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Effect of superficial cervical plexus nerve block with Ropivacaine or a combination of different adjuvants on perioperative analgesia and quality of postoperative recovery in patients undergoing radical thyroid cancer surgery under general anesthesia: a prospective randomized controlled trial

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Abstract

Objective To investigate the effect of ultrasound-guided bilateral superficial cervical plexus nerve blocks with Ropivacaine or a combination of different adjuvants on perioperative analgesia and quality of postoperative recovery in patients undergoing radical thyroid cancer surgery under general anesthesia with nerve monitoring without muscarinic maintenance.

Methods A total of 140 patients undergoing elective radical thyroid cancer surgery were randomly divided into four groups, with 35 cases in each group: general anesthesia alone group (Group C), general anesthesia + Ropivacaine group (Group R), general anesthesia + Ropivacaine combined with dexmedetomidine group (Group R1), and general anesthesia + Ropivacaine combined with dexamethasone group (Group R2). The primary observation index were postoperative resting and active Visual Analogue Score. The secondary observation index were hemodynamics, intraoperative sedative and analgesic medication use, postoperative analgesic requirements, postoperative recovery indicators, Richards-Campbell Sleep Questionnaire scores, Quality of Postoperative Recovery-15 scores, and adverse reactions.

Results Compared with group C, the resting and active VAS scores in group R were lower within 12 h after surgery ($P < 0.05$), the resting and active VAS scores in groups R1 and R2 were lower within 24 h after surgery ($P < 0.05$). Compared with group R, the VAS scores of patients in groups R1 and R2 were lower within 6 to 24 h after operation

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($P < 0.05$). Compared with group R2, only the sedation score after extubation was higher in R1 group ($P < 0.05$), and there was no statistical difference in any other aspects ($P < 0.05$).

Conclusion Bilateral superficial cervical plexus nerve blocks with Ropivacaine or a combination of different adjuvants are superior to general anesthesia alone in terms of intraoperative hemodynamics, the amount of sedative and analgesic drugs, and analgesic efficacy and quality of recovery in patients undergoing radical thyroid cancer surgery with nerve monitoring without muscarinic maintenance. Ropivacaine combined with an adjuvant has better analgesic effectiveness and quality of recovery than without an adjuvant, and Ropivacaine combined with dexmedetomidine has a better sedation level than dexamethasone.

Keywords Radical thyroid cancer surgery, Superficial cervical plexus nerve blocks, Ropivacaine, Dexmedetomidine, Dexamethasone

Introduction

Thyroid cancer is one of the most common malignant tumors of the endocrine system in the clinic, accounting for about 1% of systemic malignant tumors, and its incidence accounts for the first place of head and neck tumors, and shows an increasing trend year by year [1, 2]. At present, the main method of clinical treatment of thyroid cancer is still radical thyroid cancer surgery. However, due to the special anatomical and physiological location of the thyroid gland and the wide range of stress stimulation of surgical trauma, patients are prone to postoperative complications such as pain, infection and nerve damage, which affect the quality of postoperative recovery of patients [3]. In recent years, with the more in-depth study of superficial cervical plexus nerve block in the treatment of head, neck and shoulder painful diseases, its effect of compound anesthesia and preemptive analgesia for neck surgery have also been widely recognized [4]. The application of Ropivacaine for bilateral superficial cervical plexus block in thyroid surgery can reduce the amount of intraoperative analgesic drugs and effectively reduce postoperative pain response [5]. However, some studies have reported that the duration of analgesia from a single injection of Ropivacaine is only about 4 to 8 h, which is not adequate for longer duration surgeries and postoperative analgesia of the patients [6]. In contrast, previous studies have found that Ropivacaine combined with an adjuvant (dexmedetomidine or dexamethasone) can effectively prolong the duration of nerve block and enhance the analgesic effect of anesthesia [7, 8]. However, the application of Ropivacaine combined with adjuvants in patients undergoing radical thyroid cancer surgery has not been reported in the literature, and the effects on perioperative analgesia and postoperative recovery quality are still unclear. Therefore, in this paper, we investigate the effects of ultrasound-guided bilateral superficial cervical plexus nerve blocks with Ropivacaine or a combination of different adjuvants (dexmedetomidine or dexamethasone) on perioperative analgesia and quality of postoperative recovery in patients undergoing radical thyroid cancer surgery under general anesthesia with nerve monitoring without muscarinic maintenance, to provide reference for optimizing clinical perioperative anesthesia strategies and promoting rapid postoperative recovery of patients undergoing thyroid cancer surgery.

Materials and methods

General information

This study was approved by the Medical Ethics Committee of the People's Hospital of Guangxi Zhuang Autonomous Region (Ethics-New Technology and New Projects-2023–21), with informed consent signed by all patients or their families.

Patients and groups

A total of 140 patients who underwent elective radical thyroid cancer surgery at the People's Hospital of Guangxi Zhuang Autonomous Region from January 2024 to June 2024 were selected. Inclusion Criteria: Age 18 ~ 70 years; American Society of Anesthesiologists (ASA) grade I ~ II; body mass index (BMI) 18 ~ 30 kg/m^2; papillary thyroid carcinoma; Unilateral thyroid lobectomy + isthmus resection + central cervical lymph node dissection + parathyroid exploration was performed; signed informed consent. Exclusion Criteria: Patients with lateral lymph node dissections and total thyroidectomies; Preoperative upper respiratory tract infection and hoarseness; infection and hematoma existed at the injection site; refused nerve block; allergy to study drugs; preoperative hypoxemia; known or suspected difficult airway and oropharyngeal anatomical deformities; psychiatric disorders and inability to cooperate with the operation of the patient; hypertension, diabetes mellitus, history of cerebrovascular accident; long-term use of analgesics, cortisol drugs or psychotropic drugs; inability to cooperate with the completion of the scales used in the study. Elimination Criteria: Those with unanticipated difficult airways, those with difficulty in off-loading or extubation after surgery, and poor diffusion of local anesthetic shown on ultrasound images.

Patients undergoing elective radical thyroid cancer surgery were divided into four groups using a randomized numerical table method: general anesthesia alone group (Group C), general anesthesia + Ropivacaine group (Group R), general anesthesia + Ropivacaine combined with dexmedetomidine group (Group R1), and general anesthesia + Ropivacaine combined with dexamethasone group (Group R2).

Anesthesia protocol

Patients who met the criteria would be visited one day before surgery, and the informed consent was signed. The patients were routinely given oxygen inhalation after admission, noninvasive blood pressure, ECG, temperature, SpO_2, RR, and HR were monitored, BIS sensor was connected to monitor the depth of anesthesia, and radial artery puncture under local anesthesia was used to monitor invasive blood pressure. HR and mean arterial pressure (MAP) were recorded at 5 min after admission (T_0), at the time of skin incision (T_1), at 30 min after operation (T_2), and after extubation (T_3).

Anesthesia induction

General anesthesia was induced by intravenous injection of midazolam 0.03 mg/kg, etomidate 0.15 ~ 0.3 mg/kg, sufentanil 0.5 μg/kg, and rocuronium bromide 0.6 mg/kg. After BIS dropped below 60 and muscle relaxation, a nerve monitoring tracheal tube was inserted under the visual laryngoscope. Mechanical ventilation was performed after intubation, with the setting of a tidal volume of 6 ~ 8 ml/kg, respiratory rate of 10 ~ 14 times/min, the FiO_2 of 60%, and the partial pressure of carbon dioxide at the end of expiration was maintained between 35 ~ 45 mmHg.

After the induction of general anesthesia in group R, group R1, and group R2, a bilateral superficial cervical plexus block was performed under ultrasound guidance. The specific method was as follows: the patient was lying down with the head tilted to the right, and the high-frequency linear array probe was placed above the left sternocleidomastoid muscle, and the anatomical structures such as the sternocleidomastoid muscle, the carotid artery, the internal jugular vein, the superficial layer of deep cervical fascia, the deep layer of deep cervical fascia and the transverse cervical eminence of cervical four were identified with ultrasound imaging at the 4th cervical level. The puncture needle was inserted from the outside to the inside, and the in-plane insertion technique was used to inject the local anesthetic into the superficial layer of the deep cervical fascia and the deep layer of the deep cervical fascia. The same method was used for the right cervical nerve block, and all patients were subjected to bilateral block by the same anesthesiologist skilled in this technique. The application of local anesthetics in each group was as follows: patients in group R were injected with 16 ml of 0.5% Ropivacaine and 8 ml was administered on each side; patients in group R1 were injected with 16 ml of 0.5% Ropivacaine + 0.25 μg/kg dexmedetomidine mixture, and 8 ml was administered on each side; patients in group R2 were injected with 16 ml of 0.5% Ropivacaine + 8 mg dexamethasone mixture, and 8 ml was administered on each side; and patients in group C were not given special treatment.

Anesthesia maintenance

Intravenous injection of remifentanil 0.1 ~ 0.4 $\mu g \cdot kg^{-1} \cdot min^{-1}$ and propofol 2 ~ 10 $mg \cdot kg^{-1} \cdot h^{-1}$, inhalation of sevoflurane 0.5% ~ 2%, maintenance of SpO_2 above 95%, and MAP and HR fluctuation not more than 20% of its fundamental value, BIS value between 40 ~ 60 and end-expiratory carbon dioxide between 35 ~ 45 mmHg. Anesthesiologists intermittently added sufentanil according to clinical needs and selected appropriate vasoactive drugs to maintain vital signs.

After the surgery

Patients in all four groups were treated with Patient-Controlled Intravenous Analgesia (PCIA), with the following formula: sufentanil 1 μg/kg + tropisetron 5 mg + 0.9% saline to 100 ml. Parameter settings: the background infusion rate was 4 ml per hour. When the patient's postoperative pain was obvious (VAS score > 3), report to the supervising physician, and 70 μg of cobotide injection was injected intramuscularly. It was discontinued at 24 h after operation. This kind of surgery in our hospital needs to observe whether the patient has lymphatic leakage or hypocalcemia after surgery, and the patient needs to be observed for three days after the operation before discharge.

Observation indexes

Primary observation index

The primary observation indexes were postoperative resting and active visual analogue score (VAS) scores. The resting and active incision VAS were recorded at five time points: awake, 6 h, 12 h, 24 h, and 48 h after the operation to evaluate the patient's postoperative pain.

Secondary observation indexes

The following were used as secondary observation indexes.

1. The patients' HR and MAP were recorded at 5 min after admission (T_0), at the time of skin incision (T_1),

at 30 min after operation (T_2), and after extubation (T_3), and the changes in the values of HR and MAP at each time point minus T0 were calculated and recorded as ΔHR_1, ΔHR_2, and ΔHR_3 and ΔMAP_1, ΔMAP_2, and ΔMAP_3.

2. The dosage of remifentanil, sufentanil, propofol, and sevoflurane during the operation was recorded.
3. The number of remedial analgesia cases within 24 h after the operation (no matter how many times a patient presents, it was recorded as one case), the time of first remedial analgesia (the time from patient waking up to the first need for remedial analgesia), and the satisfaction score of analgesia with the Likert scale at the end of PCIA pump use were recorded.
4. The postoperative recovery time (the time from the discontinuation of anesthetic drugs to the patient's recovery), extubation time (the time from the discontinuation of anesthetic drugs to the patient's extubation), out of the resuscitation room time (the time from the discontinuation of anesthetic drugs to the patient's out of the resuscitation room), sedation score after extubation (Ramsay score), the application of the Chinese version of the Richards-Campbell Sleep Questionnaire (RCSQ) to evaluate the patient's preoperative, postoperative night, one day after operation of night sleep quality, the application of Quality of Postoperative Recovery-15 (QoR-15) to evaluate the patient's preoperative, one day after operation and two day after operation of recovery quality.
5. The incidence of postoperative adverse reactions (such as hoarseness, choking on drinking water, dyspnea, nausea and vomiting, hypertension, hypotension, and dizziness) in patients was recorded.

The QoR-15 score, a 15-item quality of recovery scale, consists of 5 dimensions: physical comfort (5 items), emotional state (4 items), pain (2 items), psychological support (2 items), and physical independence (2 items), each of which is assessed using an 11-point numerical rating scale, with a total score ranging from 0 (feeble recovery) to 150 (all good recovery); The RCSQ score is the Richards-Campbell Sleepiness Scale. The mean of the sum of the scores of the visualization scale consisting of 5 entries (including sleep depth, sleep latency, nocturnal arousal, return to sleep, and sleep quality) is the total RCSQ score, with higher scores indicating better sleep quality.

Statistical analysis

All data were processed for statistical analysis using IBM SPSS Statistics 22.0 software. Normally distributed measures were expressed as mean ± standard deviation ($\bar{x}$±s), and one-way ANOVA was used for multi-group comparisons. Skewed distributed measures were expressed as median and quartile M (P25, P75), and a multi-group rank-sum test was used for inter-group comparisons. Count data were expressed as cases or rates [n(%)], and the chi-square test (χ^2) or Fisher's exact probability method was used for inter-group comparisons. Comparisons at different time points were analyzed using ANOVA for repeated measures. Kaplan–Meier curves were generated, and the log-rank test was applied to analyze the time to first remedial analgesia. $P < 0.05$ was considered statistically significant.

Results

A total of 140 patients undergoing elective radical thyroid cancer surgery under general anesthesia with nerve monitoring without muscarinic maintenance were enrolled in the qualification assessment, of which 3 patients were excluded because they refused to participate in the trial, 1 patient was excluded because he did not meet the inclusion criteria of the trial (BMI > 30 kg/m^2), 2 patients withdrew from the trial halfway, 2 patients were excluded from the study due to surgical complications (1 case of postoperative lymphatic leakage, 1 case of postoperative hypocalcemia), and finally 132 patients were included in the trial (Fig. 1).

General data

There was no significant difference in gender, age, BMI, ASA grade, operation time, anesthesia time, and bleeding volume among the four groups ($P > 0.05$); That is, the four groups were comparable (Table 1).

Hemodynamic changes

Compared with group C, ΔHR_1, ΔHR_2 and ΔHR_3 and ΔMAP_1, ΔMAP_2 and ΔMAP_3 in group R, group R1, and group R2 were smaller ($P < 0.05$). Compared with group R, ΔHR3 in group R1 was smaller ($P < 0.05$) (Table 2).

Intraoperative sedative and analgesic medication use

The consumption of remifentanil, sufentanil, and sevoflurane during anesthesia in group R, group R1, and group R2 was lower than that in group C ($P < 0.05$) (Table 3).

VAS scores and postoperative analgesic requirements

VAS scores

Compared with group C, the resting and active VAS scores of patients in group R were lower within 12 h after operation ($P < 0.05$), and the resting and active VAS scores of patients in group R1 and R2 were lower within 24 h after operation ($P < 0.05$). Compared with group R, the active VAS scores of patients in group R1 and group

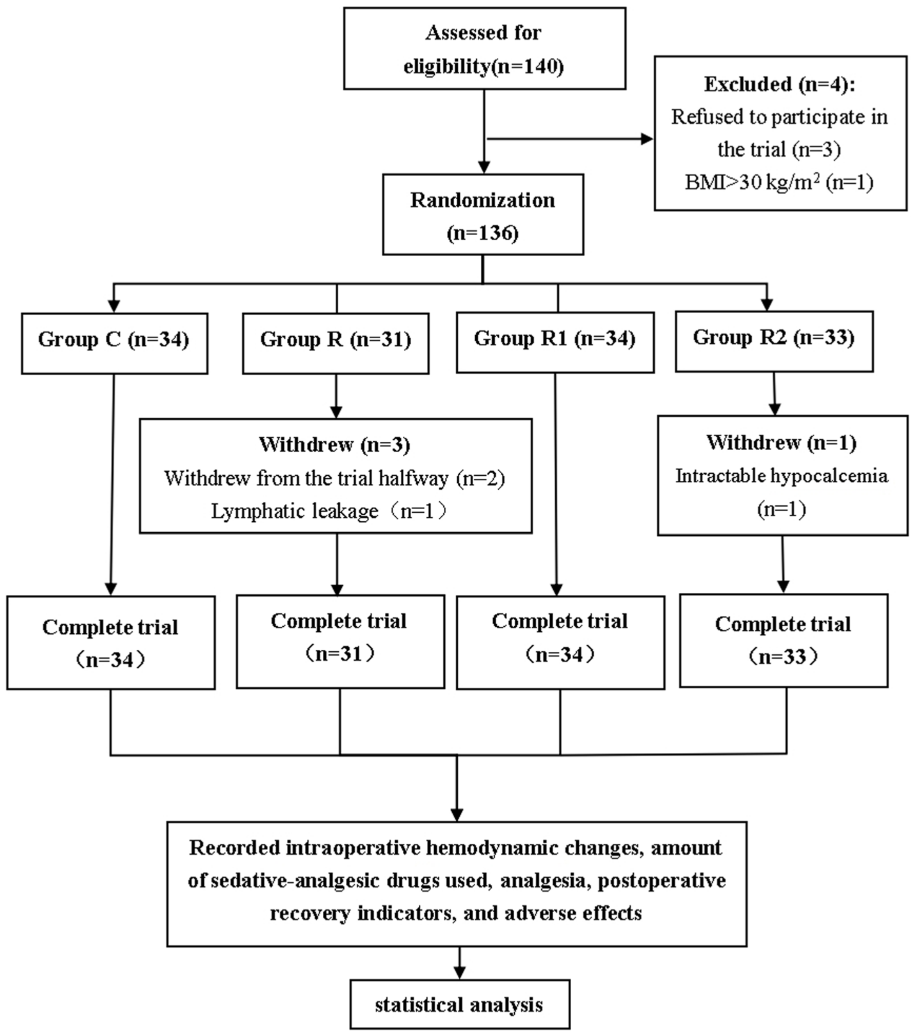

Fig. 1 Flow chart

Table 1 Comparison of the General Information in the Four Groups of Patients

Groups	Group C($n=34$)	Group R($n=31$)	Group R1($n=34$)	Group R2($n=33$)	t/χ^2	P
Sex, n (%)					6.840	0.077
Male	4(11.76)	5(16.13)	7(20.59)	12(36.36)		
Female	30(88.24)	26(83.87)	27(79.41)	21(63.64)		
Age (year)	44.38 ± 12.01	43.16 ± 10.06	44.65 ± 13.09	43.58 ± 11.36	0.113	0.952
ASA Grade, n (%)					0.49	0.920
I	27(79.41)	23(74.19)	25(73.53)	24(72.73)		
II	7(20.59)	8(25.81)	9(26.47)	9(27.27)		
BMI (kg/m^2)	22.80 ± 2.95	22.89 ± 3.22	23.53 ± 3.68	23.84 ± 3.31	0.752	0.523
Operation Time (min)	103(69,148)	95(80,130)	100(79,116)	110(85,153)	1.645	0.649
Anesthesia Time (min)	147.35 ± 69.18	125(100,150)	136.18 ± 48.56	135(110,185)	1.151	0.680
Bleeding Volume (ml)	10(9,12)	10(5,10)	10(10,15)	10(10,10)	1.296	0.730

Group C: general anesthesia alone group; Group R: general anesthesia + ropivacaine group; Group R1: general anesthesia + ropivacaine combined with dexmedetomidine group; Group R2: general anesthesia + ropivacaine combined with dexamethasone group. Operation time: the time from the beginning of skin incision to the completion of the last stitch of skin suture; anesthesia time: the time from the beginning of anesthesia induction to the discontinuation of all anesthetics

Abbreviations: ASA American Society of Anesthesiologists, *BMI* Body mass index

Table 2 Comparison of Intraoperative Heart Rate and Blood Pressure Changes in the Four Groups of Patients

	Group C($n=34$)	Group R($n=31$)	Group R1($n=34$)	Group R2($n=33$)
ΔHR(times/min)				
ΔHR_1	−11.68 ± 5.00	−6.52 ± 3.70[a]	−7.94 ± 3.80[a]	−7.52 ± 3.46[a]
ΔHR_2	−12.59 ± 6.47	−5.94 ± 3.55[a]	−7.68 ± 3.46[a]	−7.58 ± 3.23[a]
ΔHR_3	10.12 ± 4.57	7.74 ± 4.45[a]	4.85 ± 2.57[ab]	6.03 ± 3.03[a]
ΔMAP(mmHg)				
ΔMAP_1	−12.38 ± 6.30	−7.32 ± 4.85[a]	−6.35 ± 4.14[a]	−6.94 ± 3.98[a]
ΔMAP_2	8.38 ± 4.98	5.29 ± 3.56[a]	5.41 ± 3.68[a]	4.61 ± 3.53[a]
ΔMAP_3	7.47 ± 3.76	5.61 ± 3.99[a]	4.24 ± 2.28[a]	5.67 ± 3.39[a]

Compared with group C, [a] $P < 0.05$; compared with group R, [b] $P < 0.05$; compared with group R2, [c] $P < 0.05$

Abbreviations: HR Heart rate, *MAP* Mean arterial pressure, T_0: at 5 min after admission; T_1: at the time of skin incision; T_2: at 30 min after operation; T_3: after extubation; The changes of HR and MAP at each time point minus T0 were recorded as ΔHR_1, ΔHR_2, and ΔHR_3 and ΔMAP_1, ΔMAP_2, and ΔMAP_3

Table 3 Comparison of the Dosage of Sedative and Analgesic Drugs during Anesthesia in the Four Groups of Patients

Groups	Propofol (10mg/ml)	Remifentanil (μg)	Sufentanil (μg)	Sevoflurane (ml)
Group C($n=34$)	48.00(34.00,58.00)	1440.00(1175.00,2000.00)	30.00(25.00,30.00)	14.40(10.80,25.20)
Group R($n=31$)	41.00(35.00,45.00)	1100.00(820.00,1700.00) [a]	20.00(20.00,20.00) [a]	7.20(3.60,10.80) [a]
Group R1($n=34$)	39.00(33.00,50.00)	1100.00(820.00,1300.00) [a]	20.00(20.00,25.00) [a]	7.20(3.60,10.80) [a]
Group R2($n=33$)	40.00(33.50,50.00)	1140.00(900.00,1700.00) [a]	20.00(20.00,25.00) [a]	7.20(5.40,14.40) [a]

Compared with group C, [a] $P < 0.05$; compared with group R, [b] $P < 0.05$; compared with group R2, [c] $P < 0.05$

Table 4 Comparison of VAS Scores at Rest in Four Groups of Patients

the Resting VAS Scores	Group C($n=34$)	Group R($n=31$)	Group R1($n=34$)	Group R2($n=33$)
On Awakening after Surgery	1(1,2)	0(0,0) [a]	0(0,0) [a]	0(0,0) [a]
6 h after Operation	2(1,3)	0(0,0) [a]	0(0,0) [a]	0(0,0) [a]
12 h after Operation	2(1,3)	1(1,2) [a]	0(0,1) [ab]	0(0,1) [ab]
24 h after Operation	1(0,2)	1(0,1)	1(0,1) [a]	1(0,1) [a]
48 h after Operation	1(0,1)	1(0,1)	1(0,1)	1(0,1)

Compared with group C, [a] $P < 0.05$; compared with group R, [b] $P < 0.05$; compared with group R2, [c] $P < 0.05$

Abbreviations: VAS Scores Visual Analogue Score that expresses the degree of pain as a total of 11 numbers from 0 to 10, with 0 being no pain and 10 being the most painful

Table 5 Comparison of VAS Scores during Activity in Four Groups of Patients

the Active VAS Scores	Group C($n=34$)	Group R($n=31$)	Group R1($n=34$)	Group R2($n=33$)
On Awakening after Surgery	2(1,2)	0(0,0) [a]	0(0,0) [a]	0(0,0) [a]
6 h after Operation	3(2,4)	1(1,2) [a]	0(0,1) [ab]	0(0,1) [ab]
12 h after Operation	2(2,3)	1(1,3) [a]	1(0,1) [ab]	1(0,1) [ab]
24 h after Operation	2(2,3)	2(1,3)	1(1,1) [ab]	1(0,2) [ab]
48 h after Operation	1(1,2)	1(1,2)	1(1,2)	1(1,1)

Compared with group C, [a] $P < 0.05$; compared with group R, [b] $P < 0.05$; compared with group R2, [c] $P < 0.05$

Abbreviations: VAS Scores: Visual Analogue Score that expresses the degree of pain as a total of 11 numbers from 0 to 10, with 0 being no pain and 10 being the most painful

R2 were lower within 6 ~ 24 h after operation ($P < 0.05$) (Tables 4 and 5).

Postoperative analgesic requirements

Compared with group C, the number of patients in group R, group R1, and group R2 who needed remedial analgesia within 24 h after operation was less, the time of first remedial analgesia was longer, and the score of analgesia satisfaction was higher ($P < 0.05$). Compared with group R, patients in group R1 and group R2 needed less remedial analgesia within 24 h after operation, the time of first remedial analgesia was significantly prolonged, and the score of analgesia satisfaction was higher ($P < 0.05$) (Fig. 2, Table 6).

Postoperative recovery indicators

Recovery time, extubation time, time out of the resuscitation room, Ramsay sedation score after extubation, length of hospital stay

Compared with group C, the postoperative recovery time, extubation time and time out of the resuscitation room of patients in groups R, R1, and R2 were shorter ($P < 0.05$), and the sedation score after extubation was higher ($P < 0.05$). Compared with group R, the postoperative recovery time of patients in group R1 and group R2 was shorter ($P < 0.05$). Compared with group R2, patients in group R1 had a higher sedation score after extubation($P < 0.05$) (Table 7).

Table 6 Comparison of Remedial Analgesia within 24 Hours and Satisfaction in the Four Groups of Patients

Groups	Remedial Analgesia within 24h after Surgery, n (%)	Likert's Satisfaction Scores
Group C($n = 34$)	23(67.65)	4(3,4)
Group R($n = 31$)	10(32.26) [a]	4(4,5) [a]
Group R1($n = 34$)	2(5.88) [ab]	5(5,5) [ab]
Group R2($n = 33$)	2(6.06) [ab]	5(5,5) [ab]

Compared with group C, [a] $P < 0.05$; compared with group R, [b] $P < 0.05$; compared with group R2, [c] $P < 0.05$

Abbreviations: Likert Scale Score: 1 as completely dissatisfied; 2 as partially dissatisfied; 3 as slightly dissatisfied; 4 as relatively satisfied; and 5 as completely satisfied

Postoperative ECSQ scores and QoR-15 scores

Compared with group C, the postoperative RCSQ score and QoR-15 score were higher in group R, group R1, and group R2 ($P < 0.05$). Compared with group R, patients in group R1 and group R2 had higher postoperative RCSQ scores and QoR-15 scores on the first day after surgery ($P < 0.05$) (Fig. 3, Table 8).

Incidence of postoperative adverse reactions

Compared with group C, the total incidence of postoperative adverse reactions in group R, group R1, and group R2 was lower ($P < 0.05$), including nausea and

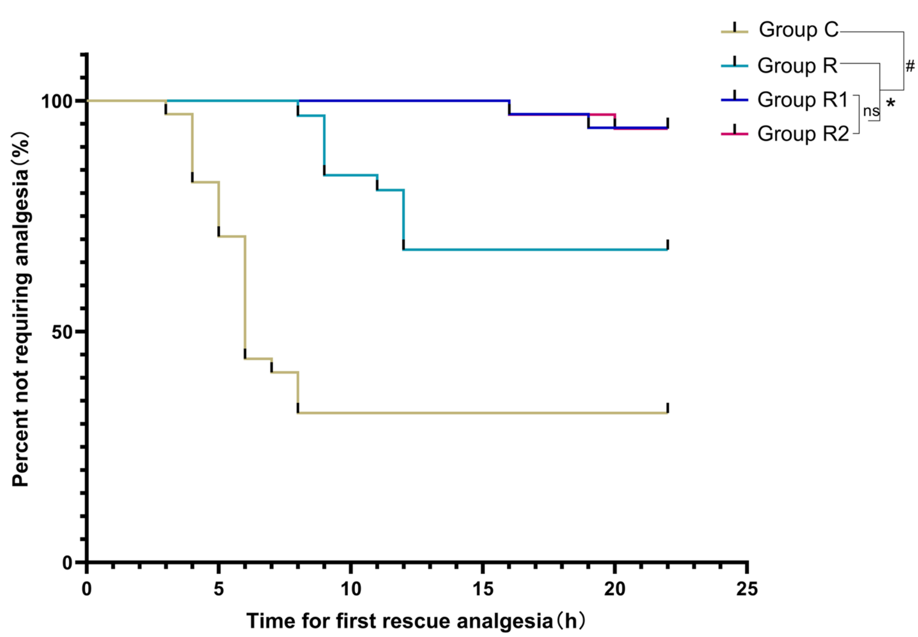

Fig. 2 Comparison of first rescue analgesia time in the four groups of patients. Note: Kaplan–Meier curves were generated, and the log-rank test was applied to analyze the time to first remedial analgesia; Compared with group C, [a] $P < 0.05$; compared with group R, [b] $P < 0.05$; compared with group R2, [c] $P < 0.05$.

Table 7 Comparison of Recovery Time, Extubation Time, Time out of the Resuscitation Room, Ramsay Sedation Score after Extubation and Length of Hospital Stay in the Four Groups of Patients

Groups	Recovery Time (min)	Extubation Time (min)	Time out of the Resuscitation Room (min)	Ramsay's Sedation Score after Extubation	Length of Hospital Stay (day)
Group C($n=34$)	24.03 ± 9.65	31.59 ± 8.19	71.41 ± 18.03	2.00(1.00,2.00)	7.56 ± 1.65
Group R($n=31$)	14.81 ± 4.94[a]	25.37 ± 10.17[a]	59.29 ± 10.78[a]	2.00(2.00,2.00) [a]	7.52 ± 2.32
Group R1($n=34$)	16.76 ± 7.29[a]	25.38 ± 10.17[a]	50.35 ± 8.10[ab]	2.00(2.00,3.00) [ab]	7.18 ± 1.48
Group R2($n=33$)	14.15 ± 6.49[a]	22.76 ± 6.99 [a]	50.00 ± 13.81[ab]	2.00(2.00,2.00) [ac]	7.15 ± 2.28

Compared with group C, [a] $P<0.05$; compared with group R, [b] $P<0.05$; compared with group R2, [c] $P<0.05$

Abbreviations: Ramsay's Sedation Score: 1 for irritability; 2 for quiet cooperation; 3 for following commands only; 4 for drowsy state but rapid response to stimuli; 5 for slow response to stimuli; 6 for no response to stimulation

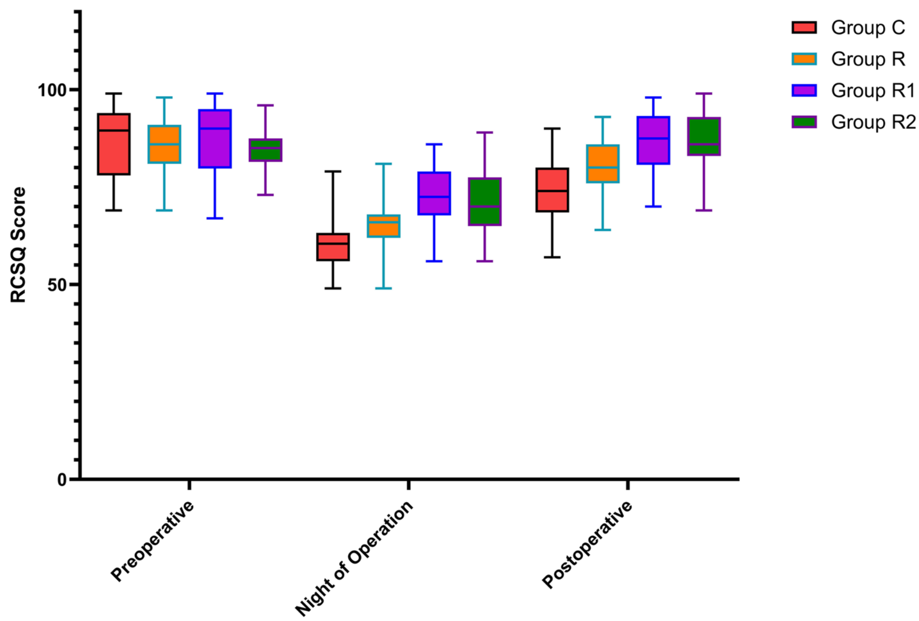

Fig. 3 Comparison of RCSQ score in the four groups of patients

Table 8 Comparison of QoR-15 Score in the Four Groups of Patients

QoR-15 Score	Group C($n=34$)	Group R($n=31$)	Group R1($n=34$)	Group R2($n=33$)
Preoperative	149.00(145.00,150.00)	149.00(137.00,150.00)	149.00(147.00,149.25)	145.00(141.50,148.00)
the First Day after Surgery	111.00(105.00,114.00)	119.00(107.00,131.00) [a]	124.50(119.75,131.00) [ab]	129.00(121.00,134.00) [ab]
the Second Day after Surgery	130.50(125.00,137.50)	144.00(139.00,148.00) [a]	142.00(142.00,145.00) [a]	142.70(139.50,147.50) [a]

Compared with group C, [a] $P<0.05$; compared with group R, [b] $P<0.05$; compared with group R2, [c] $P<0.05$

vomiting, and dizziness, which were statistically different ($P<0.05$) (Fig. 4, Table 9).

Discussion

Thyroid cancer is the highest incidence of endocrine tumors, and it is also the fastest rising incidence of solid tumor in the world [9]. Radical thyroid cancer surgery has a significant therapeutic effect and a low incidence of complications [10]. It can effectively achieve high survival rate of patients and has strong safety and reliability in clinical application [11], and it is still the main method for clinical treatment of thyroid cancer [12, 13]. The peripheral nerves of the thyroid gland are abundant, and nerve-monitored radical thyroid cancer surgery is

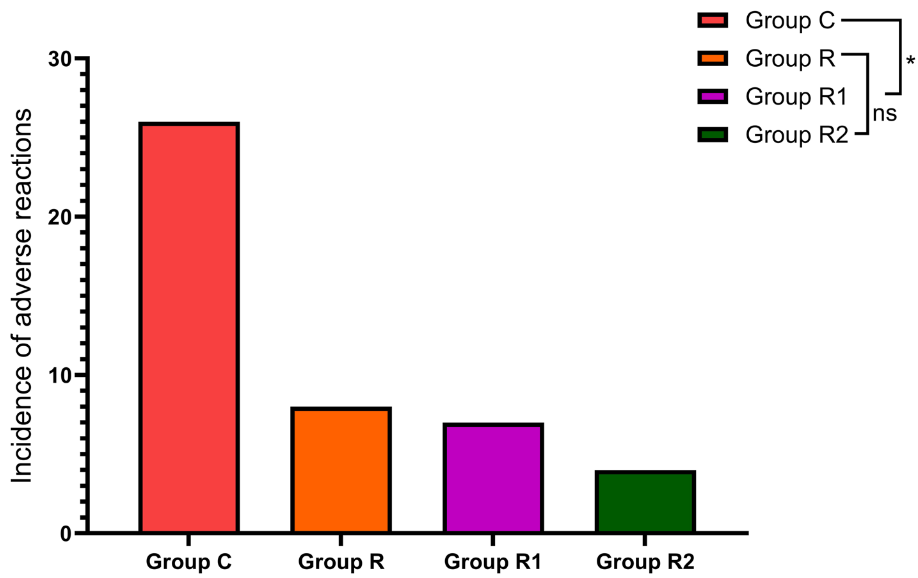

Fig. 4 Comparison of the incidence of adverse reactions in four groups of patients

Table 9 Comparison of Postoperative Adverse Reactions in Four Groups of Patients

Groups	Hoarseness	Choking on Drinking Water	Dyspnea	Nausea and Vomiting	Hypertension	Hypotension	Dizziness
Group C($n=34$)	2(5.88)	1(2.94)	0(0)	16(47.06)	1(2.94)	6(17.65)	19(55.88)
Group R($n=31$)	1(3.23)	1(3.23)	0(0)	5(16.13) [a]	0(0)	1(3.23)	7(22.58) [a]
Group R1($n=34$)	0(0)	1(2.94)	0(0)	4(14.76) [a]	0(0)	1(2.94)	5(14.71) [a]
Group R2($n=33$)	0(0)	0(0)	0(0)	1(3.03) [a]	0(0)	0(0.0)	3(9.09) [a]

Compared with group C, [a] $P<0.05$; compared with group R, [b] $P<0.05$; compared with group R2, [c] $P<0.05$

extensive and time-consuming due to the specificity of the intraoperative incision location, and intraoperative anesthesia drugs are more frequently applied [14]. Compared with other operations, the pain of patients after operation will be more intense, and the degree of pain is mostly moderate, with more adverse reactions, and the quality of postoperative recovery is poor [15]. Consistently, the study of Wang. et al. also showed that patients undergoing radical thyroidectomy experience different degrees of pain after surgery. Although the degree of pain can be alleviated by drugs, there are still some patients with poor control of the degree of pain due to large individual differences [16], leading to a high incidence of postoperative complications and affecting the quality of postoperative recovery [17]. General anesthesia is the main anesthesia method for radical thyroid cancer surgery, but under the influence of large amounts of opioids and surgical operations during general anesthesia, patients are prone to hemodynamic instability, increased inflammatory response to stress, and the presence of postoperative delayed awakening, nausea and vomiting, and other adverse reactions, which seriously affects the quality of the patient's postoperative recovery [18, 19]. Under the concept of Rapid Recovery Surgery, reducing pain, improving comfort, and promoting rapid postoperative recovery of patients have been the vital clinical objectives of anesthesiology. The superficial cervical plexus nerve at the midpoint of the posterior border of the sternocleidomastoid muscle has a radial distribution, covering the entire surgical area of radical thyroid cancer surgery, and nerve block at this point can effectively alleviate the pain of the incision in the anterior cervical region [20]. Studies related to the analgesic effect of thyroid surgery also found that the general anesthesia combined with superficial cervical plexus block group had significantly lower pain scores, significantly longer time to first need for analgesia, less consumption of opioids and total analgesics in the 24-h postoperative period, and a lower incidence of nausea and vomiting in the postoperative period [21], which markedly reduced the degree of postoperative pain in the patients and improved the quality of recovery and satisfaction of the patients [22]. However, a single injection of Ropivacaine has a limited duration of action [6], and adding adjuvants such as dexmedetomidine or dexamethasone enhances the anesthetic analgesic effect and prolongs the duration of nerve block [23–25]. Therefore, this study explored the postoperative analgesia of patients under simple general anesthesia, simple Ropivacaine for superficial cervical plexus block, and Ropivacaine combined with dexmedetomidine or dexamethasone for superficial cervical plexus block to provide a reference for the optimal anesthesia strategy and rapid postoperative rehabilitation of patients with thyroid cancer during the clinical perioperative period.

To investigate the difference between general anesthesia combined with bilateral superficial cervical plexus nerve block and general anesthesia alone for postoperative analgesia in patients undergoing radical thyroid cancer surgery, we performed a comparison of each group with Group C. Our results showed that compared with group C, the changes of HR and MAP in the other three groups were smaller, and the use of sedative and analgesic drugs was less. The postoperative VAS score was lower, postoperative analgesia demand was less, and the incidence of nausea and vomiting, and dizziness was lower. Postoperative recovery, sleep quality, and recovery quality are also better, suggesting that compared with general anesthesia alone, general anesthesia combined with bilateral superficial cervical plexus block is more stable with intraoperative hemodynamics, effectively reducing the use of sedative and analgesic drugs during anesthesia, and more beneficial to postoperative analgesia and postoperative recovery. Studies have shown that general anesthesia combined with bilateral superficial cervical plexus block can provide analgesia for up to 24 h after thyroid surgery, reducing the demand for remedial analgesia, effectively decreasing the amount of postoperative analgesic medication used by patients [26, 27], decreasing postoperative pain and improving the quality of recovery and patient satisfaction [22]. The results of this study are consistent with previous studies. The reason may be that bilateral superficial cervical plexus block combined with general anesthesia not only maintains the advantages of general anesthesia, but also makes up for the shortcomings of general anesthesia hemodynamic instability and the need for extensive use of sedative and analgesic drugs. The application of Ropivacaine in superficial cervical plexus block also effectively inhibits the perception of incision pain in patients during the period of anesthesia awakening to reduce the incidence of postoperative adverse reactions and improve the quality of prognosis of patients.

To further investigate the effects of Ropivacaine combined with adjuvant for superficial cervical plexus nerve block and without adjuvant on postoperative analgesia in patients undergoing radical surgery for thyroid cancer, we performed a comparison of the R1 and R2 groups with the R group. The results of this study showed that compared with group R, patients in group R1 had more minor changes in heart rate after extubation (T_3); patients in groups R1 and R2 had lower postoperative VAS scores, less need for postoperative analgesia, shorter time out of the resuscitation room, and better quality of postoperative sleep and quality of postoperative recovery on the first day of operation, suggesting that Ropivacaine compounded with adjuvant for nerve block has a better effect of analgesia than without adjuvant, in which Ropivacaine combined with dexmedetomidine can make the patient hemodynamically more stable. Previous studies have shown that adding dexmedetomidine [28] or dexamethasone [29] to long-acting local anesthetics for peripheral nerve block can reduce intraoperative analgesic drugs, stabilize intraoperative hemodynamics, and prolong the duration of postoperative analgesia. It has also been shown that nerve block with Ropivacaine combined with dexmedetomidine or dexamethasone prolongs the time to first postoperative analgesia, reduces the amount of perioperative sufentanil and postoperative analgesic medications, and decreases postoperative NRS scores in patients undergoing thoracoscopic lobectomy [30]. Our results are consistent with previous studies. Ropivacaine combined with dexmedetomidine can make the patient's hemodynamics more stable. The reason may be that dexmedetomidine, as a highly selective α_2 adrenergic receptor agonist, which itself has sedative and analgesic effects, reduces stress response and stabilizes hemodynamics [31], can stabilize the intraoperative hemodynamics of the patients more efficiently when it is used as an adjuvant to Ropivacaine for nerve block. The possible reason for the effect of Ropivacaine combined with dexmedetomidine or dexamethasone on postoperative analgesia is that the analgesic effect of patients after bilateral superficial cervical plexus block is definite, the use of sedative and analgesic drugs during the perioperative period is significantly reduced, and the neck discomfort is effectively improved. The incidence of related adverse reactions is lower, which is more beneficial to the rapid recovery of patients after surgery. The possible mechanisms of action are: dexmedetomidine may inhibit pain transmission by binding to α2 adrenergic receptors in peripheral nerves, which reduces the release of norepinephrine from nerve endings and affects the direct action of δ/c-fiber action potentials, resulting in peripheral analgesia [32, 33]; Dexamethasone may inhibit the synthesis and secretion of inflammatory mediators by constricting local blood vessels and prolonging the retention time of local anesthetics around the nerves; or reduce the transmission of neurotransmitters in unmyelinated c-fibers, thereby synergistically exerting a better analgesic effect with Ropivacaine [34, 35].

To further explore the effects of Ropivacaine compounded with dexmedetomidine and Ropivacaine compounded with dexamethasone on postoperative analgesia in patients undergoing radical surgery for thyroid cancer, we compared group R1 and group R2. The results showed that compared with group R2, the sedation score of patients in group R1 was higher after extubation, suggesting that Ropivacaine compounded with dexmedetomidine had a better sedative effect than compounded with dexamethasone and that patients had less postoperative analgesia demand, the possible reason is that dexmedetomidine has sedative, analgesic and hypnotic effects, which can reduce perioperative stress response and enhance the peripheral nerve block effect of local anesthetics [36], and therefore sedation is superior to dexamethasone.

The superficial cervical plexus nerves are purely sensory nerves, and ultrasound-guided bilateral superficial cervical plexus nerve blocks have essentially no blocking effect on the vagus nerve and its branches. In this study, there was no difference in the occurrence of hoarseness and choking on drinking water between the two groups, and there were no cases of respiratory distress in either group, indicating that ultrasound-guided bilateral superficial cervical plexus nerve blocks are safe and reliable. Studies have shown that patients who use 0.5% Ropivacaine for ultrasound-guided bilateral superficial cervical plexus block have lower intraoperative anesthetic consumption, better postoperative analgesic effect and quality of rehabilitation, and can take into account safety and effectiveness [37]; different concentrations of dexmedetomidine were added to the adductor canal block of Ropivacaine. The results showed that 0.25μg/kg and 0.5μg/kg dexmedetomidine could prolong the analgesic time after adductor canal block [38]; ultrasound-guided bilateral transversus abdominis block, each side of 4mg dexamethasone as an adjuvant added to the local anesthetic solution prolonged the time required for analgesia [39]. Therefore, from the perspective of safety and effectiveness, this study used 0.5% Ropivacaine concentration, 0.25μg/kg dexmedetomidine dose, and 4 mg dexamethasone dose on each side.

Evaluation of lymph node metastasis by means of ultrasound, CT, and other imaging tests is usually required prior to surgery. When patients with thyroid cancer have no cervical lymph node metastasis, or have only a small amount of lymph node metastasis and are limited to the central region of the neck, it is suitable for central cervical lymph node dissection. There is no significant difference in survival rate between the results of prophylactic and therapeutic cervical lymph node dissection in clinical practice [40]. In addition, modern radical thyroid cancer surgery has evolved from purely pursuing tumor eradication to both eradication and functional protection [41]. Prophylactic central regional lymph node dissection on the side of the lesion is recommended to help remove possible cervical lymph node metastases and reduce the risk of recurrence [42]. Parathyroid glands are one of the endocrine glands in the human body, located in the fibrous capsule between the intrinsic and surgical membranes of the thyroid gland, and are responsible for the secretion of parathyroid hormone and the regulation of calcium and phosphorus metabolism in the body. It has more variability in size, shape, number, location and blood supply, which creates difficulties in protecting the parathyroid glands during surgery. If the parathyroid glands are damaged or mistakenly cut during surgery, it may lead to serious complications such as postoperative hypocalcemia, and permanent hypoparathyroidism, which the patient is prone to after surgery [13]. When performing thyroidectomy, the parathyroid glands need to be explored to ensure that their function is not damaged or the degree of damage is minimal [43]. Therefore, all patients in our study underwent parathyroid exploration and central cervical lymph node dissection.

Differentiated thyroid cancer is a kind of malignant tumor originating from the follicular epithelial cells of the thyroid gland, mainly including papillary thyroid cancer and follicular thyroid cancer, of which papillary thyroid cancer accounts for about 80% of all thyroid cancers [44]. Based on the following two reasons, our study only selected patients diagnosed with papillary thyroid carcinoma. First, as mentioned above, papillary thyroid cancer is the most common type of thyroid cancer, with relatively unique biological characteristics and clinical manifestations. Considering that there are certain differences between other types of thyroid cancer and papillary thyroid cancer in terms of symptoms, diagnosis, and treatment, etc., our study expects to reduce the bias and interference due to the differences in the types of the disease by focusing on this specific type, and to more accurately evaluate the effectiveness and usefulness of bilateral superficial cervical plexus nerve blocks with ropivacaine or a combination of different adjuvants on the effects of perioperative analgesia and the quality of postoperative recovery in these patients. It also makes the research more rigorous and reliable in terms of study design and statistical analysis. Secondly, it is true that the number of patients with thyroid cancer diagnosed as papillary thyroid carcinoma is larger than that of other types of patients, accounting for about 80% ~ 90% of all patients with thyroid cancer. Therefore, after thorough consideration we prioritized patients diagnosed only with papillary thyroid cancer for the study. It is worth noting that although there is a rationale and necessity for our selection of patients diagnosed with papillary thyroid cancer for the study, this does not mean that other types of thyroid cancer are not worth studying. Indeed, research into the different types of thyroid cancer is equally vital and rewarding.

Our nerve blocks are all performed after induction of anesthesia and during preoperative hand washing by the surgeon, which takes about 5 min to complete (It does not delay the surgical operation of the surgeon and does not extend the stay time of the patient in the operating room). The block location is superficial, simple to operate, easy to learn and master. If there is no ultrasound equipment, traditional anatomical positioning puncture can be directly performed, which is easy to promote. The cost of our nerve block is about 50 yuan, or about 80 yuan for a single session if the postoperative pain intensity of the patient is large and remedial analgesia is needed. Our experimental results suggest that performing nerve blocks does not additionally prolong the duration of the procedure, is more beneficial to pain control, and patients require less postoperative remedial analgesia, which can result in lower costs to the patient.

This study also has some limitations: (1) the observation time of this study is relatively short, only 1 ~ 2 days after the operation of the patient's analgesia and the quality of recovery, did not follow up the quality of the patient's postoperative recovery at 1 week, 1 month, 3 months or even longer, can only assess the short-term prognosis of the patient; (2) This study is a prospective controlled clinical study with small sample size, so it is necessary to expand further the number of cases to be followed up and analyzed; (3) This study set the study drugs according to the pre-experiment and previous reports in the literature and did not conduct plasma drug concentration testing, so the optimal concentration and dosage of the specific drugs need to be verified in further randomized controlled trials with a more significant number of subjects; (4) The results of this study are applicable to the restricted subset of thyroid cancer patients, and we hope that the scope of the study can be expanded in future studies to further improve the clinical perioperative anesthesia strategies for patients with thyroid cancer and provide a reference for promoting rapid postoperative recovery.

Conclusion

Bilateral superficial cervical plexus nerve blocks with Ropivacaine or a combination of different adjuvants are superior to general anesthesia alone in terms of intraoperative hemodynamics, the amount of sedative and analgesic drugs, and analgesic efficacy and quality of recovery in patients undergoing radical thyroid cancer surgery with nerve monitoring without muscarinic maintenance. Ropivacaine combined with an adjuvant has better analgesic effectiveness and quality of recovery than without an adjuvant, and Ropivacaine combined with dexmedetomidine has a better sedation level than dexamethasone. This study suggests that the most effective perioperative anesthesia strategy for patients undergoing radical thyroid cancer surgery in a restricted subset is ropivacaine combined with dexmedetomidine for bilateral superficial cervical plexus block.

Abbreviations

Group C	General anesthesia alone group
Group R	General anesthesia + Ropivacaine group
Group R1	General anesthesia + Ropivacaine combined with dexmedetomidine group
Group R2	General anesthesia + Ropivacaine combined with dexamethasone group
ASA	American Society of Anesthesiologists
BMI	Body mass index
HR	Heart rate
MAP	Mean arterial pressure
T_0	At 5 min after admission
T_1	At the time of skin incision
T_2	At 30 min after operation
T_3	After extubation; The changes of HR and MAP at each time point minus T_0 were recorded as ΔHR_1, ΔHR_2, and ΔHR_3 and ΔMAP_1, ΔMAP_2, and ΔMAP_3
VAS	Visual Analogue Score
RCSQ	Richards-Campbell Sleep Questionnaire
QoR-15	Quality of Postoperative Recovery-15
PCIA	Patient-Controlled Intravenous Analgesia

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Authors' contributions
All authors made a significant contribution to the work reported. The data collection and writing of the main manuscripts were completed by KXY and LCF; Statistical analysis was performed by LLY, QXT and WYH; The modification and polishing of the article were completed by LY and ML; The conception, research design and overall planning were completed by ZSL and GZ. All authors endorse the final manuscript and agree to be responsible for all aspects of the work.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
This study was approved by the Medical Ethics Committee of the People's Hospital of Guangxi Zhuang Autonomous Region (Ethics-New Technology

and New Projects-2023–21), with informed consent signed by all patients or their families.

Consent for publication
Informed consent was obtained from all individual participants included in the study.

Competing interests
The authors declare no competing interests.

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