Efficacy and Safety of Oxycodone Intravenous Patient-Controlled Analgesia Combined with Thoracic Paravertebral Nerve Block for Postoperative Analgesia in Patients Undergoing Thoracoscopic Esophagectomy: A Randomized Controlled Trial

1. Study Population

This was a prospective, single-center, double-blind, parallel-controlled randomized controlled trial. A total of 160 patients undergoing esophagectomy for esophageal cancer were recruited between June 2023 and June 2024 at our hospital.

Inclusion Criteria:

1. Age between 30 and 70 years;
2. American Society of Anesthesiologists (ASA) physical status classification I or II;
3. Undergoing thoracoscopic esophagectomy at our hospital;
4. Clear consciousness and provision of signed informed consent.

Exclusion Criteria:

1. Patients unwilling to participate or those who had previously enrolled in similar studies;
2. Long-term use of analgesics or other pain medications;
3. Chronic pain or multiple comorbidities, including severe hepatic or renal dysfunction, significant cardiovascular or cerebrovascular disease, or mental disorders;
4. Severe language, hearing, or visual impairment;
5. Conversion to open surgery during the procedure;
6. Coagulation disorders or infection at the injection site;
7. Known allergies to ropivacaine, oxycodone, or sufentanil.

2. Interventions

Randomization was performed using a computer-generated randomization code. Patients were randomly allocated into four groups according to postoperative analgesic interventions:

- **OT Group:** Oxycodone + thoracic paravertebral nerve block (TPVB).
- **ST Group:** Sufentanil + thoracic paravertebral nerve block (TPVB).
- **O Group:** Oxycodone alone.
- **S Group:** Sufentanil alone.

All groups underwent standardized and unified anesthesia protocols. Postoperative analgesia was delivered via intravenous patient-controlled analgesia (PCIA):

- **OT Group and O Group:** Oxycodone 0.8 mg/kg + tropisetron 10 mg + normal saline to a total volume of 100 mL.
- **ST Group and S Group:** Sufentanil 2 μg/kg + tropisetron 10 mg + normal saline to a total volume of 100 mL.
  The PCIA settings were as follows: continuous infusion at 2 mL/h, bolus dose of 0.5 mL, and a lockout interval of 15 minutes.

For the OT and ST groups, TPVB was performed postoperatively under ultrasound guidance at the T6 level on the right side. After the needle tip penetrated the costotransverse ligament, 20 mL of 0.375% ropivacaine was injected. In the O and S groups, a similar puncture procedure was performed, but no local anesthetic was injected.

3. Data Collection and Analysis

1) Clinical Data:

Baseline clinical data were collected, including age, gender, height, weight, BMI, ASA classification (I or II), tumor size and location (proximal, middle, distal, or esophagogastric junction), tumor stage (IA/IB/IIA/IIB/IIIA/IIIB), histological type (squamous cell carcinoma, adenocarcinoma, or other), surgical duration, and intraoperative blood loss.

2) Pain Scores:

Pain levels were assessed using the Visual Analog Scale (VAS) at 2, 4, 8, 12, 24, and 48 hours postoperatively. Both resting pain and movement pain (coughing) were evaluated.

3) PCA Metrics, Postoperative Recovery Indicators, and Sedation Scores:

- PCA parameters: total PCA attempts, PCA effectiveness rate, and use of rescue analgesics.
- Postoperative recovery: extubation time, time to first mobilization, and length of hospital stay.
- Ramsay Sedation Scale: recorded at 2, 4, 8, 12, 24, and 48 hours postoperatively for all groups.

4) Serum Inflammatory Marker Levels:

Levels of TNF-α, IL-6, and IL-10 were measured using enzyme-linked immunosorbent assay (ELISA) at the following time points: preoperatively, and at 12, 24, and 48 hours postoperatively.

5) Postoperative Adverse Events:

Adverse events were recorded within **48 hours postoperatively**, including dizziness,

nausea and vomiting, hypotension, respiratory depression, pruritus, and urinary retention.

6) Patient Satisfaction:
Patients rated their analgesic satisfaction within 48 hours postoperatively using a 5-point scale:

- 5 = Very satisfied
- 4 = Satisfied
- 3 = Neutral
- 2 = Dissatisfied
- 1 = Very dissatisfied