Journal of Pain Research

Dovepress
Taylor & Francis Group

Open Access Full Text Article

STUDY PROTOCOL

Subserratus Anterior Plane Block vs Thoracic Paravertebral Block for Postoperative Analgesia in Laparoscopic Radical Nephrectomy: Protocol for a Randomized Controlled, Double-Blind, Non-Inferiority Clinical Trial

Jianghuai Lin[1], Huanghui Wu[2], Zhibin Wen[3], Yangyi Li[1], Changcheng Jiang[1], Binghong Lin[4], Yu Gu[5]

[1]Department of Anesthesiology, Quanzhou First Hospital Affiliated to Fujian Medical University, Quanzhou, Fujian Province, 362000, People's Republic of China; [2]Department of Anesthesiology and Perioperative Medicine, Shanghai Fourth People's Hospital, School of Medicine, Tongji University, Shanghai, 200434, People's Republic of China; [3]Graduate School of Fujian Medical University, Fuzhou, Fujian Province, 350122, People's Republic of China; [4]Graduate School of Victoria University of Wellington, Wellington, 6014, New Zealand; [5]Department of Anesthesiology, Zigong Fourth People's Hospital, Zigong, Sichuan Province, 643000, People's Republic of China

Correspondence: Yu Gu, Department of Anesthesiology, Zigong Fourth People's Hospital, Zigong, Sichuan Province, People's Republic of China, Email guyu951221@163.com

Introduction: Thoracic paravertebral nerve block (TPVB) is a widely used regional anesthesia technique employed in opioid-sparing anesthesia for abdominal surgery. Although the subserratus anterior plane block (SSAPB) has shown effectiveness in providing analgesia in upper abdominal surgery, it remains unclear whether the SSAPB offers comparable analgesic effects to the TPVB for retroperitoneal laparoscopic nephrectomy.

Methods and Analysis: This study is designed as a prospective, randomized controlled, double-blind, single-center, non-inferiority trial involving a total of 106 patients undergoing retroperitoneal laparoscopic nephrectomy. Participants will be randomly assigned to either the SSAPB group or the TPVB group in a 1:1 ratio. Both ultrasound-guided SSAPB and TPVB will involve the administration of 0.375% ropivacaine at a dose of 0.4 mL/kg prior to anesthesia induction. Subsequently, opioid-sparing anesthesia will be utilized during surgery. Each patient will receive standardized patient-controlled intravenous analgesia (PCIA) without a background infusion. The primary outcome measure will be the 24-hour postoperative consumption of rescue opioids. Secondary outcomes will include pain visual analogue scale (VAS) scores at various predefined time points within 48 hours post-surgery, analgesic consumption during and after surgery, time to first administration of rescue analgesics, incidence of perioperative cardiopulmonary adverse events, assessment of block characteristics, quality of recovery, time to ambulation and initiation of an oral diet, and length of stay in both the postoperative anesthesia care unit (PACU) and the hospital. Additionally, levels of inflammatory markers, including interleukin-6 (IL-6) and C-reactive protein (CRP), will be assessed at predefined time points.

Discussion: This protocol outlines the first prospective, randomized controlled, double-blinded, non-inferiority clinical trial comparing perioperative analgesic efficacy and safety of SSAPB versus TPVB in patients undergoing retroperitoneal laparoscopic nephrectomy under opioid-sparing anesthesia. The study is designed to generate preliminary insights into optimizing regional anesthesia strategies for perioperative pain management in this surgical cohort.

Keywords: thoracic paravertebral nerve block, subserratus anterior plane block, laparoscopic radical nephrectomy, opioid-sparing anesthesia

Introduction

Despite being a minimally invasive procedure, laparoscopic nephrectomy can still result in moderate to severe acute postoperative pain.[1] Surgical tissue damage elicits nociceptive pain, which is often accompanied by visceral, neuropathic,

Received: 23 November 2024
Accepted: 8 March 2025
Published: 25 March 2025

and inflammatory components. Therefore, the analgesic strategy should be individualized based on each specific surgical procedure.[2]

Although opioid-based analgesia has been the cornerstone of perioperative pain management,[3] it does not adequately address all nociceptive pathways. Opioid-based analgesia may not consistently provide optimal pain relief and is linked to negative side effects, including paralytic ileus, nausea, vomiting, and urinary retention.[4] Consequently, opioid-sparing anesthesia is increasingly being adopted as a strategy to enhance perioperative analgesia and facilitate optimal early postoperative recovery.[5] Given the ongoing effectiveness of opioid medications in managing severe pain situations, the currently available evidence for opioid-free anesthesia remains inconclusive.[6]

A key aspect of achieving opioid-sparing anesthesia is the effective administration of regional blocks. Due to its well-established analgesic efficacy, thoracic paravertebral nerve block (TPVB) is extensively utilized in thoracic and urological surgeries and is considered equivalent to unilateral epidural blockade when compared to other regional block techniques.[7–9] Although ultrasound-guided TPVB effectively alleviates postoperative somatic and visceral pain following radical nephrectomy, the procedure carries risks of serious complications, such as hemopneumothorax and nerve root injury.[10–12] Consequently, there is a compelling clinical imperative to identify alternative analgesic techniques that demonstrate comparable efficacy, procedural simplicity, and reduced complication profiles.

The rhomboid intercostal and subserratus (RISS) plane block is a novel interfascial plane block initially described by Elsharkawy et al.[13] This innovative technique has garnered attention due to its potential applications in clinical practice. The RISS block involves a two-site interfascial plane block. The first site is located between the rhomboid and intercostal muscles in the medial scapular region (T5-T6 level), while the second site is situated between the serratus anterior muscle and the intercostal muscle at the T8-T9 level, along the posterior axillary line, below the subscapular angle.

It has been reported to provide sensory blockade in the dermatomes innervated by the lateral cutaneous branches of the T3-T12 intercostal nerves and has demonstrated efficacy in analgesia for thoracic and abdominal surgeries, including laparoscopic cholecystectomy.[14–16] The subserratus anterior plane block (SSAPB), a component of the RISS block, primarily targets the lateral cutaneous branches of the intercostal nerves. The incision for retroperitoneal laparoscopic nephrectomy is strategically placed within the lateral abdominal wall, specifically in the area innervated by the T7-T11, or possibly T12, thoracic nerves.

A previous study demonstrated a significant reduction in opioids consumption when utilizing the low serratus intercostal plane block (low SIPB) for supraumbilical surgery with a Kocher incision, underscoring its potential to minimize postoperative pain and reduce reliance on opioids.[2] In a separate study on hepatectomy, Jiang et al injected 30 mL of 0.2% ropivacaine into the deep surface of the low serratus anterior muscle (low SAPB) at the 7th or 8th intercostal space along the midaxillary line. The block effectively provided postoperative analgesia for hepatectomy incisions, with the sensory blockade primarily distributed from T4 to T11.[17]

Both low SIBP or SAPB and SSAPB involve the administration of local anesthetic into the fascial plane between the serratus anterior muscle and the external intercostal muscle at the seventh to ninth rib. The primary difference, as noted in the aforementioned studies, is the relocation of the injection site from the posterior axillary line to the midaxillary line.[2,17] Based on these findings, low SAPB effectively reduces opioid consumption and alleviates surgical pain, regardless of whether the local anesthetic is injected at the midaxillary or posterior axillary line. Therefore, SSAPB suggests a potential analgesic effect for patients undergoing retroperitoneal laparoscopic nephrectomy.

Compared to TPVB, SSAPB may offer several advantages in clinical applications. It is a superficial block that is easy to perform and has a minimal learning curve; the fascial plane contains a paucity of blood vessels, resulting in fewer serious complications; and the target area is relatively distant from vital organs and nerves.

To date, no robust comparative evidence exists evaluating the analgesic efficacy of SSAPB relative to TPVB in retroperitoneal laparoscopic nephrectomy. This protocol therefore establishes a prospective, randomized controlled, double-blind, non-inferiority trial to compare perioperative analgesic outcomes and safety of SSAPB versus TPVB under an opioid-sparing multimodal analgesia regimen.

Methods

Patient and Public Involvement

The patients or the public are not engaged in the design, conduct, reporting or dissemination of this research. Furthermore, no efforts will be made to evaluate the burden of the intervention on the patients themselves. Additionally, no healthy volunteers will be recruited.

Trial Design and Setting

This study is designed as a prospective, randomized, double-blind, single-center, non-inferiority, parallel-group, two-arm study with a 1:1 allocation ratio, in accordance with the SPIRIT 2013 statement. The study protocol has been approved by the Ethics Committee of Quanzhou First Hospital affiliated to Fujian Medical University ([2024] K116) and registered with the Chinese Clinical Trial Registry (ChiCTR2200067131). All procedures will adhere to the principles of the Declaration of Helsinki. Figure 1 illustrates the study's flowchart, while Table 1 presents the SPIRIT-compliant schedule of enrollment, interventions, and assessments.

Recruitment and Consent

An independent investigator will be responsible for recruiting all participants one day prior to the surgical procedure, strictly adhering to the predetermined inclusion and exclusion criteria. Before surgery, participants and their authorized representatives will receive comprehensive information about the trial's objectives, specific protocols, potential benefits, and risks. Informed consent will be obtained from both participants and their authorized representatives ahead of the surgical intervention. Furthermore, patients will receive preoperative education from the investigator on how to effectively use the visual analogue scale (VAS) for self-assessment of pain levels.

Inclusion Criteria

1) Aged 18 to 80 years;
2) American Society of Anesthesiology physical status classification (ASA) class I–III;
3) Body mass index (BMI) between 18 and 30 kg/m^2;
4) Planning to undergo retroperitoneal laparoscopic nephrectomy;

Exclusion Criteria

1) Coagulation disorders or undergoing anticoagulant therapy;
2) Comorbidities including severe heart, lung, liver, and renal dysfunction;
3) Allergic to the anesthetic used in the trial;
4) Refusing nerve block or contraindications for nerve block, including infection at the injection site, spinal deformity and difficult anatomical visualization with ultrasound;
5) Long-term use of opioid analgesics, which may impact the assessment of outcome measures;
6) Verbal communication difficulties, psychiatric or neurological disease;
7) Pregnant or lactating women.

Randomization and Allocation Concealment

Statisticians not involved in the data analysis will generate random numbers using a permuted block size of 4 or 6 with computer software (SPSS 25.0). These random sequences will be placed in sequentially numbered opaque envelopes by the study coordinator, who will be responsible for distributing the envelopes and maintaining the randomized results. Participants will be allocated to either the SSAPB or TPVB group in a 1:1 ratio. A nurse not involved in the study will open the envelopes sequentially based on the order of enrollment and prepare the study medications as required.

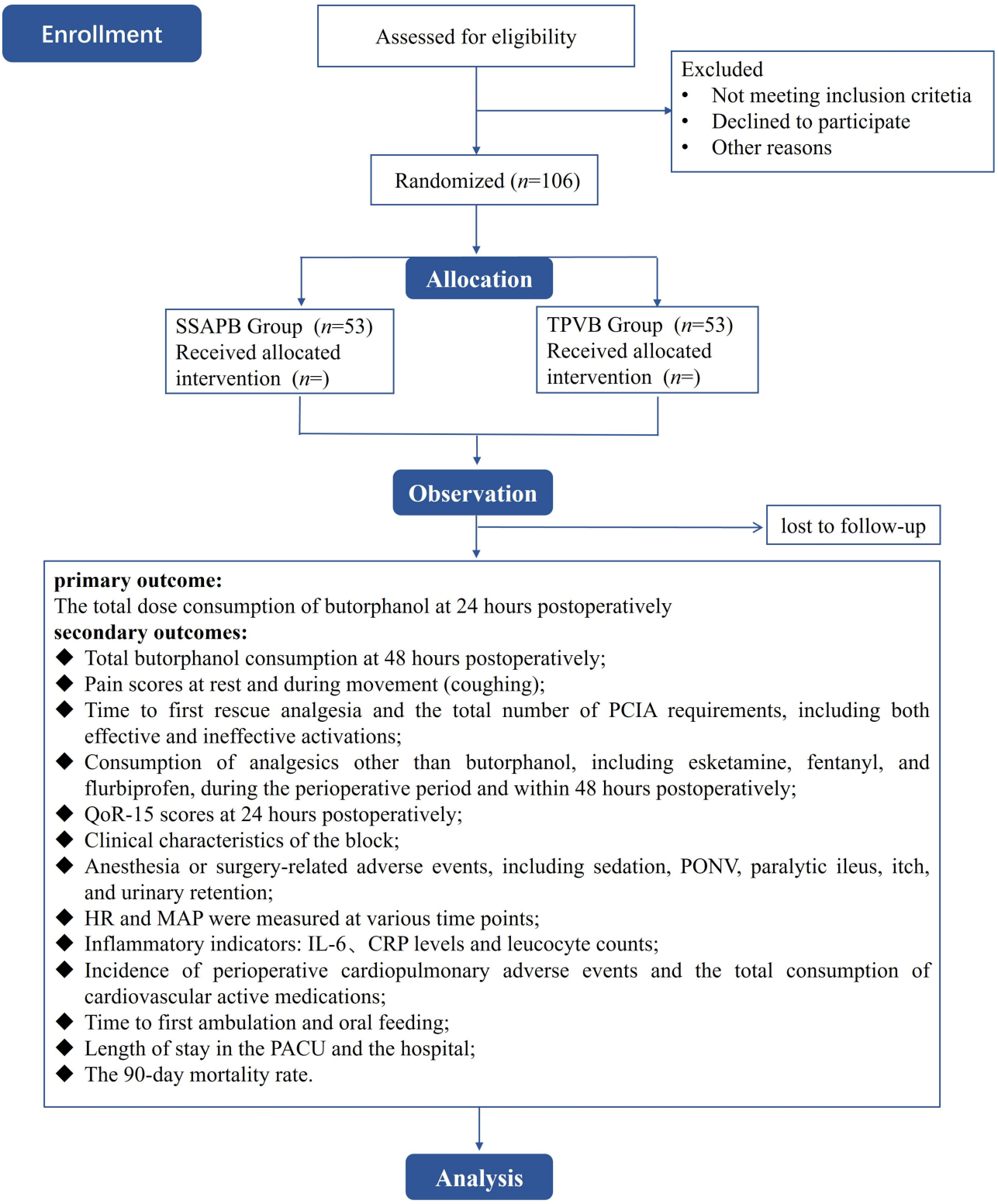

Figure 1 Flow diagram of the study.
Abbreviations: SSAPB, subserratus anterior plane block; TPVB, thoracic paravertebral block; PCIA, patient-controlled intravenous analgesia; QoR, quality of recovery; IL-6, interleukin-6; CRP, C-reactive protein; PONV, postoperative nausea and vomiting; HR, heart rate; MAP, mean arterial pressure; PACU, postoperative anesthesia care unit.

Table 1 Content and Timelines for the Schedule of Enrollment, Interventions, and Assessments

					Follow-Ups		
Time Point	**Enrollment**	**Randomization**	**PRE 30 min**	**During Anesthesia**	**POS 24h**	**POS 48h**	**POS 48h to Discharge**
Eligibility criteria	•						
Informed consent	•						
Demographic characteristics	•						
Allocation		•					
Intervention			•				
Primary outcome assessment					•		•
Secondary outcome assessment				•		•	•

Abbreviations: PRE, preoperative; POS, postoperative.

Blinding

Given the close proximity of needle injection sites for TPVB and SSAPB, participants may find it challenging to discern clinical differences in puncture sites once they are covered with sterile dressings after the block is completed. Three anesthesiologists will be involved during the perioperative care. The nerve block procedure will be performed by a senior attending physician who will not be involved in anesthesia induction or intraoperative management. The second anesthesiologist will be responsible solely for intraoperative management, while the third anesthesiologist, who will not be involved in nerve block or intraoperative management, will be designated for postoperative follow-up.

In the anesthesia information management system, only random sequence numbers will be recorded, not specific types of nerve blocks. The Ethics Committee will conduct regular monitoring and oversight of data compilation and verification processes for the case report form (CRF). Once the database is locked, the allocation data will be transferred for statistical analysis. The allocation process will remain blinded to the anaesthesiologists responsible for intraoperative management and follow-up, as well as to participants, surgeons, and statisticians. This blinding will be maintained until the completion of the final analyses.

Intervention

Upon entering the operating room, standard vital sign monitoring and intravenous access will be established, and oxygen will be provided at a flow rate of 2 L/min via a nasal catheter. Invasive arterial pressure monitoring will be performed following a modified Allen test. Prior to administering the nerve block, a bolus dose of 0.8 μg/kg dexmedetomidine will be infused over 10 minutes. The patient will then be positioned in lateral decubitus position, with the surgical side facing upward. Depending on the patient's sedation status, a single dose of midazolam (0.02–0.03 mg/kg) may be administered, if necessary, to alleviate discomfort during nerve block puncture.

Nerve block failure will be defined as a scenario where no more than two segments show a post-block score greater than zero when the intended block plane is identified using a 27-gauge needle at 30 minutes post-block. The scoring system will be evaluated based on the following criteria: 0 = no sensory block, 1 = tactile sensation present with no pain, 2 = no tactile sensation and no pain.

Ultrasound-Guided TPVB

Sagittal scanning will be conducted using a linear high-frequency probe, with the patient positioned in the lateral decubitus position. For obese patients, a low-frequency convex array probe may be utilized instead. Upon visualization of

the 12th rib, the T12 spinous process will be identified by gently sliding the probe medially and marking its position. The probe will then be maneuvered cranially to locate the T9-T10 vertebrae. Subsequently, the probe will be rotated to a transverse orientation to reveal the transverse process, pleura, and superior costotransverse ligament (Figure 2A and B).

A 22-gauge nerve block needle will be inserted using the in-plane technique, followed by a single-point high-volume block. Once the needle tip is positioned within the paravertebral space between the pleura and the superior costotransverse ligament, 3 mL of saline will be injected to confirm proper placement by observing the sign of downward pleural movement. After confirming correct needle placement, 0.4 mL/kg of 0.375% ropivacaine will be injected into the paravertebral space. Successful injection of the study medication will be indicated by the formation of a hypoechoic ellipsoid and the displacement sign within the paravertebral space under ultrasonic guidance.

Ultrasound-Guided SSAPB

Similarly, the patient will be positioned in the lateral decubitus position, with the surgical side facing upward. The 12th rib will be located by scanning the area with a linear high-frequency probe from caudal to cranial. The probe will then be moved laterally and cephalad until the eighth or ninth rib is reached in the posterior axillary line, below the subscapular angle. After a clockwise rotation of approximately 45 degrees, the ultrasound image will display a superficial-to-deep

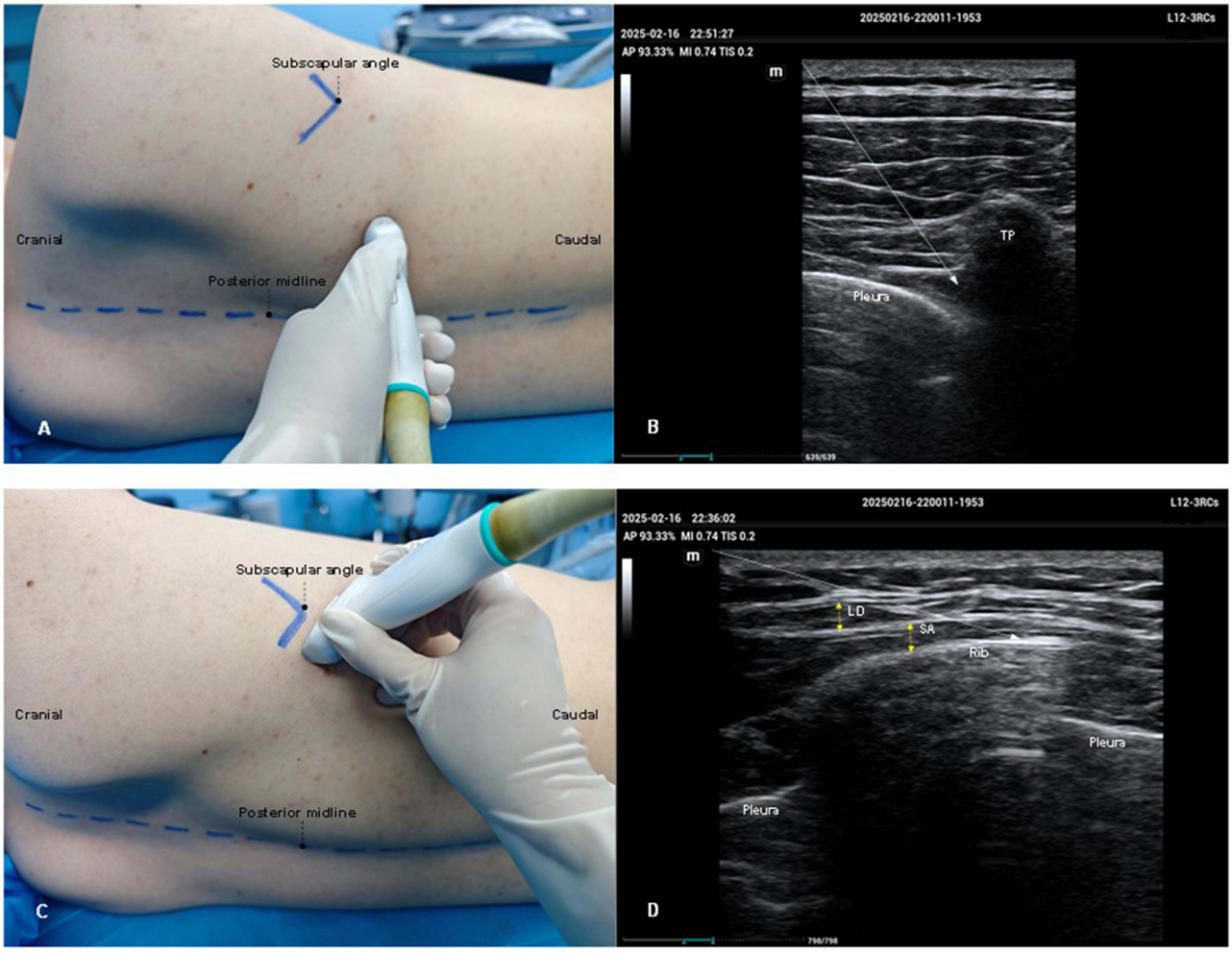

Figure 2 Body Surface Landmarks and Ultrasonographic Imaging for Nerve Block Techniques. (**A**) Ultrasound transducer positioning for performing the thoracic paravertebral-block injection at the T9–10 vertebral level. (**B**) Schematic cross-sectional view at the T9–10 level depicting needle trajectory during thoracic paravertebral nerve block. (**C**) Ultrasound transducer positioning for performing the subserratus anterior plane block at the T8–9 level. (**D**) Schematic cross-sectional view at the T8–9 level illustrating needle trajectory and anatomical relationships during subserratus anterior plane block, with corresponding ultrasonographic visualization.
Abbreviations: LD, Latissimus dorsi muscle; SA, Serratus anterior muscle; TP, Transverse process.

arrangement of the latissimus dorsi, serratus anterior, external intercostal muscle, pleura, and lungs (Figure 2C and D). The puncture needle will be positioned in a caudal and lateral orientation.

Upon reaching the plane between the anterior serratus and external intercostal muscles, 3 mL of saline will be injected to confirm accurate needle tip placement, followed by the administration of 0.375% ropivacaine at a dosage of 0.4 mL/kg. As the local anesthetic carefully separates the two muscle layers, the needle, along with the probe, will continue to move in a caudal and lateral direction, creating a distinct separation between the muscles. This continuous action ensures a seamless and precise dissection between the muscle layers, thereby enhancing the overall efficacy of the procedure.

Intraoperative Anesthesia Management

Anesthesia will be induced thirty minutes after the nerve block is completed, using an intravenous combination of propofol (1.25–1.75 mg/kg), rocuronium (0.6 mg/kg), esketamine (0.25 mg/kg), and lidocaine (1.5 mg/kg). Following tracheal intubation, anesthesia will be maintained with inhalation agent, sevoflurane (1–2%), and intravenous infusions of propofol (2–3 mg/kg/h), dexmedetomidine (0.2–0.5 μg/kg/h), lidocaine (1.5 mg/kg/h), and intermittent doses of rocuronium (0.6 mg/kg). This regimen will target a bispectral index (BIS) range of 40–60 and maintain end-tidal carbon dioxide pressure between 35 and 45 mmHg.

Intermittent administration of esketamine (0.125 mg/kg) will be at the discretion of the attending anesthesiologists to achieve a surgical pleth index (SPI) target of 20–50 and ensure that hemodynamic parameters remain within 20% of their preoperative baseline values.[18] Fentanyl will be considered only if the SPI remains above 50 or if hemodynamic parameters persist above 20% of their baseline values despite additional esketamine and deeper sedation. Dexmedetomidine and lidocaine infusions will be discontinued 30 minutes prior to the end of the procedure, followed by the administration of flurbiprofen (50 mg) and dolasetron (10 mg). Sodium sulforaphane glucose will be administered to reverse neuromuscular blockade prior to extubation. Hemodynamic monitoring data will be utilized to adjust fluid volume, infusion rates, and the dosing of vasoactive medications.

Postoperative Analgesia

After extubation, the patient will be transferred to the postoperative anesthesia care unit (PACU) for a minimum of 30 minutes of vital sign monitoring. The patient may be escorted to the ward once their Steward score reaches or exceeds 5. Each patient will receive a standardized patient-controlled intravenous analgesia (PCIA) pump containing a 0.1 mg/mL butorphanol solution. The pump is set to deliver 5 mL boluses with a lock-out interval of 10 minutes and no background infusion. The maximum allowable dose of butorphanol should not surpass 1 mg per hour. If two times PCIA are performed in an hour, then no more press should be allowed until at least two hours have passed. Prior to surgery, patients participating in this study will receive training on how to use the PCIA pump.

Rescue analgesia will be administered as follows: if the VAS score exceeds mild pain following two consecutive PCIA bolus doses (0.5 mg butorphanol each, 10-minute interval), intravenous flurbiprofen (50 mg) will be administered. If pain relief is not achieved within an additional 30 minutes after flurbiprofen administration, fentanyl (1 μg/kg) will be administered as secondary rescue analgesia.

Primary Outcome

The primary outcome measure will be the total butorphanol consumption at 24 hours postoperatively.

Secondary Outcomes

1) Total butorphanol consumption at 48 hours postoperatively.

2) Pain scores at rest and during movement (coughing), calculated as the average VAS scores recorded at 0.5, 2, 6, 12, 24, and 48 hours postoperatively. The VAS is a validated scale for quantifying subjective pain intensity, where 0 denotes "no pain" and 10 signifies "the most severe pain imaginable."The measurement unit for scoring is millimeter (mm). For clinical stratification, scores ranging from 0–4 mm, 5–44 mm, 45–74 mm, and 75–100 mm may be categorized as no, mild, moderate, and severe pain, respectively.

3) Time to first rescue analgesia and the total number of PCIA requirements, including both effective and ineffective activations.

4) Consumption of analgesics other than butorphanol, including esketamine, fentanyl, and flurbiprofen, during the perioperative period and within 48 hours postoperatively.

5) Quality of recovery (QoR) scores assessed using a 15-item QoR questionnaire in a face-to-face interview at 24 hours postoperatively.

6) Clinical characteristics of the block, including intervention duration, onset time, sensory loss distribution in the dermatomal plane, sensory recovery time and block associated adverse events.

7) Anesthesia or surgery-related adverse events, including sedation, postoperative nausea and vomiting (PONV), paralytic ileus, itching, and urinary retention.

8) Heart rate (HR) and mean arterial pressure (MAP) were measured at various time points: before the induction of anesthesia (T1), after tracheal intubation (T2), following the completion of Trocar placement (T3), and when the pneumoperitoneum pressure reaches a preset value (T4), and before leaving PACU (T5).

9) Inflammatory indicators: Interleukin-6 (IL-6), C-reactive protein (CRP) levels and leucocyte counts will be measured at three time points: preoperatively (T1), 24 hours postoperatively (T2), and 48 hours postoperatively (T3).

10) Incidence of perioperative cardiopulmonary adverse events and the total consumption of cardiovascular active medications.

11) Time to first ambulation and oral feeding.

12) Length of stay in the PACU and the hospital.

13) The 90-day mortality rate.

Data Collection, Management and Monitoring

Preoperative demographic information, including age, gender, and BMI, will be gathered. Additionally, clinical characteristics such as comorbidities, diagnoses (encompassing types, sizes, and stages of kidney tumors), history of allergies, baseline mean arterial pressure (MAP), heart rate (HR), and ASA status will be documented. The duration of anesthesia and surgery, the use of anesthetics (including sedatives and analgesics), as well as the total volume of fluid administration will be recorded.

Intraoperative data, including MAP/HR values, medications, and adverse events, along with postoperative follow-up data, will be sequentially entered into a paper CRF. Paper-based data will undergo double-entry by two research assistants to ensure accuracy before being input into the electronic files. All withdrawals will be documented. Patient information and data will be securely stored and coded. The Ethics Committee will conduct regular monitoring and data audits throughout the study. No interim analysis is planned until the target sample size is reached.

Statistical Analysis

The non-inferiority analysis for the primary endpoint will be conducted using the confidence interval method, analyzed utilizing the *R* programming language and relevant packages, and expressed in terms of effect size. If the upper limit of the one-sided 95% confidence interval for the effect size (ie, the difference in total 24-hour opioid consumption) is less than 0.6, it can be concluded that the SSAPB is non-inferior to the TPVB.

For secondary outcomes, variables with a normal distribution will be expressed as the mean± standard deviation (SD). Comparisons between groups will be performed using *Student's t*-test. For indicators requiring repeated measurements, such as vital signs and VAS scores, a repeated measures ANOVA will be conducted, provided the data meet the assumptions of normality, homogeneity of variance, and sphericity, as assessed by *Mauchly's* test. In such cases, the *Bonferroni* correction will be applied to adjust the significance threshold for multiple time points. Otherwise, a mixed-effects model or a generalized estimating equations (GEE) model will be utilized. The *Mann–Whitney U*-test will be employed to compare variables that are not normally distributed between groups, with these variables expressed as median and interquartile range (IQR). The chi-square test or *Fisher's* exact test will be utilized to analyze categorical data, presented as numbers and percentages. The *Kaplan–Meier* estimator will assess time-to-event data, and the Log rank test will be applied to compare differences between groups. A two-tailed *P*-value of less than 0.05 will be considered statistically significant. Statistical analyses will be performed using SPSS 25.0 (IBM SPSS Inc., Chicago,

IL, USA) and GraphPad Prism version 9.0 (available at www.graphpad.com). Any modifications to the statistical analysis methods will be documented in a subsequent report.

Sample Size Calculation

In our pilot study, we observed that the administration of TPVB resulted in a reduction of butorphanol consumption over 24 hours postoperatively by an average of 1.5 mg when compared to the control group (non-block), with an SD of 0.48. Assuming a difference in 24 h butorphanol consumption between SSAPB and TPVB of 0.3 mg, and the non-inferiority margin is set at 0.6 mg (an acceptable clinical practice difference), a total of 45 participants per group (1:1 ratio) is required to achieve a one-sided α level of 0.025 and 90% statistical power. Accounting for an anticipated 10% dropout rate in postoperative data collection and a 5% nerve block failure rate, the desired total sample size is 106 participants.

Safety Considerations

Ropivacaine, a commonly used local anesthetic with vasoconstrictive properties, significantly reduces puncture-related complications such as bleeding, pneumothorax, and local anesthetic toxicity when administered under ultrasound guidance. The ultrasound-guided regional block will only be carried out following the establishment of standard monitoring and intravenous access. If any adverse event occurs during the process, the intervention will be discontinued. The procedure will be conducted by a senior attending anesthesiologist specializing in nerve blocks. Participants will be closely monitored for 48 hours after surgery. The investigators will follow up with participants at predefined time intervals, and any adverse events that arise during this period will be carefully recorded. In the event of an unintended adverse event, it will be reported immediately to the trial supervisor and, if necessary, to the hospital's patient safety committee.

Trial Status

We commenced the recruitment of participants from the day we submitted our manuscript.

Trial Registration Number

ChiCTR2200067131

Discussion

Regional block techniques are fundamental components of an opioid-sparing anesthesia strategy, which aims to minimize the use of opioids during surgical procedures to reduce the risk of opioid-related side effects and complications, such as respiratory depression, nausea and vomiting, and prolonged hospital stays. This comprehensive approach targets pain through multiple pathways, presenting a promising area for future research and clinical endeavors.

The choice of regional block modalities is crucial for the effective implementation of opioid-sparing anesthesia. The emergence of TPVB as a viable alternative to epidural analgesia is attributed to its efficient analgesic properties.[9] However, the potential for serious complications associated with needle puncture, even under ultrasound guidance, as well as the increased risk of adverse cardiovascular events such as hypotension, have prompted the exploration of alternative block modalities.

Ultrasound-guided erector spinae plane block (ESPB) and quadratus lumborum block (QLB) have gained popularity in abdominal surgery, leading researchers to investigate their potential as alternatives to paravertebral blocks. However, controversy remains regarding the potential of ESPB in targeting the ventral branch of the intercostal nerve, both from clinical and anatomical perspectives.[19,20] The anterior QLB, being a deep block approach with a puncture site proximal to the surgical incision, may influence the dispersion of local anesthetics. Additionally, QLB has an inherent potential for diffusion into the lumbar paravertebral region, which may affect lower limb muscular strength.[21]

Conversely, the SSAPB is a promising interfascial plane technique characterized by a superficial puncture site and relative ease of maneuverability. Despite demonstrating analgesic advantages over intravenous analgesia, there is currently no evidence to suggest its inferiority to TPVB. Given that the anatomical mechanism of SSAPB may not be as effective as TPVB in inhibiting visceral pain, we employed a multimodal analgesic approach as the primary strategy to

maximize visceral pain inhibition and to assess the feasibility of using SSAPB as an alternative to TPVB for retroperitoneal laparoscopic nephrectomy.

This trial design is subject to several limitations. First, the restricted sample size may compromise the statistical power required to detect rare adverse events or subtle safety differences between interventions. Second, the single-center nature of this trial limits the generalizability of findings to broader populations or diverse clinical settings.

This study is the first to compare the clinical analgesic efficacy and safety of SSAPB versus TPVB within the framework of opioid-sparing anesthesia for patients undergoing radical nephrectomy. Should our trial yields positive outcomes, SSAPB may be considered an alternative nerve block technique for postoperative analgesia in abdominal surgery, potentially eliminating the need for TPVB.

Abbreviations

TPVB, thoracic paravertebral nerve block; SSABP, subserratus anterior plane block; PCIA, patient-controlled intravenous analgesia; VAS, visual analogue scale; PACU, postoperative anesthesia care unit; IL-6, interleukin-6; CRP, C-reactive protein; ASA, American Society of Anesthesiology; BMI, body mass index; CRF, case report form; SPI, surgical pleth index; QOR, quality of recovery; PONV, postoperative nausea and vomiting; HR, heart rate; MAP, mean arterial pressure.

Data Sharing Statement

Data are available upon reasonable request.

Ethics Approval

This study was approved by the Ethics Committee of QuanZhou First Hospital, affiliated to Fujian Medical University ([2024] K116). All procedures adhere to the principles of the Declaration of Helsinki. Prior to participating in the trial, participants provided informed consent.

Acknowledgments

The authors acknowledge Professor Zhiyang Huang and his surgical team from the Department of Urinary Surgery at Quanzhou First Hospital affiliated to Fujian Medical University, for their invaluable assistance in this project.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

This work was supported by the Startup Fund for scientific research, Fujian Medical University (Grant number: 2023QH1291).

Disclosure

The author(s) report no conflicts of interest in this work.

References

1. Hu CY, Yang CK, Huang CY, et al. Robot-Assisted Laparoscopic Nephroureterectomy versus Hand-Assisted Laparoscopic Nephroureterectomy for Upper Urinary Tract Urothelial Carcinoma: a Matched Comparison Study. *Biomed Res Int*. 2015;2015:918486. doi:10.1155/2015/918486
2. Fernández MT, LÓpez S, Aguirre JA, Andrés J, Ortigosa E. Serratus intercostal interfascial plane block in supraumbilical surgery: a prospective randomized comparison. *Minerva Anestesiol*. 2021;87(2):165–173. doi:10.23736/s0375-9393.20.14882-x
3. Shanthanna H, Ladha KS, Kehlet H, Joshi GP. Perioperative Opioid Administration. *Anesthesiology*. 2021;134(4):645–659. doi:10.1097/aln.0000000000003572

4. Hayhurst CJ, Durieux ME. Differential Opioid Tolerance and Opioid-induced Hyperalgesia: a Clinical Reality. *Anesthesiology*. 2016;124(2):483–488. doi:10.1097/aln.0000000000000963
5. Zhu T, Zhao X, Sun M, et al. Opioid-reduced anesthesia based on esketamine in gynecological day surgery: a randomized double-blind controlled study. *BMC Anesthesiol*. 2022;22(1):354. doi:10.1186/s12871-022-01889-x
6. Shanthanna H, Joshi GP. Opioid-free general anesthesia: considerations, techniques, and limitations. *Curr Opin Anaesthesiol*. 2024;37(4):384–390. doi:10.1097/aco.0000000000001385
7. Baik JS, Oh AY, Cho CW, Shin HJ, Han SH, Ryu JH. Thoracic paravertebral block for nephrectomy: a randomized, controlled, observer-blinded study. *Pain Med*. 2014;15(5):850–856. doi:10.1111/pme.12320
8. Copik M, Bialka S, Daszkiewicz A, Misiolek H. Thoracic paravertebral block for postoperative pain management after renal surgery: a randomised controlled trial. *Eur J Anaesthesiol*. 2017;34(9):596–601. doi:10.1097/eja.0000000000000673
9. Yeung JH, Gates S, Naidu BV, Wilson MJ, Gao Smith F. Paravertebral block versus thoracic epidural for patients undergoing thoracotomy. *Cochrane Database Syst Rev*. 2016;2(2):cd009121. doi:10.1002/14651858.CD009121.pub2
10. Choi S, Trieu J, Ridley L. Radiological review of intercostal artery: anatomical considerations when performing procedures via intercostal space. *J Med Imaging Radiat Oncol*. 2010;54(4):302–306. doi:10.1111/j.1754-9485.2010.02175.x
11. Shurtleff E, Olinger A. Posterior intercostal artery tortuosity and collateral branch points: a cadaveric study. *Folia Morphol*. 2012;71(4):245–251.
12. Burlacu CL, Buggy DJ. Coexisting harlequin and Horner syndromes after high thoracic paravertebral anaesthesia. *Br J Anaesth*. 2005;95(6):822–824. doi:10.1093/bja/aei258
13. Elsharkawy H, Maniker R, Bolash R, Kalasbail P, Drake RL, Elkassabany N. Rhomboid intercostal and subserratus plane block: a cadaveric and clinical evaluation. *Region Anesth Pain M*. 2018;43(7):745–751.
14. Elsharkawy H, Ince I, Pawa A. Rhomboid intercostal and sub-serratus (RISS) plane block for analgesia after lung transplant. *J Clin Anesth*. 2019;56:85–87. doi:10.1016/j.jclinane.2019.01.042
15. Piraccini E, Poggi P, Maitan S. An alternative approach to reduce the risk of pneumothorax during erector spinae plane block in low thoracic vertebral levels. *J Clin Anesth*. 2020;59:14–15. doi:10.1016/j.jclinane.2019.06.005
16. Ökmen K, Gürbüz H, Özkan H. Application of unilateral rhomboid intercostal and subserratus plane block for analgesia after laparoscopic cholecystectomy: a quasi-experimental study. *Korean J Anesthesiol*. 2022;75(1):79–85. doi:10.4097/kja.21229
17. Jiang F, Wu A, Liang Y, et al. Assessment of Ultrasound-Guided Continuous Low Serratus Anterior Plane Block for Pain Management After Hepatectomy: a Randomized Controlled Trial. *J Pain Res*. 2023;16:2383–2392. doi:10.2147/jpr.S406498
18. Ryu KH, Kim JA, Ko DC, Lee SH, Choi WJ. Desflurane reduces intraoperative remifentanil requirements more than sevoflurane: comparison using surgical pleth index-guided analgesia. *Br J Anaesth*. 2018;121(5):1115–1122. doi:10.1016/j.bja.2018.05.064
19. Ivanusic J, Konishi Y, Barrington MJ. A cadaveric study investigating the mechanism of action of erector spinae blockade. *Region Anesth Pain M*. 2018;43(6):567–571. doi:10.1097/AAP.0000000000000789
20. Hoogma DF, Van den Eynde R, Oosterlinck W, et al. Erector spinae plane block for postoperative analgesia in robotically-assisted coronary artery bypass surgery: results of a randomized placebo-controlled trial. *J Clin Anesth*. 2023;87:111088. doi:10.1016/j.jclinane.2023.111088
21. Balocco AL, López AM, Kesteloot C, et al. Quadratus lumborum block: an imaging study of three approaches. *Region Anesth Pain M*. 2021;46(1):35–40. doi:10.1136/rapm-2020-101554