack of statistical significance, the results of our study and reports from the other studies support that ITM was associated with clinically meaningful reductions in pain scores (32).

Time to first analgesia request was longer in parturients who received ITM as an adjuvant with spinal bupivacaine. This is similar to other studies that report the prolonged effect of analgesia with ITM (5,21,26). There is a slight elevation of request time in our study

participants when compared with a local study conducted by Jemal et al (27). This may be due to the use of ultrasound for those who take TAPB as well as the sociocultural difference of study participants. But other studies report a longer time to first analgesia request than our study in both groups (5,25). These discrepancies come from the addition of another supplemental adjuvant to the bupivacaine during spinal anesthesia. However, they support that ITM provides a longer duration than the USG-TAPB. Duale et al reported a shorter time to first analgesia request after ITM when compared to our study. They report that it is from the cephalic spread of morphine in the subarachnoid space (14).

Analgesic consumption was not statistically different between groups, but patients who received USG-TAPB favored higher total doses of analgesia than ITM, as supported by other studies (34,50,55). More analgesics were given to address the visceral pain arising from the uterine incision and contraction during the early postoperative times. But other studies found a significant higher total consumption analgesia in parturients who received TAP than ITM (2,25,27,51). In addition variety of analgesic utilized was also different from our results. This is due to the strong adherence to multimodal implementation in their protocols and most of them are meta-analysis of RCT. In addition, strategies used to address postoperative pain in our institution spares opioids unless the pain is severe enough to be uncontrolled by other medications. Hence, it reduces the total consumption and variety of drugs.

The difference in experiencing breakthrough pain was comparable between groups, but it was reported that patients who received the USG-TAPB experienced twice that of ITM. This is consistent with other studies, and it is related to the shorter duration of analgesia and variable effects of TAP block (2,34). But, a meta-analyses by Wang et al demonstrate that USG-TAP block is associated with lower breakthrough pain within the 24 hours, which may be due to the use of other opioids rather than morphine (30).

Side effects were infrequent and mild, which was clinically acceptable in both groups. In the ITM group, side effects (such as urinary retention, mild respiratory depression, and pruritus) were more prevalent, which is consistent with findings from previous

studies(27,37,41,55). These side effects were mild, transient, and didn't require any intervention, supporting the safety of ITM at the dose used in this study.

PONV was comparable between the two groups, aligning with other studies(25,27). This may be explained by the multifactorial nature of PONV, which is influenced by surgical factors and individual patient susceptibility. Notably, the incidence of pruritus in both groups was lower than that reported in other studies (2), likely due to reduced reliance on systemic opioids in our multimodal analgesia protocol.

Respiratory depression associated with ITM may happen if the doses exceed 200 micrograms, as supported by case series in England and meta-analysis by Koning et al. 2022 (41). But there is study that support our finding that it occurs at doses less than 400 micrograms (39). In our study, respiratory depression was likely exacerbated by concurrent postpartum hemorrhage and patient-reported nasal irritation from cleaning agents used in the operating room. In contrast, the USG-TAP block, which is opioid-free, demonstrated a limited side effect profile and reinforces its role in opioid-sparing analgesic strategies.

Functional recovery in terms of resumption of oral intake, ambulation, and length of hospital stay was not significantly different between the two groups, which aligned with ERAS protocols. Other previous similar studies suggest that while analgesic technique influences pain intensity and satisfaction, it may not directly translate into faster functional recovery (22,26,50). In contrast, the study conducted by Fikrie et al. demonstrated a longer duration of stay than our study (56). This discrepancy attributed to differences in patient selection in which they included all parturients undergoing CS in their study.

Patient satisfaction and willingness to repeat similar analgesic technique in the future were high and comparable in both groups, as supported by other studies (2,51). But the level of satisfaction is superior in ITM groups, aligning with other studies (13,27). In contrast to this, Salama et al. demonstrated that regional techniques provide a superior safety profile and patient satisfaction than ITM (24). This study does not compare direct

ITM and TAPB, rather with the quadratus lumborum techniques. The overall satisfaction was higher in our study when compared with a local study conducted in Bahir Dar (57). This is due to implementation of analgesic techniques in our study.

Our findings support the use of adjuvant ITM to bupivacaine for CS, particularly in settings where pain control remains a challenge. ITM provides a superior analgesic effectiveness, prolonged duration of analgesia, low analgesic consumption, and limited breakthrough pain with limited and manageable side effects. On the other side, the USG-TAPB provides a comparable clinical effect on early and late postoperative pain control. Its favorable safety and limited adverse effects make it a suitable and alternative analgesic technique supplemented with systemic analgesia when ITM is contraindicated or side effects are a major concern. It is also a preferred option in settings where monitoring for respiratory depression is challenging.

7. STRENGTHS AND LIMITATIONS OF THE STUDY

The strength of our study is the balanced cohort design with a similar sample size in both groups. It incorporates analgesic effectiveness, potential side effects, and recovery parameters and extends the follow-up till the patient's discharge from the hospital to a maximum of 72 hours. Advanced statistical methods were also employed to improve the precision and interpretability of results. The use of ultrasound to conduct TAPB enhanced the accuracy of local anesthetic deposition, reducing the risk of misplacement into non-target tissue spaces commonly associated with blind techniques. In addition, it addresses the critical gap in cesarean pain management in Ethiopia, which helps to guide locally relevant evidence for pain management.

Limitations of our study start from the single-centered study. Despite being adequate for detecting differences in the effectiveness of pain control, rare adverse effects may not be captured well by these sample sizes. Majorly, USG-TAP blocks were conducted by MSc students and staff with varying experience, which could influence block quality and analgesic outcomes.

8. CONCLUSION

The study demonstrated that ITM provided a superior analgesic effect than USG-TAPB, leading to rejection of the null hypothesis. It was associated with prolonged first analgesia request, fewer breakthrough pain episodes, and higher patient satisfaction level at the expense of a small increase in side effects when compared with USG-TAPB. However, both techniques provided effective postoperative analgesia, comparable analgesia consumption, and postoperative safety profiles, which support the alternative hypothesis. Therefore, USG-TAPB may be used as an alternative when ITM is contraindicated or undesirable. These enhance the ability to choose analgesic techniques based on individual patient needs, institutional monitoring capacity, and availability of resources.

9. RECOMMENDATIONS

Starting from our results, we would like to recommend the following points:

1. ITM should be the preferred technique for augmenting analgesia after CS by facilitating monitoring for side effects.
2. USG-TAP block is a viable alternative when ITM is contraindicated or a potential side effect is expected, by supplementing with systemic analgesia.
3. Strengthen postoperative monitoring protocols for respiratory depression and opioid-related side effects when ITM is used.
4. Local larger multicenter randomized controlled trials are recommended to confirm these findings, explore optimal dosing, and include cost-effectiveness analysis as well as effects on neonates from milk transfer.
5. Institutional protocols and National guidelines should incorporate both ITM and USG-TAP block as analgesic options based on resources and patient needs.

10. REFERENCES

1. Geleto A, Chojenta C, Taddele T, Loxton D. Association between maternal mortality and caesarean section in Ethiopia: a national cross-sectional study. *BMC Pregnancy Childbirth*. 2020 Oct 6;20(1):588.
2. Champaneria R, Shah L, Wilson MJ, Daniels JP. Clinical effectiveness of transversus abdominis plane (TAP) blocks for pain relief after caesarean section: a meta-analysis. *Int J Obstet Anesth*. 2016 Dec;28:45–60.
3. World Health Organization, United Nations Population Fund, Mailman School of Public Health. Averting Maternal Death and Disability, United Nations Children’s Fund (UNICEF). Monitoring emergency obstetric care : a handbook. *Surveill Soins Obstétricaux Urgence Man Util*. 2009;152.
4. Gedefaw G, Demis A, Alemnew B, Wondmienieh A, Getie A, Waltengus F. Prevalence, indications, and outcomes of caesarean section deliveries in Ethiopia: a systematic review and meta-analysis. *Patient Saf Surg*. 2020;14:11.
5. Kwikiriza A, Kiwanuka JK, Firth PG, Hoeft MA, Modest VE, Ttendo SS. The analgesic effects of intrathecal morphine in comparison with ultrasound-guided transversus abdominis plane block after caesarean section: a randomised controlled trial at a Ugandan regional referral hospital. *Anaesthesia*. 2019 Feb;74(2):167–73.
6. Demelash G, Berhe YW, Gebregzi AH, Chekol WB. Prevalence and Factors Associated with Postoperative Pain After Cesarean Section at a Comprehensive Specialized Hospital in Northwest Ethiopia: Prospective Observational Study. *Open Access Surg*. 2022 Jan;Volume 15:1–8.
7. Chandon M, Bonnet A, Burg Y, Barnichon C, DesMesnards-Smaja V, Sitbon B, et al. Ultrasound-Guided Transversus Abdominis Plane Block versus Continuous Wound Infusion for Post-Caesarean Analgesia: A Randomized Trial. *Gemzell-Danielsson K*, editor. *PLoS ONE*. 2014 Aug 5;9(8):e103971.
8. Kolawole IK, Fawole AA. Postoperative pain management following caesarean section in University of Ilorin Teaching Hospital (UITH), Ilorin, Nigeria. *West Afr J Med*. 2003 Dec;22(4):305–9.
9. Azanu WK, Osarfo J, Larsen-Reindorf RE, Agbeno EK, Dassah E, Amanfo AO, et al. Assessment and determinants of acute post-caesarean section pain in a tertiary facility in Ghana. *PloS One*. 2022;17(5):e0268947.

10. Abdallah FW, Halpern SH, Margarido CB. Transversus abdominis plane block for postoperative analgesia after Caesarean delivery performed under spinal anaesthesia? A systematic review and meta-analysis. *Br J Anaesth*. 2012 Nov;109(5):679–87.
11. Carvalho B, Butwick AJ. Postcesarean delivery analgesia. *Best Pract Res Clin Anaesthesiol*. 2017 Mar;31(1):69–79.
12. Kerai S, Saxena KN, Taneja B. Post-caesarean analgesia: What is new? *Indian J Anaesth*. 2017 Mar;61(3):200–14.
13. White TD, Matthew SK, Tubog TD. Postoperative Cesarean Section Pain Management Using Transversus Abdominis Plane Block Versus Intrathecal Morphine: A Systematic Review and Meta-analysis. *J Perianesthesia Nurs Off J Am Soc PeriAnesthesia Nurses*. 2024 July 10;S1089-9472(24)00123-0.
14. Dualé C, Frey C, Bolandard F, Barrière A, Schoeffler P. Epidural versus intrathecal morphine for postoperative analgesia after Caesarean section. *Br J Anaesth*. 2003 Nov;91(5):690–4.
15. Dualé C, Frey C, Bolandard F, Barrière A, Schoeffler P. Epidural versus intrathecal morphine for postoperative analgesia after Caesarean section. *Br J Anaesth*. 2003 Nov;91(5):690–4.
16. Sangkum L, Thamjamrassri T, Arnuntasupakul V, Chalacheewa T. The Current Consideration, Approach, and Management in Postcesarean Delivery Pain Control: A Narrative Review. *Anesthesiol Res Pract*. 2021;2021:2156918.
17. Perriss BW. Intrathecal Morphine. *Anesthesiology*. 1980 July 1;53(1):82–82.
18. Dhawan R, Daubenspeck D, Wroblewski KE, Harrison JH, McCrorey M, Balkhy HH, et al. Intrathecal Morphine for Analgesia in Minimally Invasive Cardiac Surgery: A Randomized, Placebo-controlled, Double-blinded Clinical Trial. *Anesthesiology*. 2021 Nov;135(5):864–76.
19. Silverman M, Zwolinski N, Wang E, Lockwood N, Ancuta M, Jin E, et al. Regional Analgesia for Cesarean Delivery: A Narrative Review Toward Enhancing Outcomes in Parturients. *J Pain Res*. 2023;16:3807–35.
20. Sharpe EE, Molitor RJ, Arendt KW, Torbenson VE, Olsen DA, Johnson RL, et al. Intrathecal Morphine versus Intrathecal Hydromorphone for Analgesia after Cesarean Delivery: A Randomized Clinical Trial. *Anesthesiology*. 2020 June;132(6):1382–91.
21. Yang T ran, He X mei, Li X han, Wang R rong. Intrathecal morphine versus transversus abdominis plane block for caesarean delivery: a systematic review and meta-analysis. *BMC Anesthesiol*. 2021 Dec;21(1):174.

22. Yan Z rong, Chen L juan, Zhang S jing, Zhang L xin, Lu H, Zhang L, et al. The transversus abdominis plane block in conjunction with intrathecal morphine use after cesarean section in women with severe pre-eclampsia: a randomized controlled trial. *BMC Anesthesiol.* 2023 Mar 30;23(1):100.
23. Belavy D, Cowlshaw PJ, Howes M, Phillips F. Ultrasound-guided transversus abdominis plane block for analgesia after Caesarean delivery. *Br J Anaesth.* 2009 Nov;103(5):726–30.
24. Salama ER. Ultrasound-guided bilateral quadratus lumborum block vs. intrathecal morphine for postoperative analgesia after cesarean section: a randomized controlled trial. *Korean J Anesthesiol.* 2020 Apr;73(2):121–8.
25. Suwarman null, Pison OM, Maulana MF, Nugraha P. Comparison of Spinal Morphine and Transversus Abdominis Plane Block on Opioid Requirements After Caesarean Section: An Observational Study. *Local Reg Anesth.* 2024;17:79–86.
26. McMorro RCN, Ni Mhuirheartaigh RJ, Ahmed KA, Aslani A, Ng SC, Conrick-Martin I, et al. Comparison of transversus abdominis plane block vs spinal morphine for pain relief after Caesarean section. *Br J Anaesth.* 2011 May;106(5):706–12.
27. Jemal B, Mohammed F, Tesema HG, Ahmed S, Mohammed A, Regasa T, et al. Analgesic Efficacy of Spinal Morphine in Comparison With Transversus Abdominis Plane Block for Postoperative Pain Management in Patients Undergoing Cesarean Section Under Spinal Anesthesia: A Randomized Controlled Trial. *Front Med.* 2022 Feb 9;9:814538.
28. El-Boghdadly K, Pawa A, Chin KJ. Local anesthetic systemic toxicity: current perspectives. *Local Reg Anesth.* 2018;11:35–44.
29. Rosenberg P, Veering B, Urmey W. Maximum recommended doses of local anesthetics: A multifactorial concept. *Reg Anesth Pain Med* [Internet]. 2004 Dec [cited 2025 Nov 10];29(6):564–75. Available from: <https://rapm.bmj.com/lookup/doi/10.1016/j.rapm.2004.08.003>
30. Wang P, Chen X, Chang Y, Wang Y, Cui H. Analgesic efficacy of ultrasound-guided transversus abdominis plane block after cesarean delivery: A systematic review and meta-analysis. *J Obstet Gynaecol Res.* 2021 Sept;47(9):2954–68.
31. Hussen I, Worku M, Geleta D, Mahamed AA, Abebe M, Molla W, et al. Post-operative pain and associated factors after cesarean section at Hawassa University Comprehensive Specialized Hospital, Hawassa, Ethiopia: A cross-sectional study. *Ann Med Surg* [Internet]. 2022 Sept [cited 2025 Jan 28];81. Available from: <https://journals.lww.com/10.1016/j.amsu.2022.104321>

32. Macias DA, Adhikari EH, Eddins M, Nelson DB, McIntire DD, Duryea EL. A comparison of acute pain management strategies after cesarean delivery. *Am J Obstet Gynecol* [Internet]. 2022 Mar [cited 2025 Nov 7];226(3):407.e1-407.e7. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0002937821009996>
33. Bimrew D, Misganaw A, Samuel H, Daniel Desta T, Bayable SD. Incidence and associated factors of acute postoperative pain within the first 24 h in women undergoing cesarean delivery at a resource-limited setting in Addis Ababa, Ethiopia: A prospective observational study. *SAGE Open Med*. 2022 Jan;10:20503121221133190.
34. Mishriky BM, George RB, Habib AS. Transversus abdominis plane block for analgesia after Cesarean delivery: a systematic review and meta-analysis. *Can J Anesth Can Anesth*. 2012 Aug;59(8):766–78.
35. Vercauteren M, Vereecken K, La Malfa M, Coppejans H, Adriaensen H. Cost-effectiveness of analgesia after Caesarean section. A comparison of intrathecal morphine and epidural PCA. *Acta Anaesthesiol Scand*. 2002 Jan;46(1):85–9.
36. Kaye AD, Lindberg AM, Shah SS, Maitiski RJ, Pendarvis EB, Cooley JF, et al. Efficacy and Safety of Intrathecal Morphine for Cesarean Delivery: A Narrative Review. *Curr Pain Headache Rep*. 2024 Oct;28(10):1007–13.
37. Sultan P, Halpern SH, Pushpanathan E, Patel S, Carvalho B. The Effect of Intrathecal Morphine Dose on Outcomes After Elective Cesarean Delivery: A Meta-Analysis. *Anesth Analg*. 2016 July;123(1):154–64.
38. Lim Y, Jha S, Sia AT, Rawal N. Morphine for post-caesarean section analgesia: intrathecal, epidural or intravenous? *Singapore Med J*. 2005 Aug;46(8):392–6.
39. Meylan N, Elia N, Lysakowski C, Tramèr MR. Benefit and risk of intrathecal morphine without local anaesthetic in patients undergoing major surgery: meta-analysis of randomized trials. *Br J Anaesth*. 2009 Feb;102(2):156–67.
40. Seki H, Shiga T, Mihara T, Hoshijima H, Hosokawa Y, Hyuga S, et al. Effects of intrathecal opioids on cesarean section: a systematic review and Bayesian network meta-analysis of randomized controlled trials. *J Anesth*. 2021 Dec;35(6):911–27.
41. Koning MV, Reussien E, Vermeulen BAN, Zonneveld S, Westerman EM, De Graaff JC, et al. Serious Adverse Events after a Single Shot of Intrathecal Morphine: A Case Series and Systematic Review. Valeriani M, editor. *Pain Res Manag*. 2022 Mar 10;2022:1–10.
42. Roofthoof E, Joshi GP, Rawal N, Van De Velde M, the PROSPECT Working Group* of the European Society of Regional Anaesthesia and Pain Therapy and

supported by the Obstetric Anaesthetists' Association. PROSPECT guideline for elective caesarean section: updated systematic review and procedure-specific postoperative pain management recommendations. *Anaesthesia*. 2021 May;76(5):665–80.

43. Onishi Y, Kato R, Okutomi T, Tabata K, Amano K, Unno N. Transversus abdominis plane block provides postoperative analgesic effects after cesarean section: Additional analgesia to epidural morphine alone. *J Obstet Gynaecol Res*. 2013 Sept;39(9):1397–405.

44. McDermott G, Korba E, Mata U, Jaigirdar M, Narayanan N, Boylan J, et al. Should we stop doing blind transversus abdominis plane blocks? *Br J Anaesth* [Internet]. 2012 Mar [cited 2025 Nov 7];108(3):499–502. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0007091217323164>

45. Tran DQ, Bravo D, Leurcharusmee P, Neal JM. Transversus Abdominis Plane Block: A Narrative Review. *Anesthesiology*. 2019 Nov;131(5):1166–90.

46. Jankovic Z, Ahmad N, Ravishankar N, Archer F. Transversus Abdominis Plane Block: How Safe is it? *Anesth Analg*. 2008 Nov;107(5):1758–9.

47. Oak S, Hemantkumar I, Narkhede H, Poduval D. Comparison of Ultrasound-guided vs Blind Transversus Abdominis Plane Block in Gynecological Abdominal Surgeries for Postoperative Analgesia in Tertiary Care Center: A Randomized Prospective Single-blind Study. *J Res Innov Anesth*. 2021 July 30;6(1):5–10.

48. Fayyaz MA, Mehmood A, Bashir H, Musarrat R, Ahmad N, Haider SA. Effectiveness of Ultrasound Guided Trans-versus Abdominis Plane (TAP) Block with Landmark Technique Guided TAP Block for Open Appendectomy. *Pak J Med Health Sci* [Internet]. 2022 Jan 30 [cited 2025 Nov 7];16(1):1249–51. Available from: <https://pjmhsonline.com/published-issues/2022/January/1-1249>

49. El-Tallawy SN, Pergolizzi JV, Amlih HF, Fairaq MM, Awaleh FI, Alsubaie AT, et al. Enhancing Postoperative Analgesia After Cesarean Section: Insights Into Transversus Abdominis Plane Block, Intrathecal Opioids, and Other Analgesic Techniques. *Cureus*. 2024 Oct;16(10):e72773.

50. Ben Marzouk S, Bennis L, Cherni I, Shili A, Touaibia M, Maghrebi H. Ultrasound-guided bilateral transversus abdominis plane block versus spinal morphine for pain relief after caesarean section. *Glob Anesth Perioper Med* [Internet]. 2016 [cited 2025 Jan 16];2(2). Available from: <http://oatext.com/Ultrasound-guided-bilateral-transversus-abdominis-plane-block-versus-spinal-morphine-for-pain-relief-after-caesarean-section.php>

51. Dereu D, Savoldelli GL, Mercier Y, Combescure C, Mathivon S, Rehberg B. The impact of a transversus abdominis plane block including clonidine vs. intrathecal morphine on nausea and vomiting after caesarean section: A randomised controlled trial. *Eur J Anaesthesiol*. 2019 Aug;36(8):575–82.
52. Hynes D, McCarroll M, Hiesse-Provost O. Analgesic efficacy of parenteral paracetamol (propacetamol) and diclofenac in post-operative orthopaedic pain. *Acta Anaesthesiol Scand* [Internet]. 2006 Mar [cited 2025 Oct 2];50(3):374–81. Available from: <https://onlinelibrary.wiley.com/doi/10.1111/j.1399-6576.2006.00971.x>
53. Marchini M, Tozzi L, Bakshi R, Pistai R, Fedele L. Comparative efficacy of diclofenac dispersible 50 mg and ibuprofen 400 mg in patients with primary dysmenorrhea. A randomized, double-blind, within-patient, placebo-controlled study. *Int J Clin Pharmacol Ther*. 1995 Sept;33(9):491–7.
54. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA*. 2013 Nov 27;310(20):2191–4.
55. Loane H, Preston R, Douglas MJ, Massey S, Papsdorf M, Tyler J. A randomized controlled trial comparing intrathecal morphine with transversus abdominis plane block for post-caesarean delivery analgesia. *Int J Obstet Anesth*. 2012 Apr;21(2):112–8.
56. Fikrie A, Zeleke R, Bekele H, Seyoum W, Hailu D, Wayessa ZJ, et al. Time-to-recovery after cesarean section delivery among women who gave birth through cesarean section at Hawassa University Comprehensive Specialized Hospital, South Ethiopia: A prospective cohort study. *PLOS Glob Public Health*. 2022;2(10):e0000696.
57. Admass BA, Diress FT, Fentie DY, Endalew NS. Maternal Satisfaction and Associated Factors with Postcesarean Section Pain Management: A Cross-Sectional Study. *Anesthesiol Res Pract*. 2024;2024:4885678.

11. ANNEXES

11.1. Annex 1: Information Sheet

Good morning/afternoon. My name is _____ and I'm from Arsi University. We are collecting research data for the study entitled "Comparing effectiveness of ultrasound guided transverse abdominis plane block and adjuvant intrathecal morphine to bupivacaine for postoperative pain management in patients undergoing caesarean section" conducted under Arsi University, Department of Anesthesia. This questionnaire was prepared to collect data for our study.

The study was conducted by Haile Demissie for his partial fulfillment of a Master's in Advanced Clinical Anesthesia. We are interviewing you about the post-operative pain experience and severity, both during rest and movement, and other related factors. We are going to ask you some questions that are not difficult to answer. The information you gave us is confidential and doesn't connect with your name. You can discontinue the interview at any time you want to discontinue, and you are not obliged to answer questions you are not comfortable with. But you are expected to answer the questions about your experience and be honest with your answers. It helps us to improve the practice of pain management after caesarean section. We appreciate your cooperation in being a part of our study. The interview will take a maximum of 30 minutes, and we will check your status until you are discharged.

Name: Haile Demissie

Phone number: +251 930 7596 27/ +251 945 1908 20

Email: hai21dem@gmail.com

11.2. Annex 2: Consent Form

I am the individual asked to be a study participant. Based on the information provided, I understand the aim of the study. I told that, she /he will not use for other purposes and the information obtained from me will help to identify effective post-operative pain management after caesarean section and improve techniques of pain management. So, I agree to be a study participant.

A. Yes B. No

If yes, go to the next section. If not, go to the next participant

Questionnaire code _____

Name of data collector _____

Signature _____

11.3. Annex 3: Questionnaire

MRN _____

11.3.1. Socio-demographic factors

S.N.	Factors	Response
101	Age	
102	Height	
103	Weight	
104	BMI	

11.3.2. Patient-related factors

S.N.	Factors	Response
201	ASA status	A. II B. III C. IV

202	Parity	_____
203	Previous scar	A. Yes B. No
204	If yes, number of scars	_____
205	Do you have motion sickness?	A. Yes B. No
206	Comorbidity	A. No B. Hypertension C. Diabetes E. Asthma F. Other specify_____
207	Gestational age	_____weeks
208	Indication for CS	_____
209	Are you anxious before surgery?	A. Yes B. No
209	How you rate your anxiety?	A. Very anxious B. Anxious. C. Not

11.3.3. Anesthesia-related factors

S.N.	Factors	Response
300	Baseline v/s	PR:_____ BP:_____ RR:_____
301	Types of local anesthetics	A. Bupivacaine B. Lidocaine C. Other specify_____
302	Baricity	A. Hyperbaric B. Isobaric C. hypobaric
303	Dose of local anesthetics	_____mg
304	Intrathecal morphine used	A. Yes B. No
305	If yes to question 304, doses	_____mcg
306	Number of attempts	_____
307	Sensory level	A. Pre-incision level_____

		B. At the end of surgery_____
308	Premedication given	A. Yes B. No
309	If yes to question 306, which drug	A. metoclopramide B. dexamethasone C. cimetidine D. others(specify)_____
310	Preoperative analgesia given	A. Yes B. No
311	If yes to question 308, specify drug, dose, and route	Drug given:_____ Dose:_____ Route:_____
312	Intra-op analgesia/opioid given	A. Yes B. No
313	If yes, the drug given	A. Ketamine B. Propofol C. Other specify_____
314	TAP given	A. Yes B. No
315	If yes to 316, Types of drugs used	A. Bupivacaine ____% B. Lidocaine____%
316	If yes to 316, dose	Left side_____ mg____ % Right side_____ mg____%
317	Is an adjuvant added to TAP	A. Yes B.No
318	If yes to 319, which drug	A. drug_____ B.dose_____ mg
319	Experience of an Anesthetist	A. MSc student B. MSc staff C. Anesthesiologist

11.3.4. Surgical-related factors

S.N.	Factors	Response

401	Length of incision	_____ cm
402	Duration of surgery	_____ min
403s	Experience of the surgeon	A. R2 B. R3 C.R4 D. Senior

11.3.5. Postoperative systemic analgesia management

S.N.	Factors	Response
501	First analgesia request	_____ hours after surgery.
502	Postoperative standing systemic analgesics	A. Paracetamol B. Tramadol C. Diclofenac D. Morphine E. Pethidine F. Other specify_____
503	Specify doses, routes, and frequency.	_____
504	Break through pain	A. Yes B. No
505	If yes to 404, specify the time with NRS from the end of surgery	_____ hrs. _____ NRS
	If yes, specify analgesics given (name, dose, and route)	_____ mg
508	Do you have a headache	A. Yes B. No
509	If yes to 407, is it PDPH	A. Yes B. No

11.3.6. Environmental Factors

How would you describe the temperature of the postoperative room?	A. Too cold B. Comfortable C. Too warm
---	--

How would you rate the lighting in the postoperative area?	A. Too dim B. Adequate C. Too bright
Did the physical environment (e.g., noise, crowding, cleanliness) affect your comfort level?	A. Not at all B. Slightly C. Moderately D. Significantly

11.3.7. Post-operative pain assessment

Postoperative hours	Numerical rating score		Document any adverse effects (like Pruritus, respiratory depression, Nausea, vomiting, etc.)	PR	BP(systolic/dias
	At rest	On movement			
Immediately					
At 2hrs					
At 6hrs					
At 12hrs					
At 24hrs					
At 36hrs					
At 48hrs					
At 72hrs					

11.3.8. Patient satisfaction

Are you satisfied with pain management?	A. Yes B. No
If yes, how do you rate?	A. Strongly satisfied B. Satisfied C. Neutral D. Dissatisfied E.Strongly

	dissatisfied.
Would you prefer the same pain management method again in the future?	A. Yes B. No C. Not sure
Total morphine consumption (morphine equivalent)	_____mg

Source: A modified version of the questionnaire described by Lee et al. (2001) was utilized in this study.

Declaration of Investigator

I, the undersigned student of Master's in advanced clinical Anesthesia, declare that this thesis is my original work, submitted in partial fulfillment for the degree of Master's in advanced clinical Anesthesia, to the best of my knowledge.

Name of investigator: _____

Signature: _____

Date_____

Declaration of Advisors

We, the undersigned, hereby declare that we have carefully reviewed this thesis and provided guidance throughout. We confirm that this thesis is ready for defense with our approval as the university advisor(s), and to the best of our knowledge, the work presented meets the academic standards and is in partial fulfillment of the requirements for the degree of Master's in advanced clinical Anesthesia.

1. Name of Principal Advisor: _____

Signature: _____

Date: _____

2. Name of Co-Advisor1: _____

Signature: _____

Date: _____

3. Name of Co-Advisor2: _____

Signature: _____

Date: _____

4. Department head: _____

Signature: _____

Date: _____