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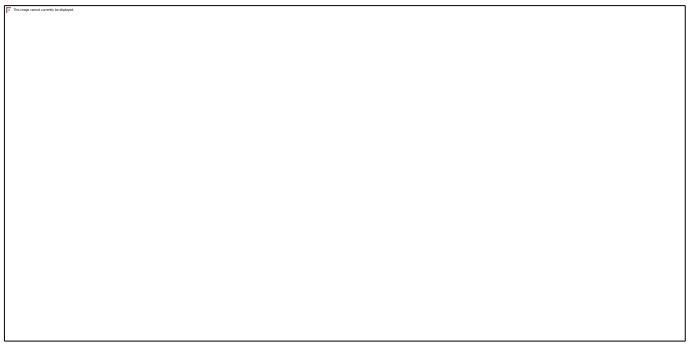
COLLEGE OF HEALTH SCIENCE

DEPARTMENT OF ANESTHESIA



COMPARING THE EFFECTIVENESS OF ULTRASOUND-GUIDED THORACIC PARAVERTEBRAL BLOCK VERSUS ERECTOR SPINAE PLANE BLOCK AS POSTOPERATIVE ANALGESIA IN ADULT PATIENTS UNDERGOING ELECTIVE OPEN UPPER ABDOMINAL SURGERY UNDER GENERAL ANESTHESIA AT TWO TERTIARY HOSPITALS, ETHIOPIA, 2025 G.C. A MULTICENTER PROSPECTIVE COHORT STUDY

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ASELLA, ETHIOPIA

ARSI UNIVERSITY COLLEGE OF HEALTH SCIENCE DEPARTMENT OF ANESTHESIA

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Title	Comparing the effectiveness of US-guided thoracic paravertebral block versus erector spinae plane block as postoperative analgesia in adult patients undergoing elective open upper abdominal surgery under general anesthesia at two tertiary governmental hospitals, Ethiopia, 2025 G.C. multicenter prospective cohort study
Duration of the Project	July–October, 2025 G.C.
Area of Study	Asella Teaching and Referral Hospital and Wolaita Sodo Comprehensive Specialized Hospital
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ABSTRACT

BACKGROUND: Managing pain well after surgery is an important part of perioperative care because untreated pain can have serious effects on the body, mind, and ability to function. Ultrasonography-guided thoracic paravertebral block and erector spinae plane block have become popular for their safety and ability to help avoid opioid use. However, there is still no agreement and local evidence comparing these methods in resource-limited settings. The purpose of this study was to compare the effectiveness of ultrasound-guided thoracic paravertebral block and erector spinae plane block as pain relief methods for adult patients who had elective open upper abdominal surgery.

METHODS AND MATERIALS: A multicenter prospective cohort study conducted at two tertiary hospitals in Ethiopia involved 76 adult patients who underwent scheduled open upper abdominal surgery under general anesthesia from July to October 2025 G.C. Participants were split into either the thoracic paravertebral block group or the erector spinae plane block group, based on the clinical assessment of the attending anesthetist. Data were gathered through interviews and structured questionnaires and analysed using SPSS version 26. The statistical methods utilised include chi-square or Fisher's exact test for categorical variables and Shapiro-Wilk and Levene's tests for assessing normality and variance homogeneity, respectively. Independent two-sample t-tests for group comparisons. A repeated measures ANOVA was employed to compare variations in visual analogue scale scores between groups over time.

RESULTS: The postoperative visual analogue scale scores at several time points at rest or during movement were comparable at several time points, specifically at 0h, 2h, 6h, and 24h, in the ESPB group compared with the TPVB group (except at 12h, $p < 0.001$). The time to first rescue analgesic was significantly lower in the ESPB group compared with the TPVB group (774.1±25.73 min, 748.1±32.99 min, $p<0.001$). Similarly, total analgesic consumption was lower in the ESPB group (38 mg [IQR9]) compared with the TPVB (38 mg [IQR37]), with a statistically significant difference ($p=0.001$). The incidence of postoperative nausea and vomiting was comparable between the two groups ($p>0.05$).

CONCLUSION: ESPB and TPVB provided comparable postoperative pain scores both at rest and during movement, except at the 12-hour mark. ESPB had a longer duration of analgesia before the first rescue analgesic and reduced total analgesic consumption within 24 hours compared with TPVB.

KEYWORDS: Erector Spinae Plane Block, Postoperative Pain, Thoracic Paravertebral Block, Visual Analog Scale, Upper Abdominal Surgeries

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Firstly, I want to thank God for all the grace, wisdom, and strength He has given me. This work would not have been possible without His help. I would like to thank Arsi University sincerely for its excellent research program, an integral part of the curriculum. I thank my advisors, Mr Abdurahman Tune, Kelifa Mama, and Abdi Oumer, as well as my Creator, for their valuable guidance and input during the preparation of this research thesis. I am also very grateful to my family and friends for always being there for me while I worked on this thesis. Finally, I want to thank the hard-working researchers and writers of the sources I have used.

Table of Contents

List of tables

List of figures

LIST OF ABBREVIATIONS

ACA	Advanced Clinical Anesthesia	Mg	Milligram
ASA	American Society of Anesthesiologists	NSAID	Non-Steroidal Anti-Inflammatory Drug
ATRH	Asella Teaching and Referral Hospital	NRS	Numerical Rating Scale
BMI	Body Mass Index	PACU	Post-Anesthesia Care Unit
CI	Confidence Interval	PONV	Postoperative Nausea and Vomiting
DBP	Diastolic Blood Pressure	PVB	Paravertebral Block
ERAS	Enhanced Recovery After Surgery	QoR	Quality of Recovery
ESPB	Erector Spinae Plane Block	RCT	Randomized Controlled Trial
ETB	Ethiopian Birr	SBP	Systolic Blood Pressure
GA	General anesthesia	SPSS	Statistical Package for Social Sciences
G.C.	Gregorian Calendar	TPVB	Thoracic Paravertebral Block
IASP	International Association for the Study of Pain	VAS	Visual Analogue Scale
ICB	Intercostal Nerve Block	WHO	World Health Organization
Kg	Kilogram		
MAP	Mean Arterial Pressure		

1. INTRODUCTION

1.1 Background information

According to the IASP, pain is an unpleasant sensory and emotional experience that is comparable to or related to actual or potential tissue damage (1). Pain management is an important part of perioperative care because pain that is not treated can have serious effects on the body, mind, and ability to function.

Patients who have surgery on their upper abdomen are more predisposed to moderate to severe pain because the tissue is cut, the diaphragm is irritated, and the thoracoabdominal nerve pathways are involved, which makes pain more sensitive (1,2)Poorly controlled pain after these kinds of procedures can slow down recovery, make lung function worse, keep patients in the hospital longer, and lead to chronic pain and more adverse effects from opioids (2). Factors that exacerbate acute postoperative pain include female gender, younger age, preoperative pain intensity, preoperative anxiety, and elevated stress levels. Increased pain levels are attributed to the type and duration of the surgery, the surgical techniques employed (open versus minimally invasive), and genetic predispositions (3).

Currently, pain relief after surgery includes systemic analgesics (both opioids and non-opioids), regional blocks, and multimodal analgesia methods. Select the regional strategy with the fewest issues to get the best results. Techniques for regional analgesia are becoming more and more crucial in multimodal analgesia strategies that try to reduce opioid use and enhance patient outcomes (4). For many years, TPVB has been utilised in upper abdominal and thoracic surgeries. Delivering local anaesthetics near the thoracic spinal nerves provides one-sided pain relief in the somatic and visceral (5). However, because TPVB is near the pleura and neuraxial structures, it must be performed carefully, as this can result in consequences like hypotension, vascular puncture, and pneumothorax (6).

The Erector Spinae Plane Block (ESPB) has recently become a safer and easier option. Forero et al. first talked about ESPB in 2016, It involves putting a local anesthetic in the fascial plane deep to the erector spinae muscle. This method can spread across multiple dermatomes and has worked well for both somatic and visceral pain relief, so it can be used for abdominal procedures (7,8)

Many factors can influence the effectiveness of TPVB and ESPB blocks, including injection volume, type and concentration of local anaesthetic, ultrasound approach (sagittal vs. transverse), adjuvant addition, block level, operator experience, anatomical differences, obesity, coagulopathy, local site infection, allergy to local anaesthetic, patient position, and surgical parameters (9–11). These variations may affect how long the block lasts, how frequently complications occur, and how consistently the pain is relieved.

Despite the abundance of global evidence, there is a paucity of studies in our country that directly compare TPVB and ESPB within a similar study population. A recent prospective cohort study conducted at Jimma University by Naser et al. (2024) found that TPVB was linked to prolonged pain relief, diminished postoperative visual analogue scores, and decreased opioid consumption compared to ESPB in upper abdominal surgery (12).

Another study conducted by Wubetu et al. (2025) at Wolaita Sodo University involved patients undergoing various upper abdominal surgeries. It was found that one-sided ESPB resulted in dramatically reduced postoperative pain scores and prolonged duration before the initial analgesic was required, in contrast to PVB. Patients receiving ESPB necessitated a reduced number of opioids within the initial 24 hours and exhibited lower median VAS scores between 3 and 24 hours (13). Consequently, the outcome findings from comparative studies have been contradictory. One study found that ESPB was superior to the alternative, whereas another study concluded that both blocks were either equally or less effective in minimising postoperative pain.

1.2 Statement of the problem

Postoperative pain after open upper abdominal surgery remains a serious challenge for clinical and public health systems, particularly in resource-limited areas such as Ethiopia. These procedures require large incisions, diaphragmatic irritation, and visceral manipulation, all of which lead to significant postoperative pain (14). Despite advances in pain management guidelines globally and the growing popularity of multimodal analgesia, various surgical patients continue to encounter moderate to severe postoperative pain. Gao et al. (2023) reported that over 47% of surgical patients experience considerable pain following their operations. The burden of postoperative pain is especially serious in African countries due to systemic challenges such as insufficient assessment, provider-deficient knowledge, drug shortages, and ineffective implementation of pain protocols (15).

The load of postoperative pain is especially severe in Ethiopia. Studies have shown over and over again that pain after surgery is common and not well managed. A study conducted at Addis Ababa University demonstrated that 82.2% of patients experienced postoperative pain, with 34.24% reporting moderate to severe pain. Also, more than 58% of patients did not get the right pain control (16,17). The findings indicated that postoperative care is a big problem, so it is important to find ways to manage pain that work for every patient.

Untreated postoperative pain after surgery offers serious challenges in clinical care and public health, restricting patient mobility and leading to complications such as atelectasis or pneumonia. This requires greater opioid use, which increases the risk of chronic pain and emotional distress. During extended periods of recovery, families face significant emotional and financial strains. Inadequate pain management leads to longer hospital stays, increased resource use, fewer bed turnovers, and higher costs, all of which burden the healthcare system. To resolve this problem in Ethiopia, it is critical to recognize and use safe and effective regional analgesia techniques for postoperative pain relief, like ESPB or TPVB. (18).

A lot of Ethiopian hospitals still use systemic opioids and NSAIDs as the main way to alleviate pain after surgery, but their problems with systemic medications are well known. Opioids can cause serious adverse effects like respiratory depression, nausea, vomiting, itching, and constipation. NSAIDs alone are often not enough to control surgical pain (16).

The World Health Organisation's pain managing ladder recommends the incorporation of regional nerve blocks within multimodal pain management strategies to enhance pain control and reduce opioid-related complications (19).

Ultrasound-guided thoracic paravertebral block (TPVB) and erector spinae plane block (ESPB) are two advanced techniques for pain control in upper abdominal procedures. TPVB targets spinal nerves near the vertebral column, but it has risks such as pneumothorax, vascular injection, and nerve damage. In contrast, ESPB is an alternative method which involves injecting local anesthetic into the fascial plane deep to the erector spinae muscle, allowing effective delivery to dorsal and ventral rami with increased safety and ease of use (20–24).

Although both blocks demonstrate effectiveness in diverse clinical settings, there is a scarcity of comparative data, especially from low-income countries. Certain research findings that TPVB has superior effectiveness for managing dynamic pain, while others say that ESPB is equally beneficial or advantageous for the reason it is safer and easier to use. Most of the studies that are already out there come from high-income countries with a wide range of patient populations, surgical methods, and healthcare systems. This makes it hard to use them in Ethiopian clinical settings (25–27).

Even though both TPVB and ESPB are used, there is not any agreement or local evidence in Ethiopia about which one is more suitable. There have not been enough direct contrasts between ESPB and TPVB, and only a few studies have examined how they can be used in Ethiopia. A study at Jimma University showed that both blocks could help with pain relief after surgery. Nevertheless this study also made it clear that more study is needed to find the best approaches intended for local use. Healthcare professionals don’t know which regional block is best for upper abdominal surgeries without adequate comparative data (12,13)

The objective of this study is to explicitly compare the effectiveness of ultrasound-guided ESPB and TPVB in adult patients undergoing elective open upper abdominal surgery in Ethiopia, thereby addressing the evidence gap. The results are anticipated to enhance postoperative pain outcomes in resource-constrained environments, support evidence-based practice, and inform clinical decision-making.

1.3 Significance of the study

This study aims to explore which treatment is more effective in relieving pain for adults following upper abdominal surgery at Asella Teaching and Referral Hospital and Wolaita Sodo University: ultrasound-guided TPVB or ESPB. The results of this study are expected to be advantageous for several different groups, as highlighted below.

Effective pain management following surgery is essential for patients' healing, reducing complications and enhancing overall satisfaction. This study may help professionals find better strategies to manage pain in patients after upper abdominal surgeries by determining which strategy, TPVB or ESPB, performs best. This could result in quicker recovery, earlier ambulation, and fewer complications after surgery. For caregivers, effective pain management makes postoperative care less physically and emotionally taxing, especially in places where resources are limited and family members are often the main caregivers. Using fewer opioids leads to a reduction in side effects such as nausea, constipation, and drowsiness, ultimately making the recovery process smoother and less burdensome.

The study aimed to offer anesthesia specialists and surgical teams valuable insights from comparisons, helping them decide on the most effective and beneficial regional anesthesia technique for their patients. Additionally, it could lessen the dependence on systemic opioids and the associated issues. Furthermore, it promotes the advancement of ultrasound-guided techniques, which enhances and advances the skills of healthcare providers. For researchers, the results will be useful for future researchers who study regional anesthesia, pain management, and the effects of surgery. This will help fill in the gaps in evidence in places where resources are limited and there is not a lot of this kind of data. It could also lead to more research on the long-term benefits, safety profiles, and cost-effectiveness of TPVB and ESPB in different types of surgery.

For hospitals, the research helps the hospital achieve its goal of providing high-quality, evidence-based medical care. It might be helpful to create or update institutional rules and procedures for dealing with pain after abdominal surgery. It fosters a culture of academic inquiry and research among staff and trainees, thereby enhancing the institution's reputation as a premier destination for medical studies and clinical research. Finding improved methods to handle pain can lead to cost savings, reduced hospital stays, and allow more patients to be treated, benefiting both the community and the healthcare system. The advantages allow the healthcare system to operate in a more effective and efficient manner. The research highlights

the importance of making regional analgesia consistent in practice, so that everyone can have fair access to safe and effective surgical care.

2. LITERATURE REVIEW

Adequate pain management after various abdominal surgeries remains the key element for the recovery and rehabilitation of patients. The impacts of not getting enough pain relief in this population are multifaceted: they include increased morbidity due to complications such as compromise of the respiratory system, delayed mobilisation, a higher risk of chronic pain development, functional decline, and prolonged hospital stay (9,10,28,29). Multimodal analgesic strategies, with an emphasis on opioid-sparing techniques, are increasingly advocated due to the well-recognised risks associated with opioid use—such as respiratory depression, gastrointestinal dysfunction, postoperative nausea and vomiting (PONV), and the potential contribution to the growing opioid epidemic (10, 30)

Ultrasound-guided TPVB and ESPB techniques are the alternative available options for postoperative pain management in upper abdominal surgeries. The TPVB, established over a century ago and refined throughout the 20th century, has been considered one of the gold-standard regional techniques for thoracic and upper abdominal surgeries. However, it poses technical difficulties with inherent risks that limit its routine use. In contrast, ESPB—introduced as recently as 2016—is advocated as an easier and safer alternative, designed to exploit the fascial pathways for a potentially wide and effective sensory blockade (14,28)

2.1 Postoperative pain among patients undergoing upper abdominal surgery

The International Association for the Study of Pain defines pain as an unpleasant physical and emotional experience that happens when tissue is injured (1). Gan et al. (2017) noted that postoperative pain is a huge problem in US healthcare, with more than 80% of patients not getting proper pain control. This pain causes worsened health outcomes, a decreased quality of life, longer recovery times, more use of opioids, and higher costs. In addition, acute postoperative pain can progress to chronic pain, necessitating the use of stronger pain relievers and anaesthetics. Traditional opioids are still the best way to treat acute pain, but they are difficult to dose and have unpleasant side effects (31).

A survey analysing three years of data collected from 26,193 patients in China found that 48.7% experienced moderate to severe postoperative pain, which affects the patients' recovery

and satisfaction. On the first day, 89% of patients received IV patient-controlled analgesia, and 68% who took systemic opioids, as well as nerve blocks, were rarely used (32).

A study done by Tano et al. (2021) in Ghana found that 138 patients underwent gastrectomy. It suggested that 50.7% had chronic pain for over 3 months but were satisfied with pain management. The type of analgesic, ways of pain relief, patients' ability to request more relief, and access to pain treatment information predicted satisfaction. Most patients admired their health care providers' pain management (33).

In Ethiopia, a prospective longitudinal study investigated how patients undergoing general, gynecologic, and orthopaedic surgery dealt with pain after the procedure. It found that 88.2% of patients were in moderate to severe pain, and 58.4% did not get enough treatment. Patients' worst pain levels were associated with chronic pain, but not with gender. The degree of pain did not predict the patients' level of satisfaction. The study discovered that many Ethiopian patients experience moderate to severe pain and functional impairment following surgery, and that the care they receive does not meet international standards and norms (16).

2.2 Anatomical Considerations (TPVB vs ESPB)

The thoracic paravertebral space (TPVS) is a wedge-shaped area adjacent to the vertebral column, bounded by the vertebral bodies, intervertebral foramina, parietal pleura, and superior costotransverse ligament. It contains critical structures such as the intercostal nerve, sympathetic chain, dorsal ramus, and intercostal vessels within fatty tissue. Local anaesthetic injections in this space provide unilateral somatic and sympathetic blockade across multiple thoracic dermatomes, allowing effective analgesia for both somatic and visceral pain. However, careful technique is required to minimise risks like pneumothorax and vascular injury, given its proximity to the pleura and spinal cord (14,34)

ESPB targets the fascial plane above the transverse process and below the erector spinae muscles with ultrasound guidance. For upper abdominal surgeries, a local anaesthetic is injected between these structures at thoracic levels T7–T9. This approach is considered safe since it is distant from the pleura and nerves, enabling the anaesthetic to disperse and inhibit nerve signals over multiple dermatomes. But it does not always work as well as direct thoracic paravertebral blocks in reaching the paravertebral space and treating deeper visceral pain. This depends on the amount of anaesthetic used and the person's anatomy (20,34).

2.3 Effectiveness of TPVB for postoperative analgesia

El-Boghdadly et al. (2016) conducted a systematic review in Toronto and showed that thoracic paravertebral blocks (TPVBs) are a common technique to manage pain during thoracic and

breast surgery, but it is still unclear how well they work for abdominal surgery. It found that TPVB had a lower pain level and required less opioids in the first few days following surgery when compared to systemic analgesia. However, there was poor information to make informed conclusions about the advantages of continuous TPVB methods or other peripheral block approaches. The main block had a 2.8% failure rate and a 1.2% complication rate (5).

A study conducted by Jemal et al. (2019) in Ethiopia, 78 patients who underwent open cholecystectomy examined two regional analgesic techniques, thoracic paravertebral block (TPVB) and intercostal block (ICB), and compared systemic analgesia. The results showed that both TPVB and ICB significantly reduced pain scores after surgery, with p-values < 0.001 when compared to the non-block group. Patients who received TPVB and ICB groups also requested painkillers later and used lower total analgesic consumption within 24 hours. Each block was found to be useful for controlling pain after an open cholecystectomy, but TPVB was superior at alleviating pain when coughing (21).

2.4 Effectiveness of ESPB for postoperative analgesia

A NICE Cochrane review from 2023 that looked at ESPB and other regional anaesthetic methods, like PVB, found low-certainty evidence that ESPB may not make postoperative pain worse at rest 24 hours after surgery compared to PVB. But it also suggested that ESPB might lower the number of adverse events related to the block (22).

Gao et al. (2022) did a meta-analysis in China that looked at how well ESPB worked in abdominal surgery compared to a placebo. The results showed that ESPB greatly lowered pain scores at 6, 12, and 24 hours after surgery, as well as 24-hour opioid use, and lengthened the time until the first rescue analgesia. The meta-analysis also showed that ESPB had lowered the incidence of PONV (23).

A meta-analysis reviewed in Ethiopia by Zewdu et al. (2024) compared the effectiveness of ESPB and transversus abdominis plane block in patients underwent laparoscopic cholecystectomy. Their findings indicated that ESPB was successful in lowering pain intensity, reducing morphine equivalent consumption, and minimising the time until the first pain relief request in the early postoperative phase (35).

A study demonstrated by Urmale et al. (2024) at Wolaita Sodo University in patients undergoing midline abdominal surgery. It found that patients who took ESPB used fewer opioids after surgery than those who took rectus sheath blocks. Patients who were given erector spinae plane blocks took longer to ask for their first painkiller than those who were given rectus

sheath blocks. There were no complications reported with the blocks in either group. They may also help patients heal faster in low- and middle-income countries (36).

2.5 Comparative Effectiveness of PVB and ESPB for Postoperative Analgesia

Yang G et al. (2024) performed a RCT in China involving 110 patients undergoing laparoscopic sleeve gastrectomy (LSG) to assess the impact of erector spinae plane block (ESPB) compared to paravertebral block (PVB) on recovery quality. Participants were allocated to undergo either each block at the T8 level while under general anesthesia. It found that there are no significant differences between the two blocks in terms of level of pain intensity, ambulation time, defecation time, total oxycodone use, or the occurrence of postoperative nausea and vomiting (PONV) within 24 hours (37).

An RCT was conducted in Türkiye to compare TPVB vs ESPB in patients who underwent elective laparoscopic cholecystectomy. In both techniques, ultrasound guidance was used to deliver 20 mL of 0.25% bupivacaine at the T-8 level. There were no significant differences between the groups in terms of demographics, complications, postoperative visual analogue scale scores, or analgesic needs ($p>0.05$). On the other hand, TPVB reported higher satisfaction scores ($P = 0.011$). The results show that although ESPB and TPVB have the same analgesic potency, ESPB is easier to use and more efficient than TPVB, making it an acceptable alternative (26).

Another study done in Turkey by Yilmaz et al. (2024) investigated ESPB and PVB in laparoscopic cholecystectomy. This study demonstrated that PVB was much better at controlling pain at rest and during coughing in the first few days after surgery than the control group. PVB also significantly lowers overall tramadol use than the control and ESPB groups. Suggested that PVB is more effective than ESPB for pain relief during laparoscopic cholecystectomy (38).

In a study conducted in Egypt, Mohamed et al. (2022) assessed the efficacy of paravertebral block (PVB) versus erector spinae plane block (ESPB) for post-operative pain relief after open cholecystectomy in 50 patients. Participants, who were ASA physical status I or II and ranged in age from 18 to 65, were split into two groups. One group received sonar-guided ESPB, while the other group received sonar-guided PVB. Both groups were given 20 mL of 0.5% bupivacaine while under GA. In comparison to the PVB group (371 ± 67 minutes), the ESPB group delayed their first use of rescue analgesic (416 ± 68 minutes) and reported lower VAS

scores at 4, 6, 12, and 24 hours after surgery. Sonar-guided ESPB is superior to PVB for managing pain after open cholecystectomy, as no notable side effects were observed (39).

A randomised study conducted in Egypt by Alansary et al. (2023) compared paravertebral block (PVB) and erector spinae plane blocks (ESPB) for postoperative pain relief following open splenectomy. Each block was associated with negative adverse effects, like pneumothorax and PONV. The result demonstrated that patients receiving either block reported lower VAS scores, lower analgesic consumption, and prolonged pain relief than the control group ($p<0.001$). Additionally, heart rate and MAP were lower post-block ($P<0.001$). While both blocks provided comparable pain relief, ESPB was reported as easier to perform (27).

There is a lack of local evidence in Ethiopia about which regional analgesia techniques were most effective for pain relief after upper abdominal surgery. A prospective study involving 78 patients demonstrated that ultrasound-guided unilateral erector spinae plane block (ESPB) is more effective than paravertebral nerve block (PVB) in alleviating pain following upper abdominal surgery in adults. Patients in the ESPB group reported lower visual analogue scores post-surgery, required their first rescue painkiller for a longer duration, and consumed significantly fewer opioids than those in the PVB group. The findings indicate that ESPB offers a superior alternative to paravertebral nerve blocks for surgical pain management (13).

A study conducted at Jimma University by Naser et al. (2024) found that TPVB and ESPB markedly diminished pain scores at rest and while coughing, leading to reduced analgesic use and an extended duration before analgesic request. Patients who received ultrasound-guided thoracic paravertebral block (TPVB) and erector spinae plane block (ESPB) required fewer total analgesics and needed rescue analgesics earlier. In comparison to ESPB, TPVB provided extensive coverage for rescue analgesics and better sustained postoperative pain alleviation (12).

2.6 Factors affecting the effectiveness of postoperative analgesia

Several factors influence the success rate of peripheral nerve blocks in alleviating postoperative pain. The effectiveness and duration of the block were affected by different factors, such as Patient factors, including obesity, anatomical variations, and comorbidities, as well as the type and location of surgeries that were also influenced.

The type of Local anaesthetic agent used, as well as the concentration, volume and dose, significantly influence the onset and duration of blockage. Perineural adjuvants substantially prolonged the effectiveness of nerve blocks and enhanced analgesia. Ultrasound guidance

greatly enhances block accuracy, success rate, and duration when compared to landmark or nerve stimulator techniques. Similarly, continuous catheter infusions can provide longer-lasting surgical analgesia than single-shot injections. These findings highlight the importance of carefully matching patient and surgical parameters with the appropriate anaesthetic, adjuvants, and block method for optimizing PNB analgesia (40–42).

2.7 Hypothesis

- ✓ **Null Hypothesis (H_0):** No significant difference exists in postoperative VAS pain scores at various time periods between patients undergoing ultrasound-guided TPVB versus those who received ESPB.
- ✓ **Alternative Hypothesis (H_1):** A notable disparity exists in postoperative VAS pain scores at various time intervals between patients undergoing ultrasound-guided TPVB compared to those who received ESPB.
- ✓

2.8 Conceptual Framework

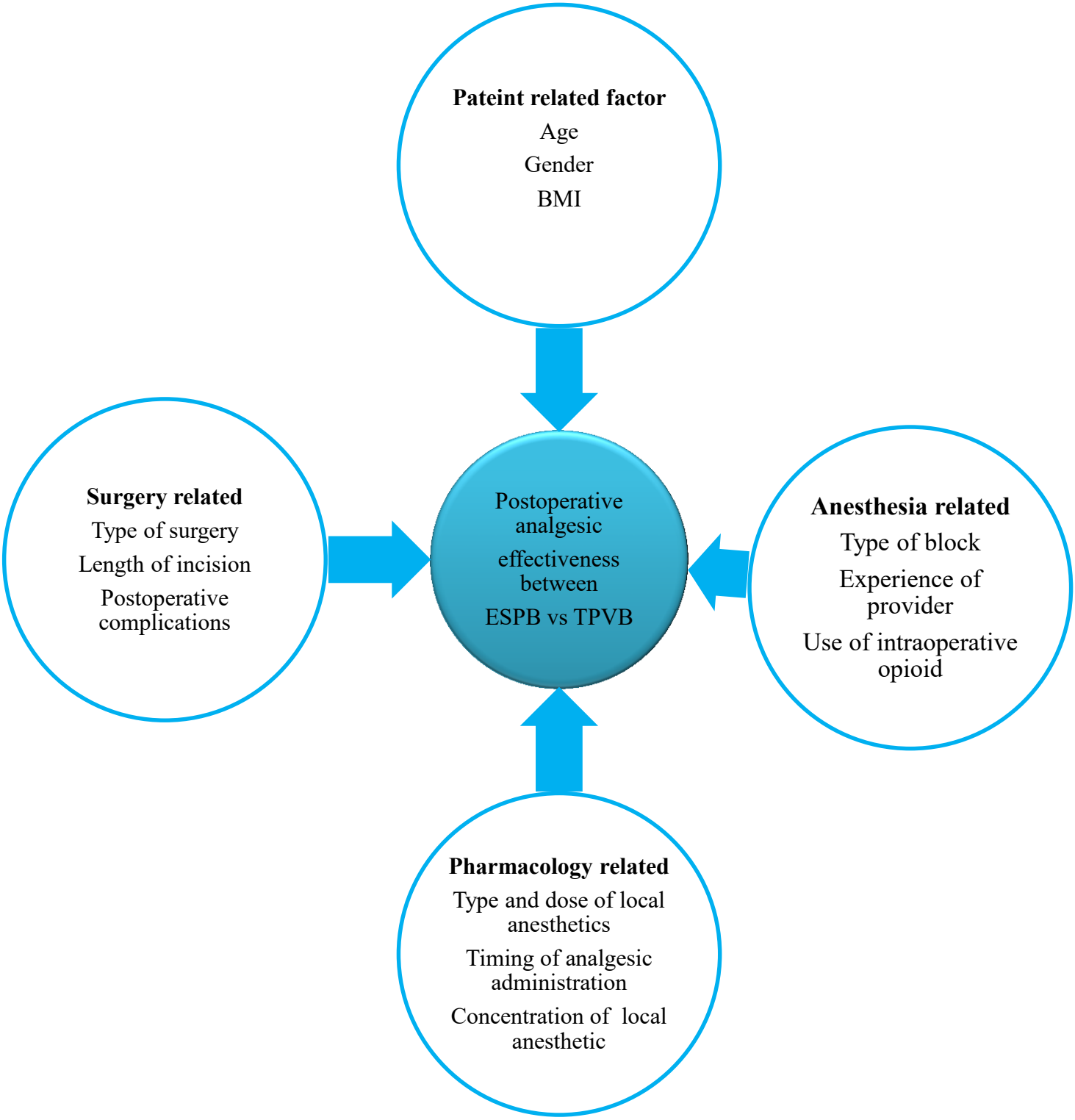

FIGURE 1: CONCEPTUAL FRAMEWORK(14)

3. RESEARCH OBJECTIVES

3.1 General objectives

- To compare the effectiveness of ultrasound-guided TPVB vs. ESPB as postoperative analgesia in adult patients undergoing elective open upper abdominal surgery under general anaesthesia at two tertiary governmental hospitals in Ethiopia from July to September 2025 G.C.

3.2 Specific objectives

- To compare the postoperative pain VAS scores at multiple time points at rest and during movement between the TPVB and ESPB groups from July to September 2025. G.C.
- To compare the time to first rescue analgesic between the TPVB and ESPB groups from July to September 2025 G.C.
- Compare the total analgesic consumption within the first 24 hours after surgery between the TPVB and ESPB groups from July to September 2025. G.C.

4. METHODS AND MATERIALS

4.1 Study Area and Period

The study was conducted at Arsi University, Asella Teaching and Referral Hospital, and Wolaita Sodo University's comprehensive specialised hospital. ATRH, founded in 1964, is located in the Arsi zone of the Oromia region and serves approximately 5 million people each year. It offers care in internal medicine, general surgery, orthopaedics, plastic surgery, neurology, obstetrics and gynaecology, paediatrics, and ophthalmology. The hospital has 321 beds, six operating rooms, and an ICU.

The Wolaita Sodo University Comprehensive Specialised Hospital (WSUCSH) was located in Sodo town, within the South Region of Ethiopia. It was founded in 1920 E.C. and serves approximately 3 million people. The hospital features four operating rooms and provides surgical intervention services. According to a quarterly report, the main operating room performed approximately 372 surgeries and orthopaedic procedures during the three-month period. These institutions were selected for the study due to their high patient flow, presence of trained anaesthesia professionals, capacity to implement ultrasound-guided regional analgesia techniques, and proximity to training facilities for health science students. The study was conducted from July to September 2025 G.C. and involved a representative sample of adult patients undergoing upper abdominal surgeries, following standardised perioperative protocols.

4.2 Study design

A multicenter, prospective, institutional-based cohort study was conducted from July to September 2025 G.C.

4.3 Population

4.3.1 Source Population

All adult patients undergoing elective open upper abdominal surgery under general anaesthesia.

4.3.2 Study Population

Adult patients meeting the inclusion criteria for elective open upper abdominal surgery under general anaesthesia and providing informed consent.

4.4 Eligibility criteria

4.4.1 Inclusion Criteria

- Age ≥18 years.
- Elective open upper abdominal surgery patients under general anaesthesia

- ASA physical status I-II.
- Patients who can understand and provide written informed consent

4.4.2 Exclusion Criteria

- Postoperative ICU admission
- Chronic opioid use
- Severe cardiopulmonary disease
- Neurological disorders affecting pain pathways
- History of chronic pain or psychiatric illness
- Patients with a BMI > 40 kg/m².
- Spinal deformities or anatomical abnormalities
- Major Intraoperative Complications

4.5 Sampling Technique and Sample Size Determination

4.5.1. Sample size calculation

Prior research was conducted in our country on the same population; however, the findings were not presented in figures (such as mean ± SD) because the data were not utilised for sample size calculation. After getting the sample mean and sample standard deviation of ESPB time to the first rescue analgesic requirement (416 ± 68 min) compared to PVB (371 ± 67 min) from the study done in Egypt, they were used to calculate the sample size (39). Sample size was calculated using G*Power version 3.1.9.7 with a two-tailed independent sample t-test, assuming an effect size of 0.667, 80% power, and alpha 5%. The output showed a minimum total sample size of 74 participants (37 per group). After adjusting for a 10% non-response rate, the final sample sizes were increased to 82 (41 per group).

4.5.2 Sampling technique

The systematic random sampling technique was used to get the required sample size during the study period. The situational analysis identified a total of 164 patients (100 from ATRH and 64 from WSUCSH) who met the inclusion criteria and underwent surgery during a 4-month period in late 2024, which coincided with the data collection timeline. A sample of 82 patients was chosen using a systematic random sampling method. A sampling k^{th} interval was calculated as K = N/n = 164/82 = 2, with the initial participant chosen by a lottery technique and every 2^{nd} patient subsequently included in the study. The assignment to each group was determined by the anaesthetist in charge, who planned to manage during the moment of surgery. These methods ensured randomisation while preserving the real-time data observation.

The two study sites were purposively selected depending on their patients' high surgical flow, availability of an ultrasound machine, and institutional willingness to participate. These criteria guarantee the viability of data collection and adequate disclosure to both block techniques.

Finally, 82 eligible adult patients were recorded, 50 from ATRH and 32 from WSUCSH. Whereas the number of eligible patients matched the required sample size during the study period, a complete enumeration strategy was employed. This allowed for proportional representation from each hospital, reflecting their respective surgical volumes. To reduce inter-institutional variability, procedures were evenly distributed across the two centres on the basis of their patient flow.

Using the proportionate allocation size (PAS) methodology to figure out the sample size, the number of samples from each hospital was found to be as follows:

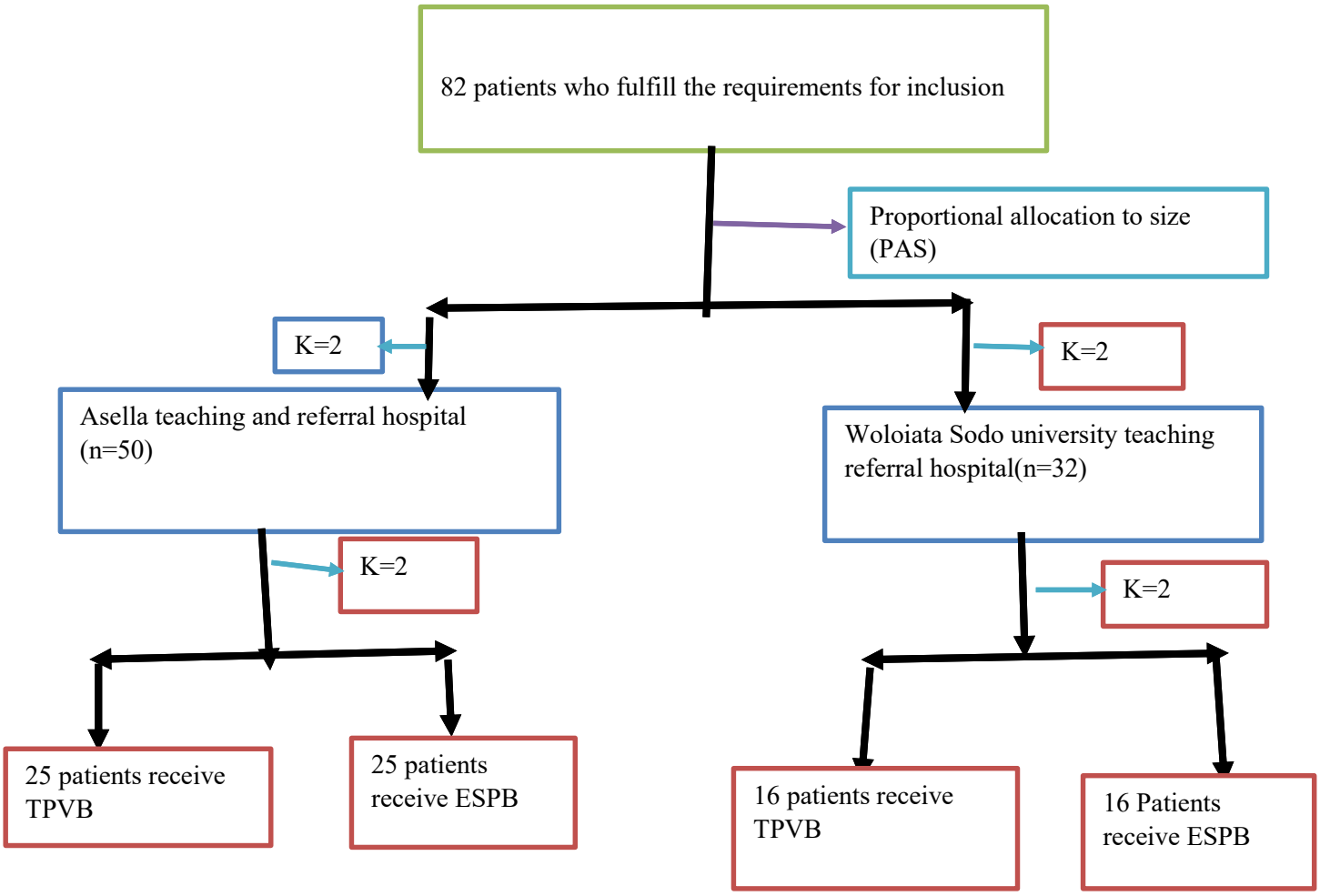

FIGURE 2: SAMPLING PROCEDURE FOR UPPER ABDOMINAL SURGERY AT ATRH AND WSUCSH.

4.6 Study variable

4.6.1 Dependent variables

Primary Outcomes: - VAS score

Time to first rescue analgesia

Total analgesia consumption

Secondary outcome: Incidence of PONV

4.6.2 Independent variables

❖ Sociodemographic factors (Age, Gender, ASA status, BMI)

❖ Surgery related variables:

- Types of procedures
- Surgery duration
- Type of opioid used
- Block type
- Experience of the anesthesia provider
- Length of incision
- Type, dose, and concentration of local anesthetic agent

4.6. Operational definitions

Effectiveness of Regional Block: The ability of TPVB or ESPB to provide adequate postoperative analgesia, measured by pain scores (VAS), time to first rescue analgesia, and total analgesic consumption within 24 hours.

Postoperative pain: The presence of pain in the postoperative period was characterized by a patient experiencing pain and registering any pain score above three within 24 hours of recovery.

Thoracic Paravertebral Block (TPVB): a regional analgesia technique that involves injecting local anesthetic into the thoracic paravertebral space, usually at the T7 level, to achieve unilateral somatic and visceral analgesia using ultrasound guidance.

Erector Spinae Plane Block (ESPB): A regional analgesia technique that involves injecting local anesthetic into the fascial plane deep to the erector spinae muscle at the thoracic level using ultrasound guidance to achieve multi-dermatomal coverage.

Failed block: no objective sensory changes within 30 min after the block or VAS≥4 within the first 2 hours postoperative despite the block.

Length of incision: the measured linear distances in centimeters of the surgical incision made during the procedure, recorded immediately after skin closure.

Duration of surgery: the time span in minutes from the initial skin incision to the final skin closure.

Concentration of local anesthetic: the percentage strength of the local anesthetic agent used in the block procedure.

Blinding: The process by which postoperative data collectors were kept unaware of the type of regional block administered to minimize observer bias.

Adopted from the National Initiative on Pain Control (NIPC)

Time to first analgesic request: is the duration of time in minutes from performing the block to the first analgesic request within 24 hours.

Total Analgesic Consumption: The total dose of analgesic drugs administered within the first 24 hours after surgery, measured in milligrams.

VAS score: a subjective tool used to assess the level of pain intensity a patient is experiencing. A 10 cm horizontal scale is used to measure pain intensity, where 0 indicates "no pain" and 10 indicates "worst imaginable pain." Patients mark their pain level at rest and during movement.

4.7 Data Collection procedures and tools

After training for data collectors, data were gathered using pre-tested questionnaires including closed-ended questions for respondents. All data collectors received training on the aim of the research, their interactions with patients, data collection tools, and the data collection procedures. As per institutional protocol, in the preoperative phase, all patients scheduled for upper abdominal surgery who met the inclusion criteria and provided informed consent underwent preoperative assessments, including detailed history-taking and evaluation of their

medical records. On the morning of the procedure, the data collector instructs the patient on how to self-assess pain using the eleven-point VAS scale, which spans from 0 to 10.

In the intraoperative phase, upon the patients' arrival in the operating theatre, standard hospital monitoring procedures were promptly implemented, including the recording of heart rate, noninvasive blood pressure, and SpO2 prior to the administration of general anaesthesia. Checked the IV line, then premedicated the patients. General anaesthesia was administered, and tracheal intubation was successfully performed. All patients were subjected to artificial ventilation, and an inhalation anaesthetic agent was employed to sustain anaesthesia. The anaesthetist responsible documented sociodemographic and intraoperative details, whereas the rest of the postoperative information was gathered by another data collector, who was unaware of the group allocated to reduce bias.

At the end of the procedures in two hospitals involved in the study, MSc anaesthesia trainees regularly rotate through various departments, ensuring they obtain adequate training in regional analgesia for effective postoperative pain management as part of multimodal analgesia. Both blocks were performed in a PACU under standard monitoring. In both hospitals, the management of postoperative pain following upper abdominal surgery is handled by either TPVB or ESPB, based on the anaesthetist's decision. The anaesthetist in charge chose the block based on their clinical judgment, considering the patient's medical history, anatomy, and the availability of resources to achieve the best results for the patient, reflecting real-world practice. Each block was typically performed using both single-injection and multiple-injection techniques guided by ultrasound; however, our study focuses solely on the single-injection technique at the T7 level thoracic dermatome for targeting a dermatomal spread from T5 to T9.

Each technique was performed under aseptic conditions using a high-frequency linear ultrasound transducer (6-13 MHz). Patients were positioned either sitting or in the lateral decubitus position, with the side to be operated on facing up. The linear probe was placed transversely, lateral to the spinous process, depending on the surgical site. In case of TPVB: The probe of ultrasound was moved laterally to identify anatomic landmarks such as, transverse process, costotransverse ligament, pleura, and paravertebral space. A 22-G echogenic needle was inserted using an in-plane approach. Correct needle placement was confirmed by hydrodissection with 1-2 mL of saline, which caused downward displacement of the pleura. Once confirmed, 0.25%-0.5% bupivacaine was injected in volumes of 15-25 mL; in our study, we used only 20 mL of 0.25% bupivacaine.

In case ESPB: The probe moved to identify the tip of the transverse process and the erector spinae muscle. The relevant anatomy, such as the trapezius, rhomboid major, erector spinae muscle, and transverse process, was confirmed. A 22-gauge echogenic needle was inserted in-plane in a cranial-to-caudal direction, targeting the fascial plane deep to the erector spinae muscle and superficial to the transverse process. After negative aspiration, 20 ml of bupivacaine (0.25%) was injected. Patients were monitored during and after the block for signs of LAST, pneumothorax, hypotension, block failure, and other complications. Appropriate resuscitation measures were available on-site in case of signs of adverse events.

After arriving in the recovery area and responding to verbal stimuli and answering questions, the sensory block was tested by unilateral pinprick feeling at the upper abdomen 30 minutes after administration. A failure block occurred if the operative side had no sensory block after 30 minutes. VAS was used to assess postoperative pain in all groups. The scale has horizontal lines from 0 (no pain) to 10 (worst agony). As soon as the patient fully responded to a vocal command, asked to report their pain using an 11-point VAS score. The VAS score was taken at recovery (up to 40 min) and at 2, 6, 12, and 24 hours after analgesia. Resting and voluntary coughing pain scores were taken. Time to first request after surgery and total analgesic use were documented from each patient's chart. Nausea, vomiting, hypotension, and respiratory problems were noted and treated after surgery.

4.8. Data analysis

The data were automatically checked for completeness, then downloaded and transferred to SPSS version 26. Categorical data were presented as numbers and frequencies (percentages), and continuous data were presented as mean ± SD or median (IQR).

The normality of data distribution was checked using the Shapiro-Wilk test, and the homogeneity of variance was determined using Levene's test (for age, weight, height, and BMI; $p > 0.05$). The mixed-design repeated measures ANOVA was used to analyze the postoperative VAS scores at multiple time points under two conditions between the TPVB and ESPB groups. For continuous variables (e.g., total analgesic consumption and time to the first rescue analgesia): After the data were normally distributed and the variances were equal between the two groups, we used an independent samples t-test. The Mann-Whitney U test was used for non-normally distributed data.

The chi-square test was used to compare proportions between two independent groups, while Fisher's exact test was used when expected cell counts were small. The life table, log-rank Kaplan–Meier survival curves, and Cox regression for variables were used to analyze the time until the first request for analgesics. In the case of continuous variables, normally distributed data were reported as mean ± standard deviation (SD), while non-normally distributed data were presented as median ± interquartile range (IQR). Categorical data were summarized as numbers and percentages. P-values less than 0.05 were considered statistically significant.

4.9. Data quality assurance

The principal investigator provided a one-day orientation to the data collectors on the study objectives, the electronic data collection instrument, and procedures for facilitating data collection. At the end of each day, the submitted forms were reviewed by the principal investigator for completeness, consistency, and accuracy, and then stored securely. A pretest study was conducted at Goba teaching and referral hospital on 5% of the sample size to test questionnaire clarity.

4.10. Ethical considerations

Ethical clearance was obtained from the Research Committee of Arsi University College of Health Science. Official support letters were written to two hospitals, and Permission was obtained from the Department of Anaesthesia to conduct the research. After explaining the aim and benefits of the study, written and verbal informed consent was obtained from each study participant, and their confidentiality was guaranteed throughout the study. Participants who were not willing to participate in the study or who wished to withdraw their participation at any stage were informed and allowed to do so without any restrictions.

4.11. Dissemination plan

The result of the research will be submitted to Arsi University, College of Health Sciences, Department of anaesthesia, the library, and others. The result will be presented at the College of Health Science through seminars, discussions, and meetings. Finally, after the defense of the thesis and correction for comments, the paper results will be published in online journals.

5. RESULTS

5.1 Demographic and Perioperative Characteristics

During the study period, 82 patients underwent upper abdominal procedures; six of these patients were excluded because they did not meet the inclusion criteria. Finally, 76 patients completed the study, with 38 in the ESPB group and 38 in the PVB group at the end of surgery for postoperative analgesia. (Figure 3)

The baseline sociodemographic and preoperative patient characteristics were similar between the TPVB and ESPB groups. The average age of the participants was 42.63 ± 12.061 years. The mean ages were comparable between the TPVB and ESPB groups (42.13 ± 12.079 and 43.13 ± 12.043 years, respectively), with no statistically significant difference ($p = 0.719$). The mean weights of the patients were comparable between the two groups. Among the study participants who underwent ESPB, nearly half (46%) were female, and the remainder were male; however, there was no statistically significant difference between the two groups. Nearly one-third (32.9%) of the participants who received TPVB were ASA 1, with a few being ASA 2 (17.1%). In the ESPB group, approximately 28.9% had ASA 1, and 21.1% had ASA 2 (Table 1).

Patients in the TPVB group had an average surgery time of 112.13 ± 14.11 minutes, while those in the ESPB group had an average surgery time of 115.26 ± 12.46 minutes. The TPVB group had a slightly shorter operative time, but the difference was not statistically significant ($p = 0.3$). Comorbid conditions were distributed similarly in both the TPVB and ESPB groups, ensuring baseline comparability. The most common comorbidities were controlled hypertension (6.6% of TPVB patients and 9.2% of ESPB patients) and controlled diabetes mellitus (6.6% of TPVB patients and 3.9% of ESPB patients). HTN + Asthma was found in 2.6% of TPVB patients and 3.9% of ESPB patients. HTN+DM was found in 2.6% of TPVB patients and 1.3% of ESPB patients. There were no statistically significant differences in the prevalence of comorbidities between the two groups ($p > 0.05$).

The two groups were similar in terms of gender, ASA physical status, weight, height, BMI, length of surgery, comorbidities, and baseline hemodynamic parameters like HR, MAP, and SpO_2 ($P>0.05$). This shows that they were the same at baseline.

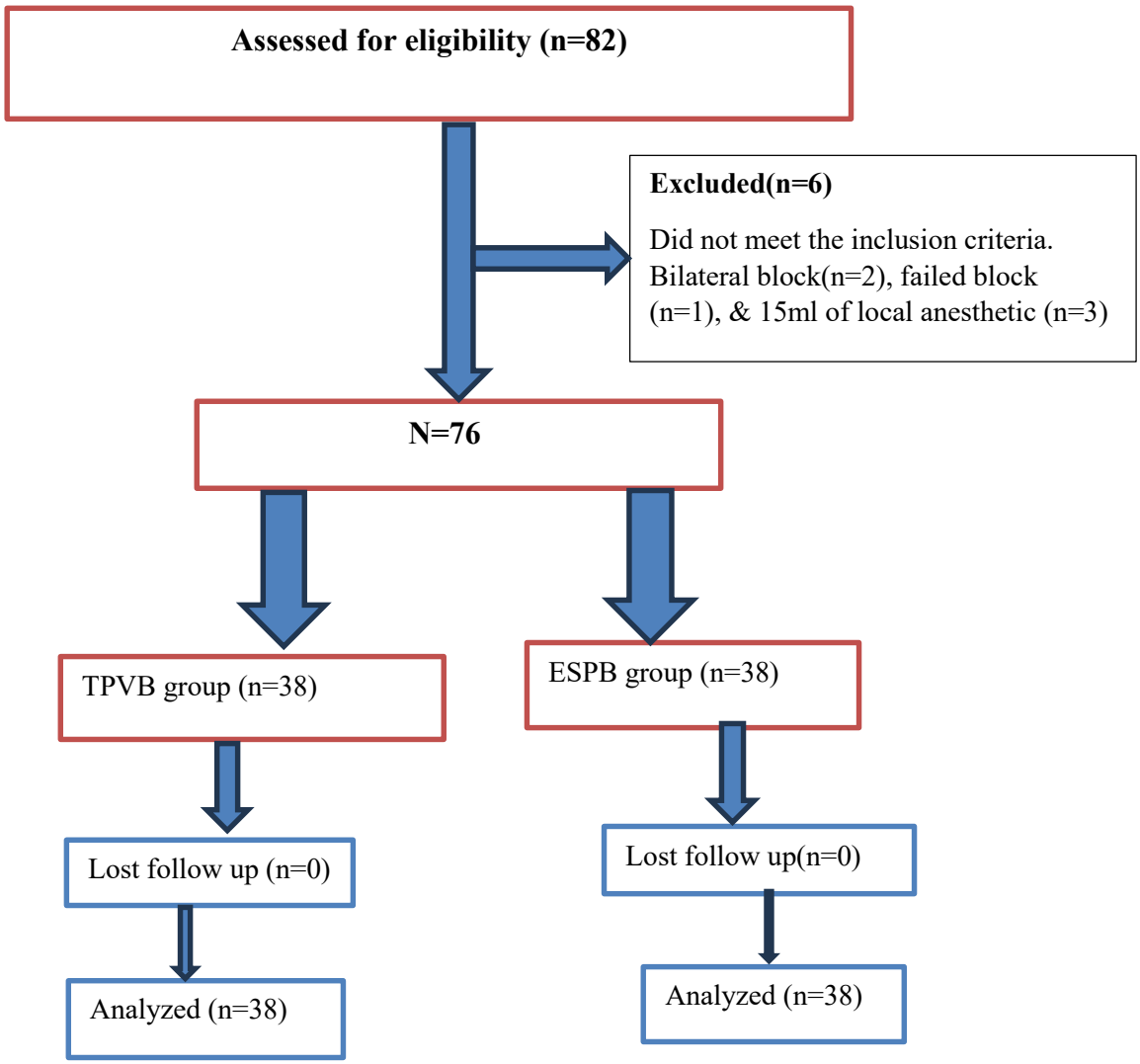

FIGURE 3: CONSORT FLOW DIAGRAM OF THE STUDY CASES THAT UNDERWENT UPPER ABDOMINAL SURGERY.

TABLE 1: SOCIODEMOGRAPHIC CHARACTERISTICS OF PATIENTS UNDERGOING UPPER ABDOMINAL SURGERY AT A TERTIARY HOSPITAL, ETHIOPIA, 2025 (N=76)

Category		TPVB (n=38)	ESPB (n=38)	P-value
		Mean ± SD	Mean ± SD	
Age*		42.13±12.079	43.13±12.043	0.719
Gender (F/M)	Female	30 (39.5%)	32 (42.1%)	0.554
	Male	8 (10.5%)	7 (7.9%)	
ASA	ASA1	25 (32.9%)	22 (28.9%)	
	ASA2	13 (17.1%)	16 (21.1%)	

Weight (kg)*		63.96±9.88	65.69±8.68	0.418
Height (m) *		1.66±0.068	1.64±0.068	0.238
BMI*		23.45±2.561	24.26±3.003	0.205
Baseline MAP (mm Hg) *		79.63±5.037	80.052±5.908	0.739
Baseline HR (bpm)*		77.105±6.374	77.973±6.635	0.562
Spo2 baseline *		96.93±0.819	96.447±0.921	0.360
Duration of surgery (min)*		112.13±14.11	115.26±12.46	0.309
Comorbidities	Yes	16 (21.1%)	17 (22.4%)	0.817
	No	22 (28.9%)	21 (27.6%)	
	Controlled HTN	5 (6.6%)	7 (9.2%)	
	Controlled DM	5 (6.6%)	3 (3.9%)	
	Controlled asthmatic	0	4 (5.3%)	
	HTN+Asthma	2 (2.6%)	3 (3.9%)	
	HTN+DM	2 (2.6%)	1 (1.3%)	
	Other diseases	2 (2.6%)	1 (1.3%)	

*Hint: ESPB—erector spinae plane block, TPVB—thoracic paravertebral block. * mean and standard deviation, analyzed by an independent t-test*

Cholecystectomy was the most common procedure performed in both groups (73.7% in the ESPB group vs. 78.9% in the TPVB group), while the remaining procedures were rare. Other procedures, such as gastrectomy and hepatic hydatid cyst excision, were more evenly distributed across groups. For example, 7.9% of TPVB cases and 10.5% of ESPB cases underwent gastrectomy, while 7.9% of cases in both groups underwent hydatid cyst excision. There were also 5.3% of patients in TPVB and 7.9% of patients in ESPB who had other upper abdominal surgeries. This demonstrates that the types of surgeries were relatively similar across groups (Figure 4).

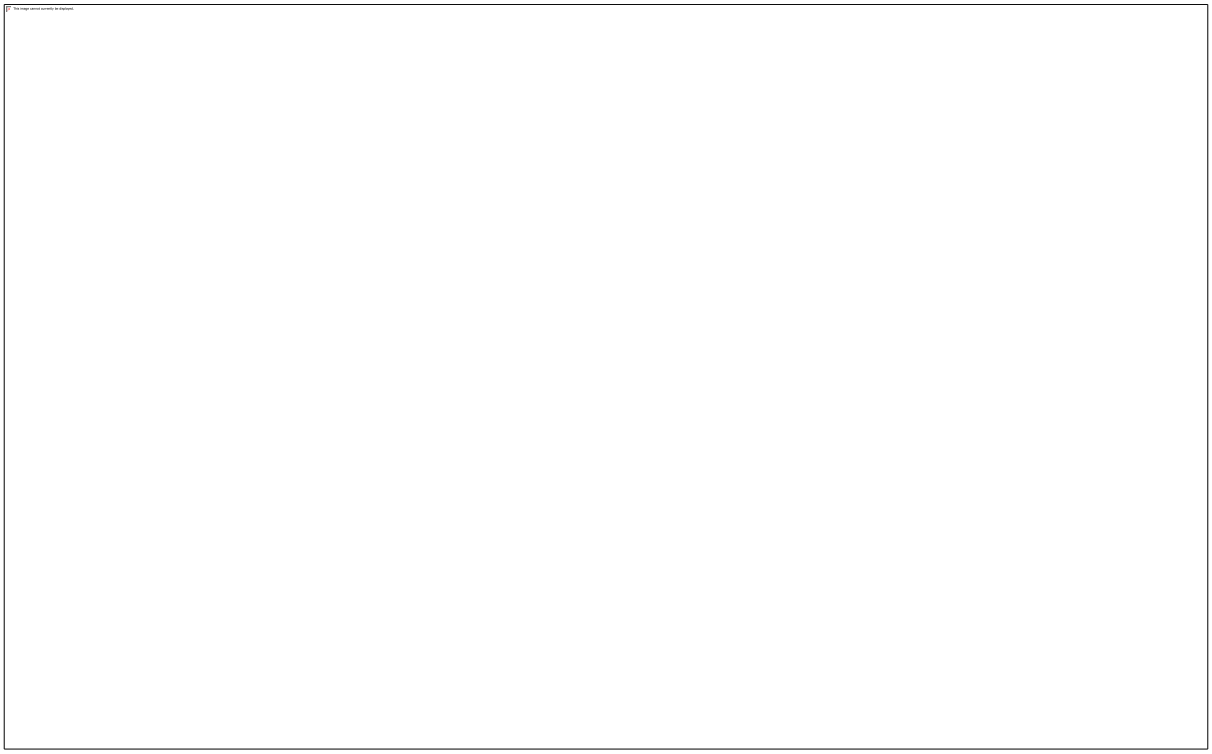

FIGURE 4: BAR CHART OF TYPE OF UPPER ABDOMINAL SURGERY AT TWO TERTIARY HOSPITALS, ETHIOPIA, 2025 (N=76)

TABLE 2: INTRAOPERATIVE PARAMETERS AND ANESTHETIC CHARACTERISTICS OF PATIENTS UNDERGOING UPPER ABDOMINAL SURGERY AT TWO TERTIARY HOSPITALS, ETHIOPIA, 2025 (N=76)

		TPVB (n=38)	ESPB (n=38)	P-Value
		Mean ± SD	Mean ± SD	
Intraop HR		77.97±5.548	80.18±5.066	0.74
Intraop MAP		76.41±3.584	77.61±5.011	0.24
INTRAOP Spo2		96.63±0.819	96.45±0.921	0.360

Length of incision		10.31±1.00	10.19±1.06	0.619
Induction agent	Ketamine	6 (7.9%)	8 (10.5%)	0.714
	Propofol	18 (23.7%)	19 (25%)	
	Ketofol	14 (18.4%)	11 (14.5%)	
Analgesic agent	Morphine	11 (14.5%)	11 (14.5%)	0.176
	Pethidine	23 (30.3%)	17 (22.3%)	
	Pethidine & diclofenac	4 (5.2%)	10 (13.2%)	
Experience of anesthetists	M.Sc. staff	1 (1.3%)	3 (3.9%)	P=0.331
	M.Sc. year 2	9 (11.9%)	5 (6.6%)	
	M.Sc. year 1	28 (36.8%)	30 (39.5%)	

The intraoperative heart rate after induction was 80.18 ± 5.07 bpm in the ESPB group and 77.97 ± 5.55 bpm in the TPVB group ($p = 0.74$). Mean arterial pressure (MAP) after induction was 77.61 ± 5.01 mmHg in ESPB and 76.41 ± 3.58 mmHg in TPVB ($p = 0.24$). Oxygen saturation (SpO_2) remained constant in both groups at mean values of $96.63 \pm 0.82\%$ and $96.45 \pm 0.92\%$, respectively ($p = 0.360$) (Table 2).

Only 7.9% of study participants who experienced TPVB were induced with ketamine, whereas the majority (23.7%) were induced with propofol. One-fourth of the patients who received ESBP had propofol induction, whereas 10.5% had ketamine induction. The overall variations in the induction agent were not statistically significant ($P = 0.714$). Each group received the same amount of morphine (14.5%). ESPB used pethidine and diclofenac together more often (13.2%) than TPVB (5.2%), while TPVB used pethidine more often (30.3%) than ESPB (22.3%). According to Table 2, the overall variation in analgesic use was not statistically significant ($p = 0.176$) (Table 2).

M.Sc. Year 1 anesthetists performed the most procedures in both groups (36.8% in TPVB and 39.5% in ESPB), followed by M.Sc. Year 2 staff (11.8% and 6.6%, respectively). Senior M.Sc. Staff contributed a small percentage of cases (1.3% in TPVB vs. 3.9% in ESPB). The anesthetist experiences of the TPVB and ESPB groups did not differ statistically significantly overall ($p = 0.331$) (Table 2).

The average length of the surgical incision was similar for both groups, measuring 10.31 ± 1.00 cm for TPVB and 10.19 ± 1.06 cm for ESPB (p = 0.619).

Postoperative analgesic requirements

The TPVB and ESPB groups both took about the same amount of tramadol, with a median dose of 50 mg in each group (p = 0.329), which means that there was no significant difference in the need for opioids. The TPVB group used significantly more diclofenac (median 37 mg) than the ESPB group (median 9 mg), indicating that TPVB patients required more non-opioid supplements (p = 0.025). These findings show a statistically significant disparity in diclofenac use, whereas tramadol requirements were consistent across groups.

The Mann-Whitney U test revealed a statistically significant difference in the amount of diclofenac administered between the TPVB (median = 38, IQR = 37) and ESPB (median = 38, IQR = 9) groups. The ESPB group needed much less pain relief (U = 541, z = -2.24, p = 0.025). The Mann-Whitney U test found no significant difference between the TPVB (median=50, IQR=50) and ESPB (median=50, IQR=38) groups for the use of rescue tramadol (u=390, z=-0.977, p=0.329).

TABLE 3: COMPARING RESCUE ANALGESIA AND TOTAL ANALGESIA CONSUMPTION BETWEEN PATIENTS WHO TAKE PARAVERTEBRAL BLOCK VERSUS ERECTOR SPINAE PLANE BLOCK AT TWO TERTIARY HOSPITALS, ETHIOPIA, 2025 (N=76)

		TPVB (n=38)	ESPB (n=38)	P-value
		Mean ± SD	Mean ± SD	
Time to first rescue analgesic*		748.1 ± 32.99	774.1 ± 25.73	0.000
Total tramadol consumption**		50 (38)	50 (38)	P=0.329
Total diclofenac consumption**		38 (37)	38(9)	P=0.025

Hint: TPVB- thoracic paravertebral block, ESPB- erector spinae plane block, one star (*) shows mean ± standard deviation, and two stars (**) show median (interquartile range).

The average time to the first rescue analgesia was much longer in the ESPB group (774.1 ± 25.73 minutes) than in the TPVB group (748.1 ± 32.99 minutes). This means that ESPB provided better and longer-lasting pain relief after surgery (p = 0.000). Kaplan-Meier survival analysis was used to look at the time it took to get the first rescue analgesic. All of the patients needed rescue analgesia within 24 hours, so there was no censoring. The average time to the first rescue analgesic was much longer in the ESPB group than in the TPVB group (774.1 minutes (765.9–782.3) vs. 748 minutes (737.6–758.6)). The log-rank test showed that the groups were not the same (X^2=9.66, df=1, p=0.002). The Kaplan-Meier survival curve demonstrated that patients in the ESPB group sustained analgesia for an extended period prior to necessitating rescue medication, in contrast to those in the TPVB group (figure 5).

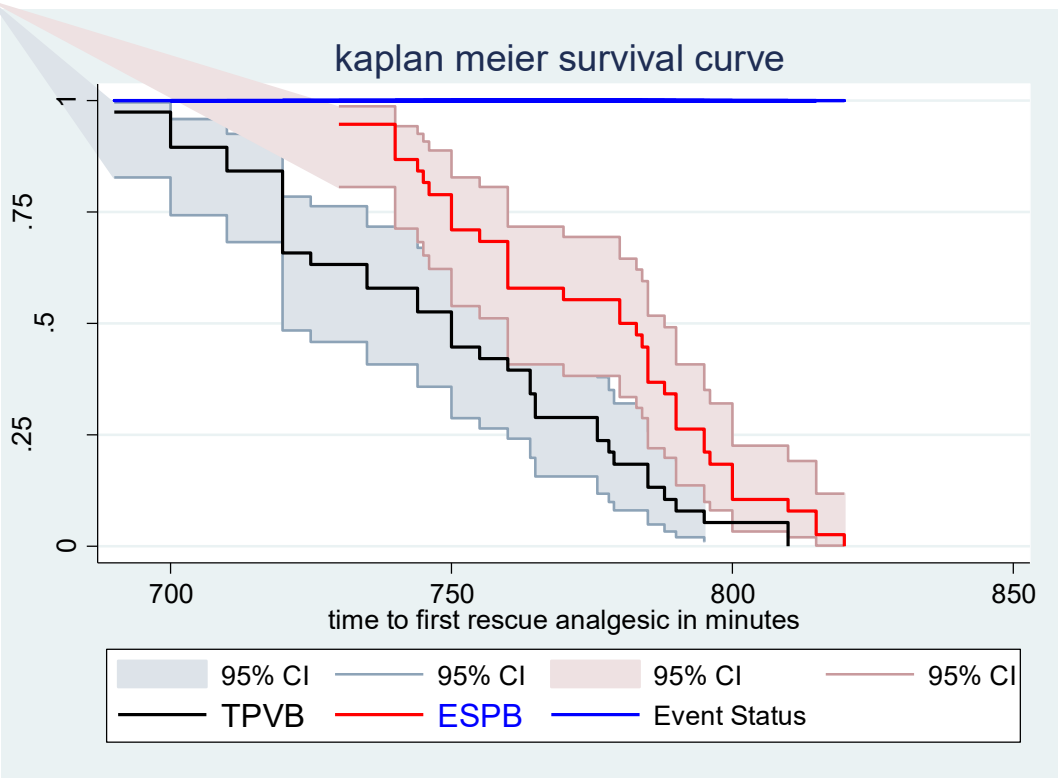

FIGURE 5: KAPLAN-MEIER SURVIVAL FOR TIME FROM BLOCK PERFORMED UNTIL FIRST RESCUE ANALGESIC ADMINISTRATION OF PATIENTS WHO TAKE THORACIC PARAVERTEBRAL BLOCK VERSUS ERECTOR SPINAE PLANE BLOCK AT TWO TERTIARY HOSPITALS, ETHIOPIA, 2025 (N=76)

In the TPVB group, 8 patients (10.5%) experienced postoperative nausea and vomiting (PONV), while in the ESPB group, 4 patients (5.3%) experienced the same condition. Most patients did not experience PONV: 30 (39.5%) in TPVB and 34 (44.7%) in ESPB. PONV was

slightly less common in the ESPB group, but the difference was not statistically significant, indicating that the two block techniques had similar safety profiles (Figure 6).

FIGURE 6: BAR CHART OF POSTOPERATIVE NAUSEA AND VOMITING AMONG PATIENTS WHO TAKE THORACIC PARAVERTEBRAL BLOCK VERSUS ERECTOR SPINAE PLANE BLOCK AT TWO TERTIARY HOSPITALS, ETHIOPIA, 2025 (N=76)

A repeated-measures mixed-design ANOVA was conducted to analyze postoperative pain VAS scores at five intervals (0, 2, 6, 12, and 24 hours) under two conditions (rest and movement) across two intervention groups (TPVB and ESPB).

Mauchly's test showed that the assumption of sphericity had been broken for the main effect of time and time*condition: X2(9) = 50.83, P < 0.001, and X2(9) = 24.76, P = 0.003. Because of this, the corrected tests by Huynh-Feldt and Greenhouse-Geisser (̃ = 0.860 and 0.705, respectively) were reported. Main Effects: Pain scores exhibited statistically significant main effects for time ($F(2.82, 208.81) = 271.97$, $p = 0.000$, partial $\eta^2 = 0.79$), group ($F(1, 74) = 65.49$, $p = 0.000$, partial $\eta^2 = 0.47$), and condition (rest vs. movement) ($F(1, 74) = 138.13$, $p = 0.000$, partial $\eta^2 = 0.97$), indicating substantial variation over time, between block types, and between rest and movement conditions. The type of block and the condition under which pain was measured were found to have an impact on the trajectory of pain scores over time. Significant

interactions were found between time and condition (F (3.68, 272.25) = 12.57, p = 0.000, partial $\eta^2 = 0.15$), as well as between time and group (F (4, 296) = 18.58, p = 0.000, partial $\eta^2 = 0.20$). The effects of time, condition, and block type did not seem to change the pain pathways because there was no significant interaction between condition and group (p = 0.58) or the three-way interaction (time × condition × group) (p = 0.583). These results suggest that although ESPB and TPVB have different responses to movement and temporal analgesic profiles, their relative performance in rest versus movement conditions is constant over time.

TABLE 4: REPEATED MEASURES ANOVA PAIN SCORES AT REST AND MOVEMENT OVER TIME (TPVB VS ESPB)

Effect	F	Df1, df2	P-value	Partial η^2
Time (0, 2, 6, 12, 24 h)	271.97	2.82, 208.81	0.000	0.79
Group (TPVB vs ESPB)	65.49	1, 74	0.000	0.47
Condition (rest vs movement)	138.13	1,74	0.000	0.97
Time*condition	12.57	3.68, 272.25	0.000	0.15
Time*group	18.58	4, 296	0.00	0.20
Condition*group	0.31	1, 74	0.58	0.004
Time*condition*group	0.71	4, 296	0.583	0.01

Block performed * Time * Condition

Measure: VAS score

Block type	Time	Condition	Mean	SD error	95% CI	
					LB	UB
TPVB	0hr	rest	4.500	.118	4.266	4.734
		movement	5.447	.104	5.241	5.654
	2hr	rest	1.947	.146	1.657	2.237
		movement	2.579	.120	2.339	2.819
	6hr	rest	1.316	.161	.995	1.637
		movement	2.079	.172	1.735	2.423
	12hr	rest	3.921	.119	3.685	4.158

		movement	4.947	.118	4.713	5.182
	24hr	rest	3.842	.083	3.677	4.007
		movement	4.789	.096	4.598	4.981
ESPB	0hr	rest	4.737	.118	4.503	4.971
		movement	5.632	.104	5.425	5.838
	2hr	rest	1.816	.146	1.526	2.106
		movement	2.474	.120	2.234	2.714
	6hr	rest	.921	.161	.600	1.242
		movement	1.632	.172	1.288	1.975
	12hr	rest	2.237	.119	2.000	2.473
		movement	3.158	.118	2.923	3.392
	24hr	rest	3.789	.083	3.624	3.955
		movement	4.816	.096	4.624	5.007

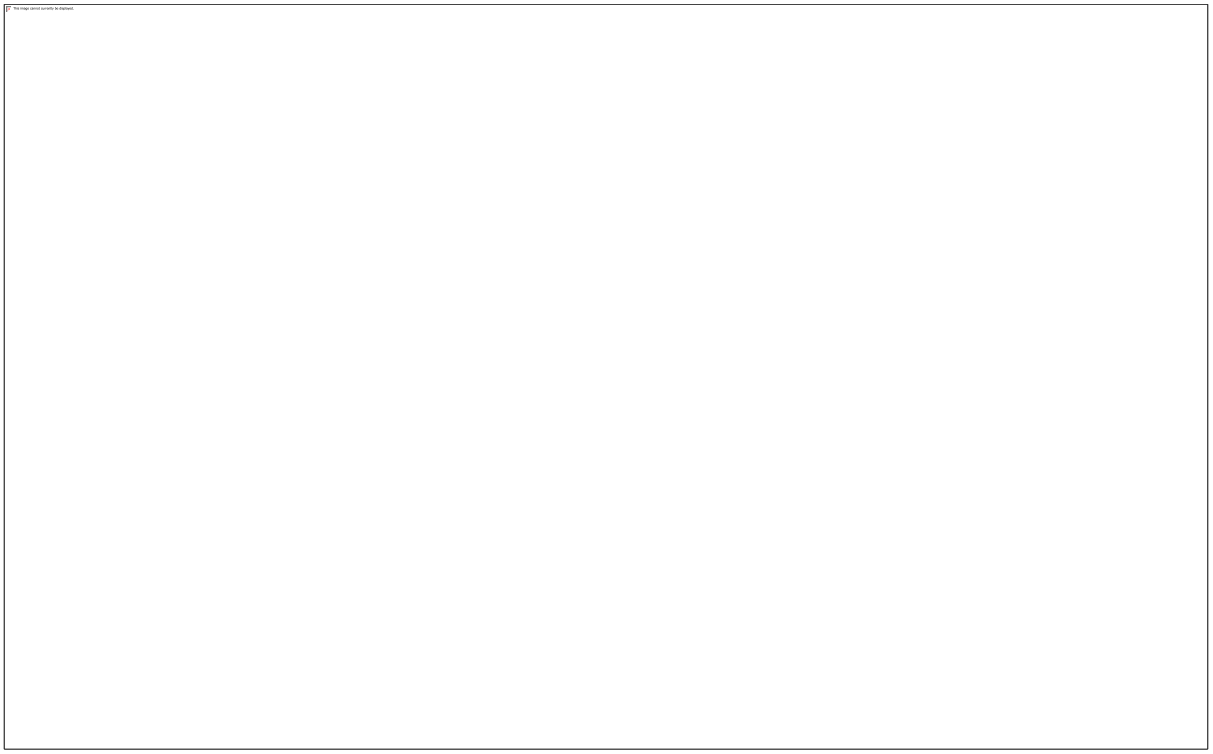

FIGURE 7: GRAPH OF POSTOPERATIVE VAS SCORE AT REST IN PATIENTS UNDERGOING UPPER ABDOMINAL SURGERY AT TWO TERTIARY HOSPITALS IN ETHIOPIA, 2025 G.C

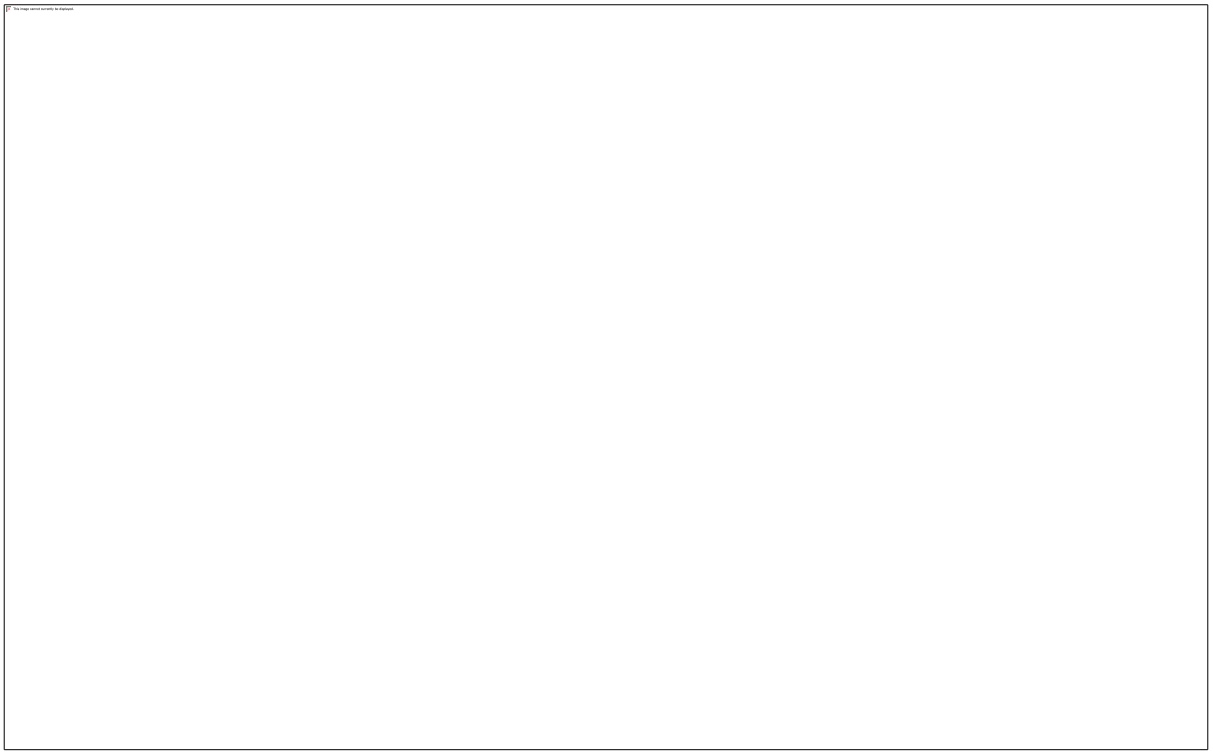

FIGURE 8: POSTOPERATIVE VAS SCORE DURING MOVEMENT IN PATIENTS UNDERGOING UPPER ABDOMINAL SURGERY AT TWO TERTIARY HOSPITALS IN ETHIOPIA, 2025 G.C

6. DISCUSSION

This prospective multicenter cohort study examined the effectiveness of ultrasound-guided in-line plane unilateral TPVB and ESPB at T7 in assisting adults undergoing planned upper abdominal surgery. Outcomes assessed included postoperative pain scores (VAS), total analgesic consumption, time to first rescue analgesic within 24 hours after surgery, and complication rates. Both techniques were performed as single-injection, unilateral blocks using 20 mL of 0.25% bupivacaine at a single thoracic dermatome level.

Our study showed that both TPVB and ESPB were effective in relieving pain after surgery, with clinically significant drops in VAS scores during the first 24 hours. Patients in the ESPB group had slightly lower pain scores than those in the TPVB group at most time intervals. This difference may be because the ESPB group was better able to spread out 20 ml of bupivacaine at a single-level injection. At rest and during dynamic motion, though, VAS scores were the same in both groups at 0, 2, 6, and 24 hours.

A study by Bezen et al. (2024) indicated no significant differences between the ESPB and TPVB groups regarding demographic characteristics (age, gender, comorbidities), postoperative pain scores (at rest and during movement), incidence of nausea and vomiting, complication rates, block application duration, or time to first rescue analgesia ($p>0.05$). The findings revealed that the two approaches were clinically similar in a variety of outcome areas (26). The noted discrepancy could result from differences in surgical methods, block techniques, or sample attributes.

In contrast to our findings, a recent study by Yang et al. indicated no significant differences between the ESPB and TPVB groups regarding postoperative pain scores, cumulative oxycodone consumption, or the incidence of postoperative nausea and vomiting. Furthermore, no complications associated with nerve blocks were noted in either group. These findings indicate clinical equivalence between the two techniques in terms of analgesic effectiveness and safety (37). The discrepancy from our study may be due to variations in surgical context, analgesic protocols, or outcome sensitivity. Their study may have encompassed a wider array of abdominal procedures or employed varying pain assessment intervals; however, our cohort concentrated exclusively on elective upper abdominal surgeries utilizing standardized block techniques and repeated measures analysis.

A study by Alansary et al. (2024) in patients undergone open splenectomy, comparing ultrasound-guided ESPB and TPVB found that both methods reduced overall opioid consumption and associated side effects while also providing sufficient postoperative analgesia. However, it was demonstrated that ESPB was more effective and technically simpler with a single injection, while TPVB needed a two-level injection to produce comparable results (27). These results are consistent with our research, which indicated that ESPB managed to slightly lower pain scores, a longer time to first rescue analgesia, and a lower consumption of diclofenac when compared to those received TPVB. Because ESPB requires one injection and targets a more superficial anatomical target, its technical simplicity makes it especially useful in environments with limited resources. Its increasing popularity and reproducibility in a variety of surgical contexts could be attributed to its simplicity of use.

A recent study investigated by Wubetu et al. (2025) in patients undergone upper abdominal surgery demonstrated that postoperative VAS scores were significantly lower in the ESPB group at 3, 6, 12, and 24 hours postoperatively ($p < 0.05$). The ESPB group experienced a longer duration until the first rescue analgesia (mean 16.8 hours; 95% CI, 14.9–18.5) compared to the TPVB group (mean 13.1 hours; 95% CI, 11.9–14.3; $p = 0.03$) and exhibited significantly reduced opioid consumption within the initial 24 hours (13). These findings are remarkably comparable to those of our findings, which indicated that ESPB offered greater pain reduction, longer pain relief, and reduced the need for additional pain relief than TPVB. The consistency of these outcomes validates the clinical role of ESPB in upper abdominal surgeries, notably in enhancing recovery and lowering opioid-related negative effects.

Naser et al. conducted a comparative study demonstrating that both regional techniques (TPVB vs ESPB) significantly diminished postoperative numeric rating scale (NRS) pain scores at 4, 6, 12, and 24 hours, both at rest and during coughing ($p < 0.001$), and were correlated with reduced total analgesic consumption ($p < 0.001$). The time to first rescue analgesia was longer in the TPVB group (median 15 hours; 95% CI, 14.27–15.72) than in the ESPB group (median 7 hours; 95% CI, 5.98–8.01), suggesting that TPVB may provide more prolonged analgesia (12). These results partially contradict our study, which showed that ESPB provided a longer duration of analgesia (mean 774.1 minutes compared to 748.1 minutes for TPVB, $p = 0.000$) and reduced adjunct analgesic consumption (diclofenac 9 mg versus 37 mg, $p = 0.025$). The discrepancy could be due to how the block was administered (for example, single or bi-level injection), the type of surgery, or the patient. In our group of patients who underwent upper

abdominal surgery, ESPB may have performed better because it covered more dermatomes or provided better visceral pain alleviation.

A meta-analysis by Fenta et al. found that TPVB significantly reduced pain scores during movement 12 hours post-surgery and resulted in less opioid use during the first 24 hours compared to ESPB. However, there was no significant difference between the two groups in the incidence of postoperative nausea and vomiting or the time to first rescue analgesia ($p > 0.05$) (43). Our results, which showed that ESPB was associated with slightly lower pain levels, a longer time to initial rescue analgesia, and a lower use of adjunct analgesics (e.g., diclofenac) than TPVB in patients undergoing upper abdominal surgery, partially contradict these findings. The differences in the surgical setting, block technique, or patient population may be the cause of the discrepancy. The meta-analysis merged data from various procedures and institutions, while our study focused on elective upper abdominal surgeries using standardized ultrasound-guided block protocols.

A study by Khot et al. (2023) Comparing ESPB and TPVB found no significant differences in demographic variables, postoperative pain scores, time to first rescue analgesia (mean 16.6 h for TPVB vs. 16.3 h for ESPB, $p = 0.95$), or total analgesic doses used ($p > 0.05$). The time it took to do TPVB, on the other hand, was much longer than the time it took to do ESPB ($p = 0.01$), which shows how efficient ESPB is as a procedure (44). These results resembling our study in some ways. For example, they indicated that both groups used the same quantity of opioids, but the ESPB group took longer to get their first rescue analgesia and used less diclofenac. The difference could be due to disparities in the way the block was done, the level of the injection, or the standardization of the surgery. The discrepancies from our study could be related to changes in the surgical setting, painkiller administration, or the sensitivity of the outcomes. Our study only included elective upper abdominal procedures that used standardized block techniques and repeated measures analysis. Their study may have included a broader range of abdominal procedures or used different pain evaluation intervals.

Some strength of our study includes a multicenter, prospective cohort design, which enhances the external validity and generalizability of our findings to a larger population; the use of ultrasound guidance for block placement; and the application of standardized pain control approaches. The use of a consistent and fixed amount and concentration of local anesthetic in all blocks (20 ml of 0.5% bupivacaine). Use a blinded data accessor for all postoperative assessments to prevent measurement bias in our primary outcome, the VAS score.

This research has certain limitations that need to be recognized. First, the study used a prospective cohort design instead of an RCT, which increased the risk of unmeasured confounding variables and selection bias between the two groups. Second, our analgesic approach did not use a continuous catheter for either block, which may have reduced the overall duration of effective analgesia and was essential for long-term major abdominal surgery. Third, the results were only measured for 24 hours, with no consideration given to long-term pain control or functional recovery. The many procedures used in our investigation produced a degree of heterogeneity.

Although both TPVB and ESPB offered similar postoperative pain relief, except at the 12-hour mark, the ESPB demonstrated a longer duration of analgesia and decreased overall analgesic consumption in adult patients undergoing elective upper abdominal surgery. Future studies should investigate the ideal volume and concentration of local anesthetic for ESPB, along with its suitability for a broader spectrum of surgical interventions.

7. CONCLUSION

This multicenter, prospective cohort study indicated that clinicians can use ultrasound-guided TPVB and ESPB to manage postoperative pain in adult elective open upper abdomen surgery patients. ESPB had a longer analgesic duration and lower total analgesic use in the first 24 hours postoperatively, while both blocks deliver equivalent pain control at rest and during movement. Both methods were safe and had equal complication rates (PONV). Baseline characteristics and potential confounding variables were well-matched between groups.

ESPB's ease of administration, extended analgesic duration, and opioid-sparing effects may aid resource-limited settings like Ethiopia. These data support ESPB incorporation into multimodal analgesia procedures for upper abdominal surgeries, improving perioperative outcomes.

8. RECOMMENDATION

Based on what I have studied, I respectfully recommend the following: ESPB is a more effective choice for postoperative pain management in elective upper abdominal surgery due to its extended analgesic duration and diminished requirement for additional analgesics. An ESPB demonstrated benefits in reducing the need for additional analgesics, although TPVB is still a valid and effective technique. A Both blocks are safe to use during perioperative pain management with ultrasound guidance, so they are a good option for this group of patients. Fourth, future research should perform comprehensive randomized controlled trials to confirm these results and examine their long-term effects, cost-effectiveness, and patient satisfaction.

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ANNEX ONE: CONSENT FORM

Dear participant:

This study aims to compare the effectiveness of thoracic paravertebral block and erector spinae plane block with 0.25% bupivacaine in patients undergoing upper abdominal surgery under general anesthesia for postoperative analgesia. By the lottery method, you were included in the study. As a result, we respectfully request your participation in the study and an honest response to achieve the study's objectives. Your response is completely confidential, and you have the

right to refuse any question or withdraw from the study. However, your honest response to those questions will help us to assess and understand the effect. We kindly request that you provide a truthful response and continue participating.

Would you be willing to participate in the study, please? YES/NO

Thank you for participating in the study.

For further questions, ask the investigator.

Tel: +251915929250

E-mail: kelilmusa4@gmail.com

ANNEX TWO: PATIENT DATA

Part I: Sociodemographic Data (Chart Review)

	Card number: _____	
S.no	**Question**	**Response**
1	Age	-------yrs
2	Sex (M/F)	A. Male

		B. Female
3	Height	------ m
4	Weight	------- kg
5	ASA	A. ASA I B. ASA II
6	BMI:	----------kg/m^2

Part II: Clinical and Surgical Data

S. no.	Question	Response	code
7	Type of upper abdominal surgery planned	a. cholecystectomy b. Gastrectomy c. Hydatid cyst excision d. Other: ----------	
8	Does the patient have any comorbidities?	1. YES 2. NO	
9	If yes, specify (select all that apply):	A. Controlled DM B. Controlled HTN C. Controlled Asthma D. Other diseases	
10	Baseline heart rate	-------bpm	
12	Baseline BP (MAP)	-------mmhg	
13	Baseline SPO2	-----%	

Part III: Intraoperative Period

s. no	Question	Response	code
14	Which induction agent is used?	a. Ketamine b. Propofol c. Ketofol d. thiopental	
15	Was an intraoperative opioid administered?	a. Yes b. No	
16	Name of intraoperative systemic analgesia used	a. Morphine b. Pethidine	

		c. Tramadol and diclofenac d. Pethidine and diclofenac e. Pethidine and tramadol f. other	
17	What type of block was used?	A. TPVB B. ESPB	
18	Side of the block performed	A. Unilateral B. Bilateral	
19	What was the timing of the block administration?	A. Pre-induction B. post-induction C. Postoperative	
20	Which ultrasound probe approach was used?	A. Sagittal B. Transverse	
21	What dermatomal level was it injected?	A. T5 B. T6 C. T7 D. T8 E. T9	
22	Write the volume and concentration of the local anesthetic used:	----------ml, ----------%	
23	Any complications during the block?	A. Yes. B. No	
24	If yes, specify the above question:	----------	
25	Length of incision	----------cm	
26	Duration of surgery (in minutes)	_____	
27	hemodynamic parameter during the intraoperative period after induction		
	BP: _____ mmhg PR: _____ bpm SaO_2: _____%		
28	Experience of an anesthetist	A. MSc Year 2 under supervision B. MSc Year 1 under supervision	

		C. MSc staff	

Part IV: Data in the post-operative period

S.No.	V/S	**Immediately upon Arrival of Recovery Room (at 0 hr.-1 hr.)**	**2nd hr.**	**6th hr. post-op**	**12th hr. post-op**	**24th hr. post-op**
29	Time (local)					
30	VAS					

31. Do you require analgesics in the first 24 hours? A. Yes B. No

32. If yes, what was the time (in minutes) from the end of surgery to the first dose? _____

33. What rescue analgesic was given first? _____

34. Was any opioid analgesic administered within 24 hours postoperatively?

A. Yes B. No

35. Specify the opioids given and total dose (in mg): _____

36. Were any non-opioid analgesics given within 24 hours?

a. Diclofenac B. paracetamol C. None D. Other

37. Specify the name, route, and total dose of non-opioid analgesics given. _____

38. Postoperative nausea and vomiting (PONV): A. Yes B. No

39. Any other postoperative complications? _____

APPENDIX 1: AMERICAN SOCIETY OF ANESTHESIOLOGISTS (ASA) PHYSICAL STATUS CLASSIFICATION

ASA PS Classification	***Definition***	***Adult Examples, including but not Limited to:***
ASA I	A normal, healthy patient	Healthy, non-smoking, no or minimal alcohol use
ASA II	A patient with mild systemic disease	Mild diseases without substantive functional limitations. Current smoker, social alcohol drinker, pregnancy, obesity (30<BMI<40), well-controlled DM/HTN, mild lung disease
ASA III	A patient with severe systemic disease	Substantive functional limitations; one or more moderate to severe diseases. Poorly controlled DM or HTN, COPD, morbid obesity (BMI ≥40), active hepatitis, alcohol dependence or abuse, implanted pacemaker, moderate reduction of ejection fraction, ESRD undergoing regularly scheduled dialysis, history (>3 months) of MI, CVA, TIA, or CAD/stents.
ASA IV	A patient with severe systemic disease that is a constant threat to life	Recent (<3 months) MI, CVA, TIA, or CAD/stents; ongoing cardiac ischemia or severe valve dysfunction, severe reduction of ejection fraction, shock, sepsis, DIC; ARD; or ESRD not undergoing regularly scheduled dialysis
ASA V	A moribund patient who is not expected to survive without the operation	Ruptured abdominal/thoracic aneurysm, massive trauma, intracranial bleed with mass effect, ischemic bowel in the face of significant cardiac pathology, or multiple organ/system dysfunction
ASA VI	A declared brain-dead patient whose organs are being removed for donor purposes.	

Adapted from Barash, Cullen, and Stoelting's Clinical Anesthesia, 9th edition

ANNEX THREE: DECLARATION

Declaration of Investigator

I, the undersigned student in the Master of Advanced Clinical Anesthesia program, declare that this thesis is my original work, submitted in partial fulfillment of the requirements for the degree of Master of Advanced Clinical Anesthesia, to the best of my knowledge.

Name of investigator: KELIL MUSA

Signature: _____

Date _____

Declaration of Advisors

We, the undersigned, hereby confirm that we have thoroughly reviewed this thesis and provided guidance for its development. We agree that this thesis is prepared for defense with our approval as the university advisor(s). To the best of our knowledge, the work presented meets academic standards and partially fulfills the requirements for the degree of Master of Advanced Clinical Anesthesia.

1. Name of Principal Advisor: _____

    Signature: _____

    Date: _____

2. Name of Co-Advisor: _____

    Signature: _____

    Date: _____

3. Name of Co-Advisor: _____

    Signature: _____

    Date: _____