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Remimazolam Anesthesia With Intratracheal Topical Anesthesia and Cervical and Glossopharyngeal Nerve Blocks for Thyroid Lobectomy: A Case Report

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Abstract

In thyroid surgery, anesthetic management is required to maintain the reliability of intraoperative neuromonitoring (IONM) while facilitating early postoperative assessment of vocal function, suppressing coughing during extubation, and providing adequate postoperative analgesia. In a 63-year-old man undergoing right thyroid lobectomy with IONM, general anesthesia with remimazolam was combined with intratracheal topical anesthesia, bilateral superficial cervical plexus blocks, and bilateral glossopharyngeal nerve blocks. After induction of anesthesia, intratracheal topical anesthesia was performed using 4 mL of 4% lidocaine. A total of 10 mL of 0.25% levobupivacaine was used for the bilateral superficial cervical plexus blocks, and a total of 5 mL of 0.25% levobupivacaine was used for the bilateral glossopharyngeal nerve blocks. Four minutes after the start of surgery, sugammadex was administered to reverse neuromuscular blockade. Electromyographic responses were confirmed after sugammadex administration, and no loss of signal occurred during surgery. At the end of surgery, 0.5 mg of flumazenil was administered, resulting in rapid and clear emergence from anesthesia. No coughing was observed before or after extubation. After extubation, the patient was able to phonate clearly, with no apparent hoarseness, and postoperative pain was well controlled. General anesthesia with remimazolam combined with intratracheal topical anesthesia and head and neck nerve blocks may be an anesthetic option for thyroid surgery with IONM to facilitate early postoperative assessment of vocal function, suppress coughing during extubation, and provide adequate postoperative analgesia.

Categories: Anesthesiology
Keywords: case report, glossopharyngeal nerve block, intraoperative neuromonitoring, remimazolam, thyroid surgery, topical airway anesthesia

Introduction

In thyroid surgery, intraoperative neuromonitoring (IONM) is widely used to facilitate identification and preservation of the recurrent laryngeal nerve [1]. Because IONM records evoked electromyographic responses from the laryngeal muscles using an endotracheal tube equipped with surface electrodes that contact the vocal cords, attention must be paid to residual neuromuscular blockade. In addition, the endotracheal tube used for IONM may cause pharyngolaryngeal stimulation, and coughing during emergence from anesthesia may interfere with smooth extubation and contribute to the formation of postoperative cervical hematoma [2]. Furthermore, after thyroid surgery, early assessment of phonation is important for the clinical evaluation of recurrent laryngeal nerve function, and postoperative bleeding must also be promptly identified because of the risk of airway compromise. Therefore, anesthetic management is required to maintain the reliability of IONM while achieving clear emergence, suppression of coughing before and after extubation, and adequate postoperative analgesia.

Because the sedative effects of remimazolam can be reversed with flumazenil, a benzodiazepine receptor antagonist, remimazolam may be useful for achieving clear emergence after thyroid surgery and facilitating early assessment of vocal function [3]. Bilateral superficial cervical plexus block reduces pain associated with anterior neck incision [4], whereas glossopharyngeal nerve block attenuates the gag reflex and oropharyngeal stimulation [5]. In the present case, the patient's history of pronounced gagging during dental extraction raised concern about gagging induced by oropharyngeal stimulation from the endotracheal tube during emergence from anesthesia. Although these situations involve different clinical circumstances and stimuli, bilateral glossopharyngeal nerve blocks were selected as a preventive measure to attenuate this potential response. The potential effects of glossopharyngeal nerve blockade on swallowing and airway protection should also be considered. Laryngotracheal topical anesthesia is used to reduce coughing induced by laryngeal and tracheal stimulation, and administration of 4 mL of 4% lidocaine does not significantly alter the recurrent laryngeal nerve stimulation threshold during IONM [6]. However, reports of thyroid surgery with IONM in which remimazolam-based general anesthesia is combined with intratracheal topical anesthesia and head and neck nerve blocks remain limited. We report a case of right thyroid lobectomy successfully managed under general anesthesia with remimazolam combined with intratracheal topical

anesthesia, bilateral superficial cervical plexus blocks, and bilateral glossopharyngeal nerve blocks, with the aim of facilitating early postoperative assessment of vocal function, suppressing coughing before and after extubation, and providing postoperative analgesia.

Case Presentation

A 63-year-old man (height, 168.5 cm; weight, 77.6 kg) was scheduled to undergo right thyroid lobectomy for a mediastinal goiter because of the size of the thyroid mass. His medical history included hypertension, a pancreatic cyst, and a gallbladder polyp. Preoperatively, he had no hoarseness or swallowing difficulties and was able to eat a regular diet. His blood pressure was 131/89 mmHg, heart rate was 56 beats/min, and oxygen saturation was 96% on room air. Preoperative laryngoscopic examination was not performed.

The patient had previously undergone attempted extraction of the left mandibular third molar under local anesthesia with sedation. Gagging occurred during the procedure, resulting in discontinuation of the extraction with part of the tooth remaining. The specific stimulus that triggered the gag reflex and whether similar episodes had occurred during previous dental treatments could not be confirmed.

His regular medication comprised pemafibrate 0.1 mg/day, azilsartan 20 mg/day, amlodipine 10 mg/day, and mecobalamin 500 μg/day.

Preoperative blood tests revealed an elevated thyroglobulin level of 174.5 ng/mL (reference range: ≤33.7 ng/mL), with no other apparent abnormalities, and thyroid hormone levels were within the normal range. Electrocardiography showed sinus rhythm, and pulmonary function testing revealed no apparent abnormalities. Cervical ultrasonography showed a 63 × 54 × 39 mm mass lesion in the right thyroid lobe (Figure *1*). Fine-needle aspiration cytology revealed sheet-like clusters of follicular epithelial cells, and the lesion was diagnosed as benign. Cervicothoracic computed tomography showed a well-defined 49 × 44 mm mass in the right thyroid lobe (Figure *2*). The trachea was mildly deviated to the left without stenosis. The mass showed slight extension into the superior mediastinum. In this case, remimazolam was used for anesthesia maintenance to achieve clear emergence, thereby enabling early postoperative assessment of vocal function.

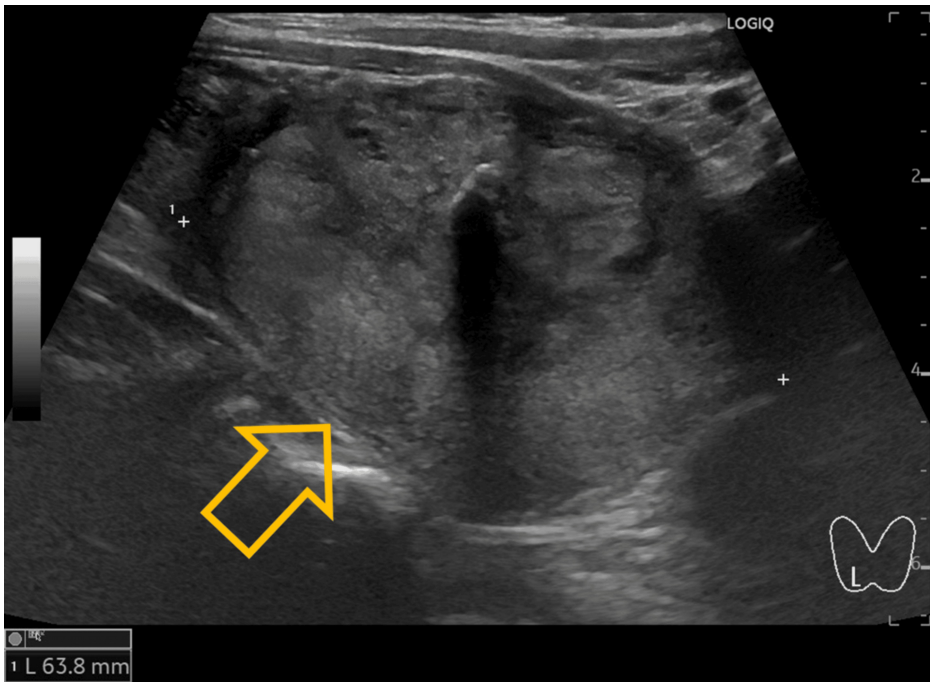


FIGURE 1: Cervical ultrasonography

A mass lesion in the right thyroid lobe.

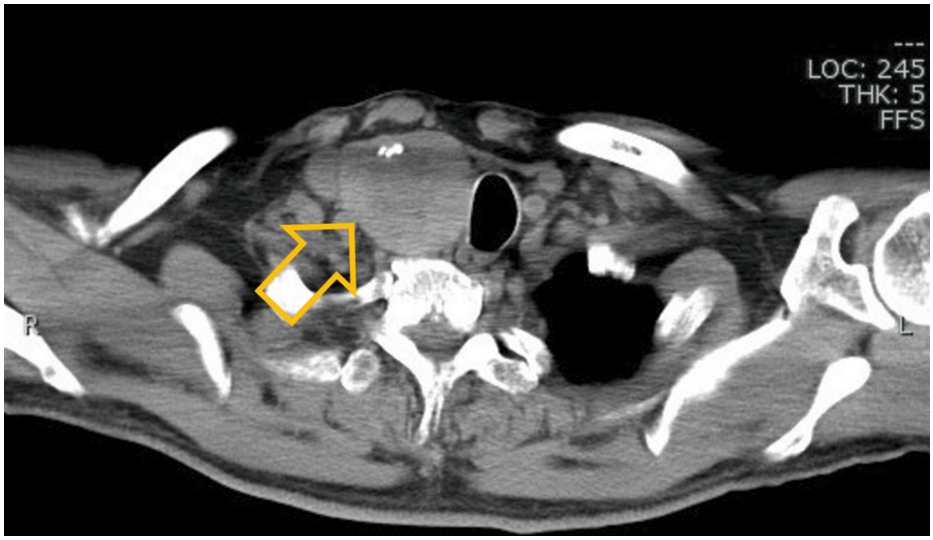


FIGURE 2: Cervicothoracic computed tomography

A well-defined mass in the right thyroid lobe.

Bilateral superficial cervical plexus blocks were planned to reduce postoperative pain. Given the patient's history of gagging during dental extraction, bilateral glossopharyngeal nerve blocks were planned to attenuate potential gagging induced by oropharyngeal stimulation from the endotracheal tube during emergence from anesthesia. Intratracheal topical anesthesia was also planned to suppress coughing induced by tracheal stimulation. General anesthesia was induced in combination with intratracheal topical anesthesia and nerve blocks. Anesthesia was induced with remimazolam 15 mg, remifentanil 200 μg, and rocuronium 50 mg. After induction of anesthesia, laryngoscopy was performed using a McGRATH™ MAC (Medtronic, Minneapolis, MN, USA), and the glottis was visualized. Subsequently, the tip of an intratracheal spray tube (Hakko Co., Ltd., Nagano, Japan) was advanced beyond the glottis into the trachea under visualization on the McGRATH™ MAC screen, and 4 mL of 4% lidocaine was sprayed to provide intratracheal topical anesthesia. Because intratracheal topical anesthesia took longer than anticipated, an additional 200-μg bolus of remifentanil was administered before tracheal intubation to attenuate the intubation response. Tracheal intubation was then performed using a NIM TriVantage™ EMG tube (Medtronic Japan Co., Ltd., Tokyo, Japan), an endotracheal tube equipped with surface electrodes.

After tracheal intubation, bilateral superficial cervical plexus blocks were performed with the patient in the supine position using an ultrasound system (Sonosite® ST, FUJIFILM, Tokyo, Japan). A linear transducer was placed transversely on the neck, and the posterior border of the sternocleidomastoid muscle was identified at the C4 level. Under ultrasound guidance, the needle was advanced using an in-plane approach, and 5 mL of 0.25% levobupivacaine was administered on each side while confirming the spread of the local anesthetic, for a total volume of 10 mL bilaterally (Figures *3*, *4*).

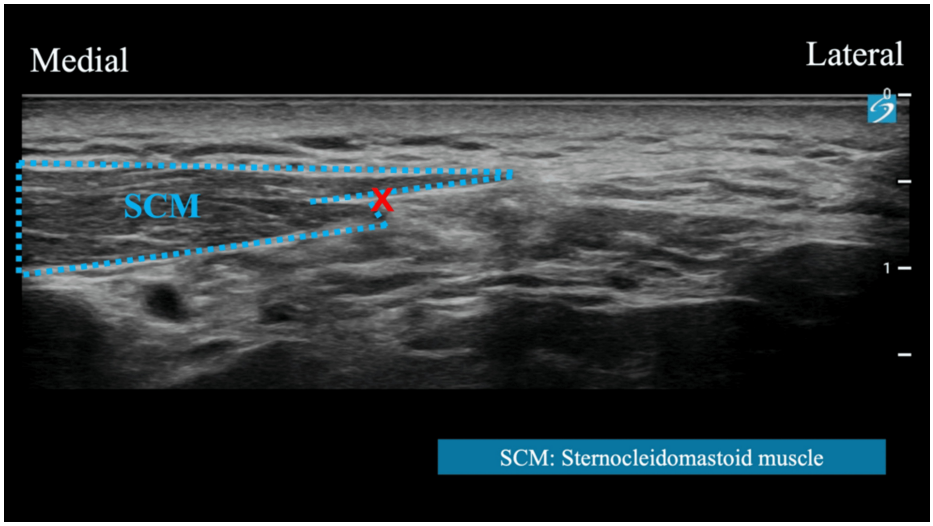


FIGURE 3: Ultrasound image during superficial cervical plexus block at the C4 level

×: Posterior border of the sternocleidomastoid muscle. The superficial cervical plexus block was performed at this site.

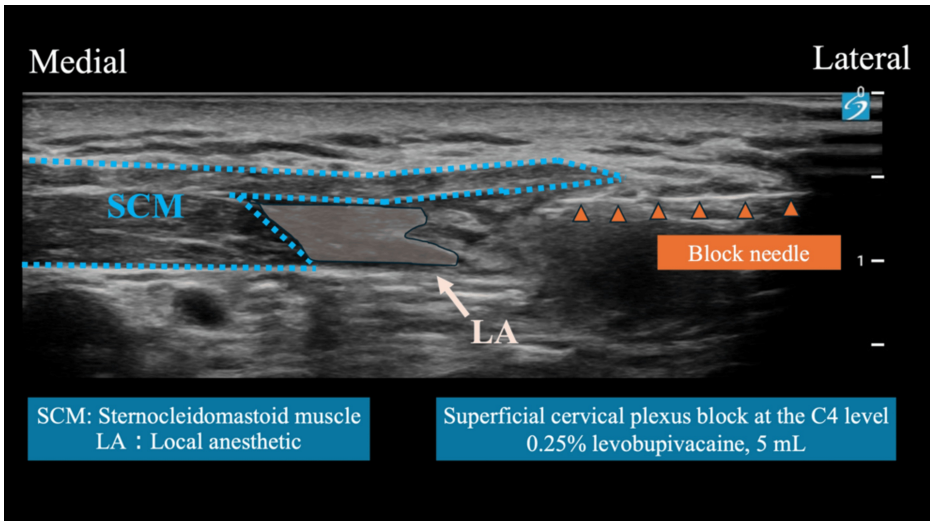


FIGURE 4: Ultrasound image after superficial cervical plexus block at the C4 level

Subsequently, bilateral ultrasound-guided glossopharyngeal nerve blocks were performed according to a previously described technique [5]. A linear transducer was placed transversely on the neck to identify the sternocleidomastoid muscle, after which the transducer was rotated 90° to visualize the sternocleidomastoid and stylohyoid muscles. Under ultrasound guidance, the needle was advanced using an out-of-plane approach, and 2.5 mL of 0.25% levobupivacaine was administered on each side while confirming the spread of the local anesthetic deep to the stylohyoid muscle, for a total volume of 5 mL bilaterally (Figures *5*, *6*). During anesthesia induction and preparation for surgery, blood pressure decreased to as low as 83/58 mmHg, with the reduction lasting approximately seven minutes. Ephedrine was administered in three divided doses of 8 mg, 4 mg, and 8 mg (total 20 mg), and blood pressure subsequently increased to approximately 107/72 mmHg. Four minutes after the start of surgery, 200 mg of sugammadex was administered to reverse the neuromuscular blockade produced by rocuronium. Quantitative neuromuscular monitoring confirmed a train-of-four ratio of 0.95 shortly after administration, after which neuromuscular monitoring was discontinued. Electromyographic responses were subsequently confirmed using IONM, and no loss of signal was observed throughout surgery. Anesthesia was maintained with air, oxygen, remimazolam, and remifentanil. Remimazolam infusion was initiated at 1 mg/kg/h and maintained at 0.6-0.8 mg/kg/h intraoperatively. Remifentanil was administered at 0.15-0.3 μg/kg/min and reduced to 0.03

μg/kg/min at wound closure. For postoperative analgesia, acetaminophen 1,000 mg and flurbiprofen 50 mg were administered. The surgical duration was 1 h 15 min, and the anesthesia duration was 2 h 14 min (Figure 7).

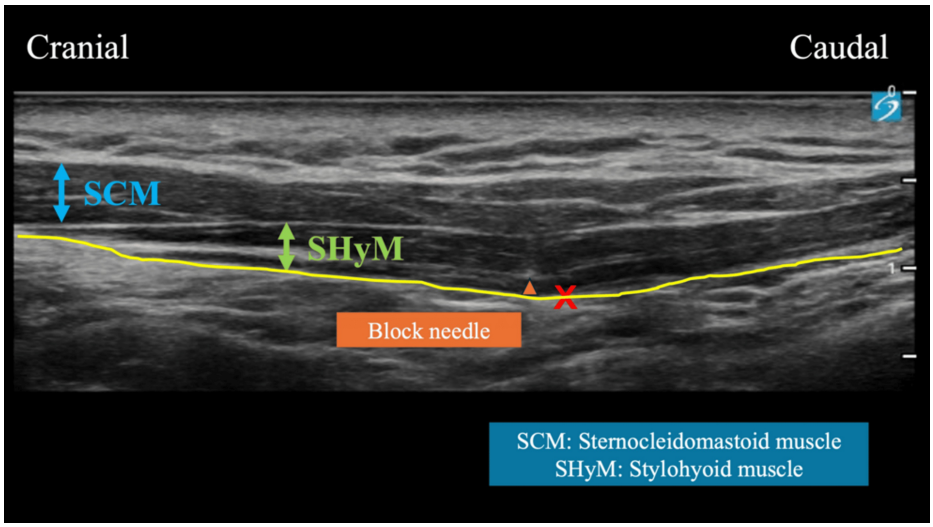


FIGURE 5: Ultrasound image during glossopharyngeal nerve block

×: Target point deep to the stylohyoid muscle. The glossopharyngeal nerve block was performed at this site. The yellow line indicates the deep border of the stylohyoid muscle.

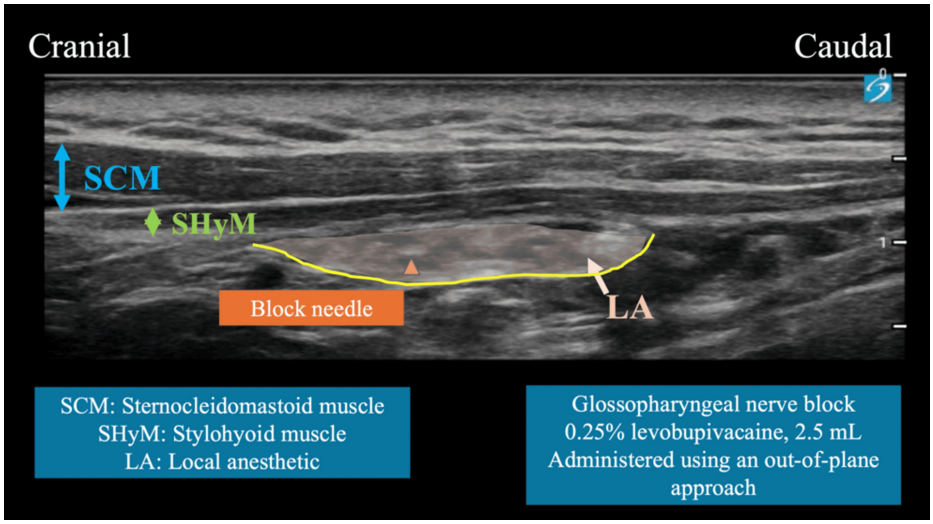


FIGURE 6: Ultrasound image after glossopharyngeal nerve block

The yellow line indicates the deep border of the stylohyoid muscle.

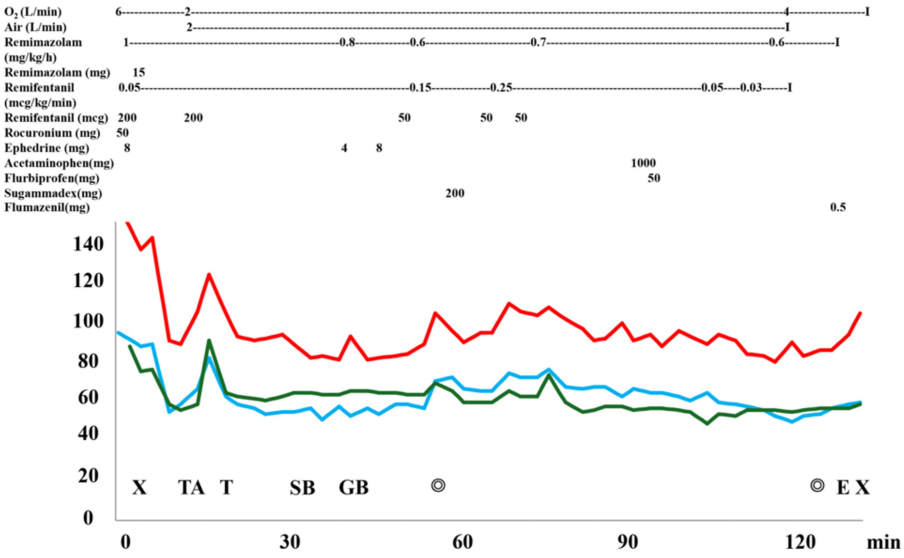


FIGURE 7: Anesthesia chart

HR: Heart rate; NIBP: non-invasive blood pressure measurement; Sys: systolic blood pressure; Dia: diastolic blood pressure; x: start/end of anesthesia; TA: intratracheal topical anesthesia; T: tracheal intubation; SB: bilateral superficial cervical plexus block; GB: bilateral glossopharyngeal nerve block; □: start/end of surgery; E: extubation.

Five minutes after completion of surgery, 0.5 mg of flumazenil was administered, and the patient was fully awake and extubated one minute later. Neither coughing nor gagging was observed before or after extubation. After extubation, the patient reported mild sore throat but no incisional pain. When asked to phonate, he was able to speak clearly, and no apparent hoarseness was noted in the operating room. On postoperative day 1, laryngoscopic examination confirmed preserved vocal cord mobility. No clinically apparent swallowing difficulties or problems handling oral secretions were observed postoperatively. The patient remained fully awake without recurrent sedation. Ward records documented no pain, although numerical pain scores were not recorded. Postoperative analgesia consisted of regularly scheduled loxoprofen 60 mg three times daily, and no rescue analgesics were required. No apparent complications occurred, and the patient was discharged on postoperative day 3.

Discussion

In thyroid surgery, IONM is widely used to facilitate identification and preservation of the recurrent laryngeal nerve [1]. Ensuring the reliability of IONM is important for appropriate intraoperative assessment of recurrent laryngeal nerve function. The recurrent laryngeal nerve innervates the vocal cords, and injury resulting in paralysis may cause hoarseness, dyspnea, and aspiration, thereby markedly impairing the patient's quality of life [1].

Mild to moderate pain commonly occurs after thyroid surgery, with most pain localized to the surgical incision [4]. Coughing during emergence from anesthesia and in the early postoperative period may also contribute to the development of postoperative cervical hematoma [2]. A cervical hematoma caused by postoperative bleeding can compress the airway and result in life-threatening airway obstruction.

In the present case, in addition to undergoing thyroid surgery with IONM, the patient had a history of a dental procedure being discontinued because of a pronounced gag reflex; particular attention was therefore paid to minimizing perioperative pharyngeal stimulation. Accordingly, anesthetic management was planned to achieve clear emergence, adequate postoperative analgesia, and attenuation of pharyngeal and airway stimulation while considering potential effects on IONM.

In thyroid surgery, IONM generally involves the use of an endotracheal tube equipped with surface electrodes that contact the vocal cords to record evoked electromyographic responses from the laryngeal muscles. Because residual neuromuscular blockade can attenuate electromyographic responses, neuromuscular blocking agents must be carefully managed during IONM. In a case series of five patients undergoing thyroid surgery under remimazolam anesthesia, positive electromyographic responses were obtained in all patients from the first stimulation after the start of surgery, and IONM was performed without difficulty throughout the procedure [1]. Remimazolam is an ultra-short-acting intravenous benzodiazepine anesthetic characterized by high clearance and a short context-sensitive half-time [7]. Its sedative effects can be reversed with flumazenil, a benzodiazepine receptor antagonist [3]. In a

pharmacokinetic and pharmacodynamic study in healthy adults, the context-sensitive half-time after a 4-h continuous infusion was estimated as 6.8 ± 2.4 min, demonstrating rapid decreases in plasma concentrations even after prolonged continuous infusion [7].

The ability to reverse the sedative effects of remimazolam with flumazenil is advantageous for achieving clear emergence after thyroid surgery. In thyroid surgery using an endotracheal tube equipped with surface electrodes, maintenance of anesthesia with remimazolam followed by administration of flumazenil after extubation has been reported to achieve full emergence, thereby allowing clinical assessment of recurrent laryngeal nerve function by phonation and early detection of postoperative bleeding [3].

In the present case, clear emergence was also achieved after administration of 0.5 mg of flumazenil, and the patient was able to phonate in the operating room without apparent hoarseness. Therefore, the combination of remimazolam and flumazenil may represent an anesthetic option for thyroid surgery in which early postoperative assessment of vocal function is required. However, assessment by phonation alone does not allow direct evaluation of vocal cord movement. Therefore, laryngoscopic examination is necessary for objective postoperative assessment of vocal cord mobility. In the present case, laryngoscopic examination was performed on postoperative day 1, and preserved vocal cord mobility was confirmed.

Pain associated with thyroid surgery is related to the anterior cervical skin incision and traction and manipulation of the cervical tissues. The cutaneous branches of the superficial cervical plexus arise mainly from the anterior rami of C2-C4 and consist of the lesser occipital, great auricular, transverse cervical, and supraclavicular nerves, which emerge superficially from the posterior border of the sternocleidomastoid muscle [8,9].

Among these branches, the transverse cervical nerve innervates the skin of the anterior neck, whereas the supraclavicular nerves innervate the skin of the lower neck, supraclavicular region, and upper anterior chest. The superficial cervical plexus block involves subcutaneous injection of the local anesthetic near the midpoint of the posterior border of the sternocleidomastoid muscle to block these cutaneous branches and is therefore suitable for reducing pain arising from the anterior cervical incision in thyroid surgery [8,9]. Bilateral superficial cervical plexus block has been reported to reduce opioid consumption after thyroid surgery, prolong the duration of analgesia, and decrease postoperative pain scores, rescue analgesic requirements, intraoperative morphine consumption, and postoperative nausea and vomiting [4]. The phrenic nerve courses through the deep cervical region, where the vagus, recurrent laryngeal, and hypoglossal nerves are also located in close proximity [9]. Deep cervical plexus block may be associated with paralysis of the phrenic, recurrent laryngeal, vagus, and hypoglossal nerves. In contrast, superficial cervical plexus block is considered to carry a lower risk of affecting these deep cervical nerves [8,9].

In the present case, no incisional pain was reported immediately after extubation, and postoperative pain remained well controlled without rescue analgesics. However, because systemic analgesics were administered in addition to bilateral superficial cervical plexus blocks, the independent contribution of the blocks to postoperative analgesia cannot be determined. In addition, confirming that the needle tip was positioned at the posterior border of the sternocleidomastoid muscle under ultrasound guidance and administering the local anesthetic while observing its spread may have been useful in avoiding unintended spread into deep cervical tissues. No complications, such as recurrent laryngeal nerve palsy suggestive of deep cervical spread of the local anesthetic, were observed intraoperatively or postoperatively.

Sensory innervation of the upper airway varies by anatomical region. The oropharynx and posterior one-third of the tongue are innervated primarily by the glossopharyngeal nerve. In contrast, the supraglottic region, including the epiglottis, is innervated by the internal branch of the superior laryngeal nerve, whereas the subglottic region and trachea are innervated by the recurrent laryngeal nerve, both of which are branches of the vagus nerve [10]. The afferent limb of the pharyngeal reflex is mediated primarily by the glossopharyngeal nerve, whereas the cough reflex elicited by stimulation of the larynx and trachea is mediated through the vagus nerve [10]. Therefore, glossopharyngeal nerve block and intratracheal topical anesthesia target different airway regions and reflex pathways.

Glossopharyngeal nerve block provides sensory blockade of the posterior one-third of the tongue, tonsils, and pharyngeal wall, thereby attenuating the pharyngeal reflex and oropharyngeal stimulation. However, glossopharyngeal nerve block alone cannot block sensation of the larynx and trachea, which are innervated by the vagus nerve system, and other airway anesthesia techniques are therefore required to reduce stimulation of these regions [10]. In addition, endotracheal tubes used for IONM have a larger outer diameter than that of conventional endotracheal tubes and are equipped with surface electrodes [11], making them more likely to cause stimulation of the trachea and vocal cords. Therefore, airway stimulation caused by the tube should be minimized. Kojima et al. [5] performed ultrasound-guided selective glossopharyngeal nerve block using a posterior mandibular ramus approach, with the local anesthetic injected deep to the stylohyoid muscle, in three healthy volunteers; after the block, cold sensation was abolished in the posterior one-third of the tongue, tonsillar region, and pharyngeal region, and the gag reflex elicited by pharyngeal stimulation with a cotton swab disappeared in all participants. The effect lasted for approximately 1.5 h following administration of 1 mL of 1% lidocaine. Laryngotracheal topical anesthesia is

used to reduce stimulation of the larynx and trachea and to suppress coughing during emergence from anesthesia. However, because IONM uses an endotracheal tube equipped with electrodes that contact the vocal cords, local anesthetic administration to the larynx and trachea may affect electromyographic responses to nerve stimulation. Pachuski et al. [6] measured recurrent laryngeal nerve stimulation thresholds before and after laryngotracheal topical anesthesia with 4 mL of 4% lidocaine in 18 patients undergoing thyroid surgery and reported no significant changes in stimulation thresholds at 5 or 10 min after administration. In the present case, no problems with the IONM signal were observed. The glossopharyngeal nerve blocks were intended to attenuate the pharyngeal reflex and stimulation from the endotracheal tube in the oropharynx, whereas intratracheal topical anesthesia with lidocaine spray was intended to reduce coughing associated with stimulation of the subglottic region and trachea. By combining these techniques, we aimed to provide complementary attenuation of stimulation in anatomically distinct regions with different sensory innervation, namely, the oropharynx innervated by the glossopharyngeal nerve and the subglottic region and trachea innervated by the vagal system. Given the patient's history of pronounced gagging during dental extraction, bilateral glossopharyngeal nerve blocks were selected as a preventive measure to attenuate potential gagging during emergence from anesthesia. However, because gagging during dental treatment does not necessarily predict gagging during emergence from general anesthesia, the additional benefit of these blocks in this case remains uncertain. No coughing was observed from wound closure through the post-extubation period, and the surgery was completed without any apparent complications.

This case report has several limitations. The stimulation settings and baseline and final electromyographic amplitudes for IONM were unavailable, and numerical postoperative pain scores and the exact time to command following flumazenil administration were not recorded. In addition, preoperative vocal cord mobility was not assessed by laryngoscopy. These limitations restrict the objective assessment of neuromonitoring, emergence, and postoperative outcomes. Furthermore, because multiple anesthetic interventions were used concurrently, the contribution of each intervention to the observed outcomes cannot be determined.

Conclusions

In a 63-year-old man undergoing thyroid surgery with IONM, remimazolam-based general anesthesia was combined with intratracheal topical anesthesia, bilateral superficial cervical plexus blocks, and bilateral glossopharyngeal nerve blocks. No coughing was observed from wound closure through the post-extubation period, and no incisional pain was reported immediately after extubation. Flumazenil administration resulted in prompt and complete emergence, enabling assessment of phonation in the operating room. This multimodal anesthetic approach may represent an option for facilitating early postoperative voice assessment, attenuating coughing during emergence, and providing postoperative analgesia in thyroid surgery with IONM. However, because multiple anesthetic interventions were used concurrently in a single patient, their individual contributions cannot be determined, and the additional benefit of bilateral glossopharyngeal nerve blocks remains uncertain. Furthermore, the absence of apparent complications in this case does not establish the safety of this combined approach, and further studies are needed to evaluate its efficacy and safety.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Saki Atsumi, Shota Tanimoto, Tomoharu Shakuo, Megumi Hashimoto, Kenji Shida

Drafting of the manuscript: Saki Atsumi, Shota Tanimoto

Critical review of the manuscript for important intellectual content: Tomoharu Shakuo, Megumi Hashimoto, Kenji Shida

Supervision: Megumi Hashimoto, Kenji Shida

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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