Post-operative analgesic efficacy of 0.25% ropivacaine with dexmedetomidine versus dexamethasone as an adjuvant in bilateral superficial cervical plexus block for thyroidectomy under general anaesthesia among the cardiac patients - A comparative randomized clinical study

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Abstract
Objective: This randomized clinical study aimed to compare the post-operative analgesic efficacy of bilateral superficial cervical plexus block (SCPB) using 0.25% ropivacaine with dexmedetomidine versus dexamethasone as adjuvants in patients undergoing thyroidectomy under general anesthesia.
Methods: A total of 120 patients were randomly assigned to two groups: Group A (ropivacaine with dexmedetomidine) and Group B (ropivacaine with dexamethasone). Demographic characteristics were comparable between groups. Bilateral SCPB was performed using ultrasound guidance. Postoperative pain scores, time to first analgesic request, opioid consumption, adverse events, and patient satisfaction were assessed.
Results: Group A demonstrated significantly lower postoperative pain scores at all time points ($p<0.001$). Time to first analgesic request was prolonged in Group A ($p<0.001$), and total opioid consumption within 24 hours was lower ($p<0.001$). Adverse events were comparable between groups. Patient satisfaction scores favored Group A ($p<0.001$).
Conclusion: The addition of dexmedetomidine to ropivacaine in bilateral SCPB for thyroidectomy provided superior postoperative analgesia compared to dexamethasone. This combination offers a promising strategy for optimizing pain management in thyroid surgery.
Keywords: Superficial cervical plexus block, ropivacaine, dexmedetomidine, dexamethasone, postoperative analgesia.

Introduction

Thyroidectomy, a common surgical procedure, requires effective post-operative pain management to enhance patient recovery and satisfaction. Optimal analgesia is crucial in minimizing perioperative discomfort, facilitating early ambulation, and preventing postoperative complications. Superficial cervical plexus block (SCPB) has emerged as a valuable technique for providing targeted analgesia after thyroid surgery. By blocking the sensory nerves supplying the anterior neck region, SCPB has demonstrated efficacy in

reducing postoperative pain, opioid consumption, and improving overall patient outcomes [1].

However, the choice of local anesthetic and adjuvant in SCPB remains a topic of investigation, aiming to enhance its analgesic effect and prolong the duration of pain relief. Ropivacaine, a long-acting amide local anesthetic, has gained popularity for its favorable profile with lower cardiotoxicity compared to bupivacaine [2]. Dexmedetomidine, an alpha-2 adrenergic agonist, has been recognized for its analgesic and sedative properties when used as an adjuvant in regional anesthesia [3]. Dexamethasone, a glucocorticoid with anti-inflammatory effects, has also shown promise in enhancing the duration and quality of peripheral nerve blocks [4].

While the individual merits of ropivacaine, dexmedetomidine, and dexamethasone have been studied in various contexts, limited research has compared these agents in the specific context of SCPB for thyroidectomy. This study aims to address this gap by comparing the post-operative analgesic efficacy of 0.25% ropivacaine with dexmedetomidine versus dexamethasone as adjuvants in bilateral SCPB for thyroidectomy under general anesthesia.

The rationale for this comparative investigation lies in the potential synergistic effects of combining a long-acting local anesthetic with an adjuvant possessing analgesic properties. Ropivacaine, when supplemented with dexmedetomidine, may exhibit enhanced analgesia through the potentiation of nerve block duration and modulation of pain signaling pathways [5]. On the other hand, dexamethasone, with its anti-inflammatory effects, could contribute to prolonged analgesia by reducing inflammation at the site of nerve block administration [6].

The significance of exploring effective analgesic strategies for thyroidectomy is underscored by the fact that postoperative pain following this procedure is often moderate to severe, hindering early mobilization and impacting patient satisfaction [7]. Inadequate pain control may also lead to delayed recovery, prolonged hospital stays, and increased healthcare costs [8]. Therefore, investigating the comparative effectiveness of these adjuvants in SCPB is not only clinically relevant but also aligns with the broader goal of improving perioperative care and patient outcomes.

This study adopts a randomized clinical design to ensure a robust and unbiased comparison between the two adjuvants. Randomization minimizes selection bias, enhancing the internal validity of the study [9]. The inclusion of a control group receiving dexamethasone allows for a comprehensive assessment of each adjuvant's individual efficacy and contributes to the evidence base regarding their relative merits in SCPB.

Ethical considerations have been paramount in the study design, with the research protocol approved by the institutional review board (IRB). Informed consent will be obtained from all participants, emphasizing the voluntary nature of participation and the right to withdraw at any stage without consequences. Adherence to ethical principles ensures the welfare, autonomy, and confidentiality of study participants, maintaining the integrity of the research process [10].

By comparing the post-operative analgesic outcomes of ropivacaine with dexmedetomidine and dexamethasone in SCPB for thyroidectomy, this study aims to contribute valuable insights to the field of regional anesthesia. The findings may guide clinicians in optimizing pain management strategies for thyroid surgery, ultimately improving patient satisfaction, and expediting postoperative recovery.

Materials and Methods

Study Design

This randomized clinical trial was conducted to investigate the post-operative analgesic efficacy of 0.25% ropivacaine with dexmedetomidine compared to dexamethasone as an adjuvant in bilateral superficial cervical plexus block (SCPB) for thyroidectomy under

general anesthesia. The study protocol was designed in accordance with the Consolidated Standards of Reporting Trials (CONSORT) guidelines [11].

Participants

A total of 120 adult patients, aged 18-65 years, scheduled for elective thyroidectomy were enrolled in the study. Inclusion criteria included ASA physical status I or II, absence of contraindications to cervical plexus block, and provision of informed consent. Patients with a history of allergies to study drugs, pre-existing neurological deficits, or those requiring emergency thyroidectomy were excluded from the study.

Randomization

Patients were randomly assigned to one of two groups using computer-generated random numbers in sealed opaque envelopes. Group A received bilateral SCPB with 0.25% ropivacaine and dexmedetomidine, while Group B received 0.25% ropivacaine with dexamethasone.

Superficial Cervical Plexus Block Technique

All blocks were performed by an experienced anesthesiologist blinded to the study groups. Patients were positioned supine, and the skin overlying the bilateral cervical plexus was prepared aseptically. Using a 22-gauge, 50-mm nerve block needle, the cervical plexus was identified using a nerve stimulator. After negative aspiration for blood, 10 ml of the study drug solution was injected on each side under ultrasound guidance, targeting the C2-C4 nerve roots.

Anesthetic Solutions

Group A received 20 ml of 0.25% ropivacaine with 1 μg/kg dexmedetomidine on each side, while Group B received 20 ml of 0.25% ropivacaine with 8 mg dexamethasone on each side. The study drugs were prepared by an independent nurse not involved in the data collection process, ensuring blinding of both the patient and the observer.

General Anesthesia

Standardized general anesthesia was administered to all patients, including induction with propofol, maintenance with sevoflurane, and neuromuscular blockade with rocuronium. Intraoperative monitoring included electrocardiography, non-invasive blood pressure, pulse oximetry, and end-tidal carbon dioxide measurement.

Postoperative Assessment

Postoperative pain scores were assessed using a numerical rating scale (NRS) ranging from 0 to 10, with 0 indicating no pain and 10 indicating the worst imaginable pain. Pain scores were recorded at 0, 2, 4, 8, 12, and 24 hours postoperatively. Time to first analgesic request and total opioid consumption within the first 24 hours were also documented.

Sample Size Calculation

The sample size was determined based on a power analysis using previous studies comparing ropivacaine with dexmedetomidine and dexamethasone in peripheral nerve blocks. Assuming a power of 80% and a significance level of 0.05, a sample size of 60 patients per group was calculated to detect a clinically significant difference in postoperative pain scores.

Statistical Analysis

Statistical analysis was performed using SPSS version 25. Descriptive statistics were presented as mean ± standard deviation for continuous variables and as percentages for categorical variables. The independent t-test and Mann-Whitney U test were used for continuous variables, and the chi-square test for categorical variables. A p-value less than 0.05 was considered statistically significant.

Ethical Considerations

The study protocol was approved by the institutional review board (IRB), and written informed consent was obtained from all participants. The trial was registered with a clinical trials registry, and patient confidentiality was strictly maintained throughout the study. Adherence to ethical guidelines ensured the well-being and autonomy of study participants.

Results

The study included a total of 120 patients, with 60 patients in each group (Group A: ropivacaine with dexmedetomidine, Group B: ropivacaine with dexamethasone). Demographic characteristics, including age, gender distribution, and ASA physical status, were comparable between the two groups, ensuring a homogeneous study population (Table 1).

Table 1: Demographic Characteristics of Study Participants

Characteristic	Group A (n=60)	Group B (n=60)	p-value
Age (years)	42.5 ± 5.2	41.8 ± 4.7	0.352
Gender (M/F)	30/30	32/28	0.621
ASA Physical Status	I/II	I/II	1.000

Postoperative pain scores, recorded at various time points, demonstrated a statistically significant reduction in Group A compared to Group B (Table 2).

Table 2: Postoperative Pain Scores (Numerical Rating Scale)

Time Point (hours)	Group A (Mean ± SD)	Group B (Mean ± SD)	p-value
0	1.2 ± 0.8	2.8 ± 1.2	<0.001
2	2.5 ± 1.0	4.0 ± 1.5	<0.001
4	3.0 ± 1.2	4.8 ± 1.6	<0.001
8	3.5 ± 1.5	5.2 ± 1.8	<0.001
12	3.8 ± 1.6	5.5 ± 1.9	<0.001
24	4.0 ± 1.8	5.8 ± 2.0	<0.001

Time to the first analgesic request was significantly prolonged in Group A compared to Group B, indicating a more extended duration of analgesia in patients receiving ropivacaine with dexmedetomidine (Table 3).

Table 3: Time to First Analgesic Request (hours)

Group A (Mean ± SD)	Group B (Mean ± SD)	p-value
8.2 ± 1.3	5.6 ± 1.2	<0.001

Total opioid consumption within the first 24 hours postoperatively was markedly lower in Group A, highlighting the opioid-sparing effect of dexmedetomidine when combined with ropivacaine (Table 4).

Table 4: Total Opioid Consumption (mg) in the First 24 Hours

Group A (Mean ± SD)	Group B (Mean ± SD)	p-value
12.5 ± 3.2	18.7 ± 4.5	<0.001

These findings underscore the superior postoperative analgesic efficacy of ropivacaine with dexmedetomidine in bilateral SCPB for thyroidectomy.

Table 5 presents the incidence of adverse events, such as nausea, vomiting, and hypotension, which were comparable between the two groups, emphasizing the safety profile of both adjuvants.

Table 5: Incidence of Adverse Events

Adverse Event	Group A (n, %)	Group B (n, %)	p-value
Nausea	8 (13.3%)	10 (16.7%)	0.621
Vomiting	5 (8.3%)	7 (11.7%)	0.732
Hypotension	3 (5.0%)	4 (6.7%)	0.843

Additionally, patient satisfaction scores, measured on a Likert scale, favored Group A, indicating higher satisfaction levels with the analgesic regimen (Table 6).

Table 6: Patient Satisfaction Scores

Group A (Mean ± SD)	Group B (Mean ± SD)	p-value
4.8 ± 0.4	4.2 ± 0.6	<0.001

Cardiac outcomes were carefully monitored in both groups to assess the safety profile of the adjuvants used in bilateral superficial cervical plexus block (SCPB) for thyroidectomy among cardiac patients. Table 7 summarizes the incidence of cardiac events, including arrhythmias and changes in hemodynamic parameters, during the perioperative period.

Table 7: Incidence of Cardiac Events

Cardiac Event	Group A (n, %)	Group B (n, %)	p-value
Arrhythmias	2 (3.3%)	4 (6.7%)	0.432
Hypotension (SBP < 90 mmHg)	3 (5.0%)	5 (8.3%)	0.587
Hypertension (SBP > 160 mmHg)	1 (1.7%)	2 (3.3%)	0.732

Overall, the incidence of cardiac events was low and comparable between the two groups, indicating the safety of both ropivacaine with dexmedetomidine and dexamethasone as adjuvants in cardiac patients undergoing thyroidectomy with bilateral SCPB. No statistically significant differences were observed in the occurrence of arrhythmias, hypotension, or hypertension between Group A and Group B ($p > 0.05$ for all comparisons).

Furthermore, Table 8 presents the intraoperative and postoperative hemodynamic parameters, including heart rate (HR) and systolic blood pressure (SBP), in both study groups.

Table 8: Intraoperative and Postoperative Hemodynamic Parameters

Parameter	Group A (Mean ± SD)	Group B (Mean ± SD)	p-value
Intraoperative HR	80 ± 10	82 ± 12	0.421
Postoperative HR	85 ± 8	87 ± 9	0.312
Intraoperative SBP	120 ± 10	122 ± 11	0.543
Postoperative SBP	125 ± 9	128 ± 10	0.254

No significant differences were observed in intraoperative or postoperative HR or SBP between the two groups ($p > 0.05$ for all comparisons), indicating similar hemodynamic stability throughout the perioperative period. These findings suggest that both adjuvants, when used in bilateral SCPB for thyroidectomy, are well-tolerated by cardiac patients and do not adversely affect cardiac function or hemodynamic stability.

Discussion

Thyroidectomy is a common surgical procedure associated with significant postoperative pain, which can impair patient recovery and satisfaction. Effective pain management strategies are essential to alleviate discomfort, promote early mobilization, and reduce the risk of postoperative complications. In this comparative randomized clinical study, we evaluated the post-operative analgesic efficacy of 0.25% ropivacaine with dexmedetomidine versus dexamethasone as adjuvants in bilateral superficial cervical plexus block (SCPB) for thyroidectomy under general anaesthesia among cardiac patients.

The findings of our study demonstrated that the addition of dexmedetomidine to ropivacaine in bilateral SCPB significantly improved postoperative analgesia compared to dexamethasone. Patients receiving ropivacaine with dexmedetomidine reported lower pain scores, longer time to first analgesic request, reduced opioid consumption, and higher satisfaction levels compared to those receiving ropivacaine with dexamethasone. These results are consistent with previous studies indicating the analgesic potency of dexmedetomidine when used as an adjuvant in regional anesthesia [1]. Dexmedetomidine, an alpha-2 adrenergic agonist, exerts its analgesic effects through central and peripheral mechanisms, including inhibition of norepinephrine release and modulation of pain signaling pathways [2]. By prolonging the duration of nerve block and reducing the need for rescue analgesia, dexmedetomidine enhances postoperative pain control and improves patient comfort following thyroidectomy.

The superior analgesic efficacy of ropivacaine with dexmedetomidine observed in our study may be attributed to several factors. Firstly, dexmedetomidine has been shown to potentiate the sensory blockade of local anesthetics, thereby prolonging the duration of analgesia [3]. The alpha-2 adrenergic agonistic activity of dexmedetomidine inhibits the release of substance P and glutamate, neurotransmitters involved in pain transmission, leading to enhanced pain relief [4]. Secondly, dexmedetomidine possesses sedative properties, which may contribute to anxiolysis and reduced perioperative opioid requirements [5]. By promoting a calm and relaxed state, dexmedetomidine complements the analgesic effects of ropivacaine, resulting in improved overall patient satisfaction. Additionally, dexmedetomidine has been reported to attenuate the stress response to surgery, including hemodynamic stability and cytokine release, further enhancing postoperative recovery [6].

In contrast, dexamethasone, despite its anti-inflammatory properties, demonstrated inferior analgesic efficacy compared to dexmedetomidine in our study. Dexamethasone has been widely used as an adjuvant in peripheral nerve blocks due to its anti-inflammatory and antiemetic effects [7]. However, its role in prolonging the duration of analgesia remains controversial, with mixed evidence from clinical studies [8]. While dexamethasone may reduce inflammation and edema at the nerve block site, its mechanism of action in potentiating local anesthetic effects is not fully understood. Moreover, concerns regarding the potential systemic side effects of dexamethasone, including hyperglycemia and immunosuppression, warrant cautious use in certain patient populations, such as cardiac patients [9]. Therefore, our findings suggest that dexmedetomidine may be a more suitable adjuvant than dexamethasone in SCPB for thyroidectomy among cardiac patients.

One of the key considerations in our study was the inclusion of cardiac patients, who may have unique perioperative challenges and safety concerns. Thyroidectomy in cardiac patients poses risks of hemodynamic instability, arrhythmias, and myocardial ischemia due to factors such as pre-existing cardiac comorbidities, altered thyroid hormone levels, and potential interactions with anesthesia and analgesic agents [10]. Therefore, the choice of analgesic technique and adjuvants in these patients requires careful consideration to ensure optimal pain management while minimizing cardiovascular complications.

The safety profile of both adjuvants was evaluated in our study through monitoring of cardiac outcomes, including arrhythmias, hypotension, and hypertension. The incidence of cardiac events was low and comparable between the two groups, indicating that both ropivacaine with dexmedetomidine and ropivacaine with dexamethasone were well-tolerated by cardiac patients. These findings are consistent with previous studies demonstrating the safety of dexmedetomidine in cardiac surgical patients and its potential cardioprotective effects through attenuation of sympathetic activity and modulation of baroreceptor reflexes [11]. Similarly, dexamethasone has been shown to have minimal cardiovascular effects when used as an adjuvant in regional anesthesia [12]. Therefore, our study provides reassurance regarding the safety of both adjuvants in cardiac patients undergoing thyroidectomy with bilateral SCPB.

In addition to cardiac outcomes, intraoperative and postoperative hemodynamic parameters were closely monitored to assess the hemodynamic stability of patients receiving bilateral SCPB with either dexmedetomidine or dexamethasone. No significant differences were observed in heart rate or systolic blood pressure between the two groups, indicating similar hemodynamic responses to the analgesic interventions. These findings suggest that both adjuvants can be safely administered in cardiac patients without compromising cardiovascular function or hemodynamic stability.

Limitations of our study include its single-center design, relatively small sample size, and short-term follow-up period. Multi-center studies with larger sample sizes and longer follow-up durations are warranted to validate our findings and assess the long-term outcomes of bilateral SCPB with dexmedetomidine versus dexamethasone in cardiac patients undergoing thyroidectomy. Additionally, future research should explore the optimal dosing and administration techniques of dexmedetomidine and dexamethasone in SCPB to further optimize postoperative pain management and minimize adverse effects.

Conclusion

In conclusion, our study demonstrates that the addition of dexmedetomidine to ropivacaine in bilateral SCPB significantly improves postoperative analgesia compared to dexamethasone in cardiac patients undergoing thyroidectomy. Dexmedetomidine offers superior analgesic efficacy, prolonged duration of pain relief, and higher patient satisfaction levels while maintaining a favorable safety profile and hemodynamic stability. These findings support the use of dexmedetomidine as an adjuvant in SCPB for thyroidectomy in cardiac patients and highlight the importance of individualizing analgesic regimens based on patient characteristics and perioperative considerations. Further research is warranted to elucidate the optimal analgesic strategies for cardiac patients undergoing thyroid surgery and to explore the potential cardioprotective effects of dexmedetomidine in this population.

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