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CASE REPORT

Multiple sinus pauses during suspension laryngoscopy with external laryngeal manipulation in hyperextended neck position in a patient with enlarged cervical lymph nodes: a case report

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Abstract

Suspension laryngoscopy is a commonly performed procedure for effective laryngeal microsurgery (LMS). Although it is associated with few adverse events, cardiac complications such as severe arrhythmia induced by exaggerated vagal tone may arise during this procedure. Here, I present the case of a 52-year-old female patient who presented with a suspected thyroid follicular neoplasm and enlarged cervical lymph nodes. LMS was planned to remove a vocal fold polyp before the thyroid surgery. The patient was placed in a Boyce-Jackson position, and suspension laryngoscopy was performed. However, several sinus pauses were detected whenever external laryngeal manipulation (ELM) was performed to improve surgical field exposure, which was presumed to be attributed to vagal stimulation or reflex induced by numerous external and internal factors during laryngeal manipulation. The suspected mechanism was the direct stimulation of the vagus nerve termed the laryngo-cardiac reflex, or carotid sinus reflex, a type of baroreceptor reflex. When the first episode of sinus pause occurred, the effect-site target concentration of propofol was unadjusted after checking the bispectral index level indicating an adequate anesthetic depth, but ELM was discontinued. When the second episode occurred, ELM could not be stopped until good laryngeal visualization was achieved. Then, the patient received 0.2 mg of intravenous glycopyrrolate. Her heart rate returned within the normal range whenever ELM was not applied. When performing suspension laryngoscopy, the head and neck positioning, the procedure itself and laryngeal manipulation may act as external factors that could induce an exaggerated vagal response. Further, patients with head and neck tumors have various internal factors, such as tumor itself, cervical lymphadenopathy or post-irradiation fibrosis, which can affect the carotid sinus and deteriorate the vagal response. Therefore, careful preoperative evaluation is required to identify these internal factors in advance and take proper care to minimize the additional influence of external factors.

Keywords

Suspension laryngoscopy; Head and neck cancer; Vagal stimulation; Vagal reflex; Sinus pause

1. Introduction

Laryngeal microsurgery (LMS) is widely used as a surgical procedure to diagnose and treat benign or malignant laryngeal diseases [1, 2]. Good exposure and visualization of the glottic region are critical for effective LMS [2]. Thus, suspension laryngoscopy is a commonly performed otolaryngology procedure used to increase the effectiveness of LMS. It is associated with relatively few side effects, although cardiac complications may arise on rare occasions [3], for which anesthesiologists should take relevant cautions.

In this study, I report a case of multiple long sinus pauses during suspension laryngoscopy in a patient with a thyroid tumor and enlarged cervical lymph nodes (LNs) when placed in a hyperextended neck position and discussed the various coexisting factors that might have induced excessive vagal responses.

2. Case presentation

A 52-year-old female patient (height, 155.4 cm; weight, 59.4 kg) was diagnosed with a follicular neoplasm of the thyroid (right: 3.0 × 1.9 × 1.2 cm; left: 0.8 × 0.5 × 0.6 cm) (Fig. 1) by fine-needle aspiration. She was first scheduled to undergo

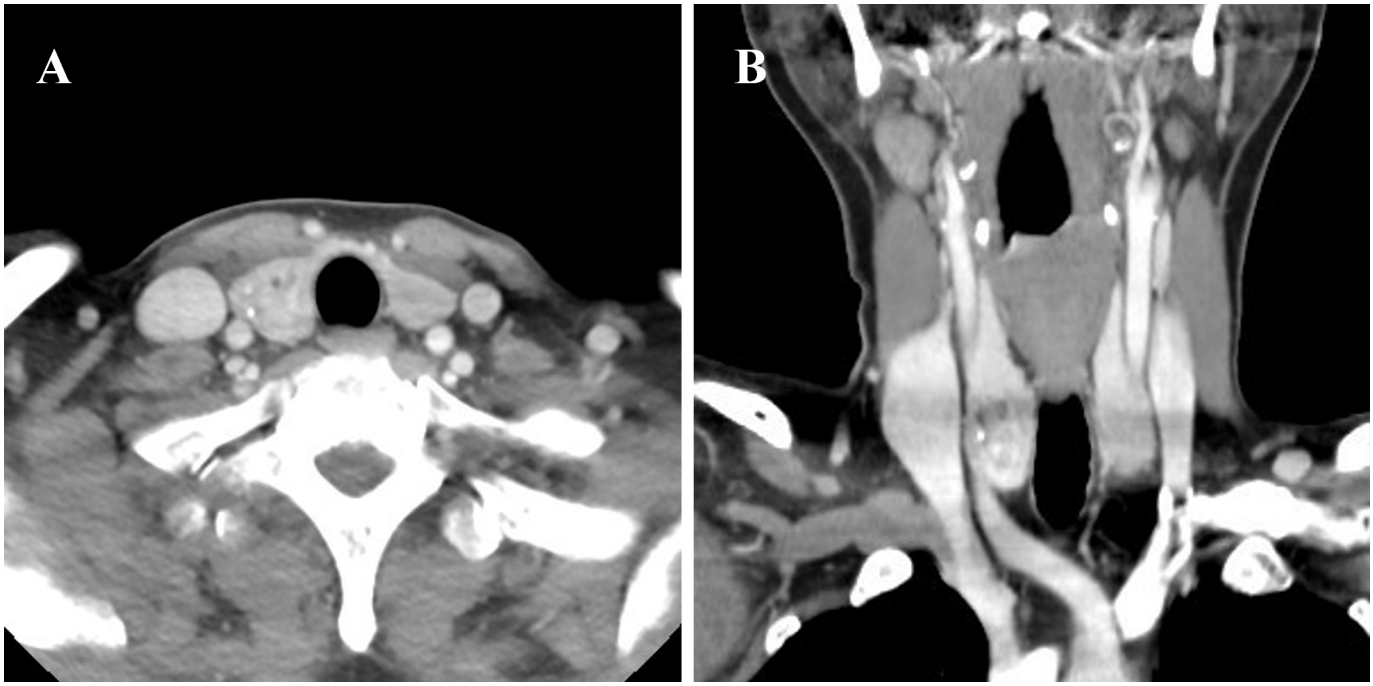

FIGURE 1. Computed tomography of the neck showing a solid nodule of approximately 3 cm in size in the right lobe and a few small solid nodules in the left lobe of the thyroid gland. (A) Axial view; (B) coronal view.

a right thyroid lobectomy, and the extent of the surgery was to be decided based on perioperative frozen-section analysis, as well as judging the necessity of total thyroidectomy. The patient was previously diagnosed with a vocal cord polyp 4 months ago due to a year-long hoarse voice, and LMS was scheduled to be performed by an otolaryngologist to remove the polyp before the thyroid surgery. The patient had no notable underlying diseases or other abnormal findings on preoperative evaluation. The preoperative thyroid function test was unremarkable, and the levels of thyroid-stimulating hormone and free thyroxine (fT4) were within the normal range of 2.0 mlU/L and 1.24 ng/dL, respectively. In addition, the patient had a preoperative normal sinus rhythmic heart rate of 62 beats/min. Preoperative airway evaluation of the patient showed a class 3 Mallampati score, 5 cm inter-incisor gap, favorable neck motion range and acceptable dental status.

The patient was not administered any specific premedication. Upon entering the operating room, standard monitoring was performed, including non-invasive blood pressure, electrocardiogram and peripheral oxygen saturation (SpO_2). The depth of anesthesia was monitored using a bispectral index (BIS) sensor attached to the patient's forehead. Preoxygenation was performed using a face mask with 100% oxygen. Total intravenous anesthesia was induced using 4.0 mcg/mL propofol effect-site target concentration (Ce) and 4.0 ng/mL remifentanil Ce. After BIS reached below 60, 0.6 mg/kg rocuronium was administered. A Cormack-Lehane grade 2 was observed on video laryngoscopy, following which tracheal intubation was successfully completed using an endotracheal tube with an internal diameter of 6.5 mm.

For the LMS, the otolaryngologist adjusted the patient's posture. A roll was placed under the shoulder of the patient in the supine position to support the Boyce-Jackson (flexion-extension) position to enhance the laryngeal exposure of the patient. Her vital signs at the time were stable (blood pressure, 106/53 mmHg; heart rate, 62 beats/min). The Ce of propofol and remifentanil, which were slightly decreased during surgical preparation, was increased to 4.0 μg/mL and 4.0 ng/mL, respectively, immediately before suspension laryngoscopy for sufficient depth of anesthesia and hemodynamic control, as well as during the tracheal intubation. The main otolaryngologist used a straight rigid laryngoscope (Karl Storz, GmBH & Co., Germany) to the right side of the patient's mouth for it to pass through, and a lifting action was performed to place the laryngoscope at the midline of the tongue base and to expose the glottis for suspension laryngoscopy.

Next, to enhance the surgical field's exposure, external laryngeal manipulation (ELM) was applied, during which a sinus pause was detected for approximately 5 s (Fig. 2A), and her heart rate was restored as the ELM was discontinued (Fig. 2B). During the process of adjusting the patient's posture to enhance the surgical field exposure, that is, when the neck was extended a little further for ELM, several sinus pauses recurred following the initial 3.5 s sinus pause (Fig. 2B,C). As the BIS at the time was 30–40, indicating adequate anesthesia depth, the level of propofol Ce was unadjusted. As laryngeal exposure was not adequate, ELM was not discontinued in the second episode, and an intravenous injection of glycopyrrolate 0.2 mg was administered to the patient. After good laryngeal visualization was achieved and the ELM was no longer required, the heart rate returned to the normal range (Fig. 2D), with a blood pressure of 150/70 mmHg. Since the vital signs had stabilized, the laryngoscope holder and the chest device were carefully fixed.

During the surgery, the level of propofol was maintained at Ce 3.0–4.0 ng/mL according to the BIS, and the level of remifentanil was maintained at Ce 2.0–4.0 ng/mL according to the hemodynamic parameters. LMS was completed without

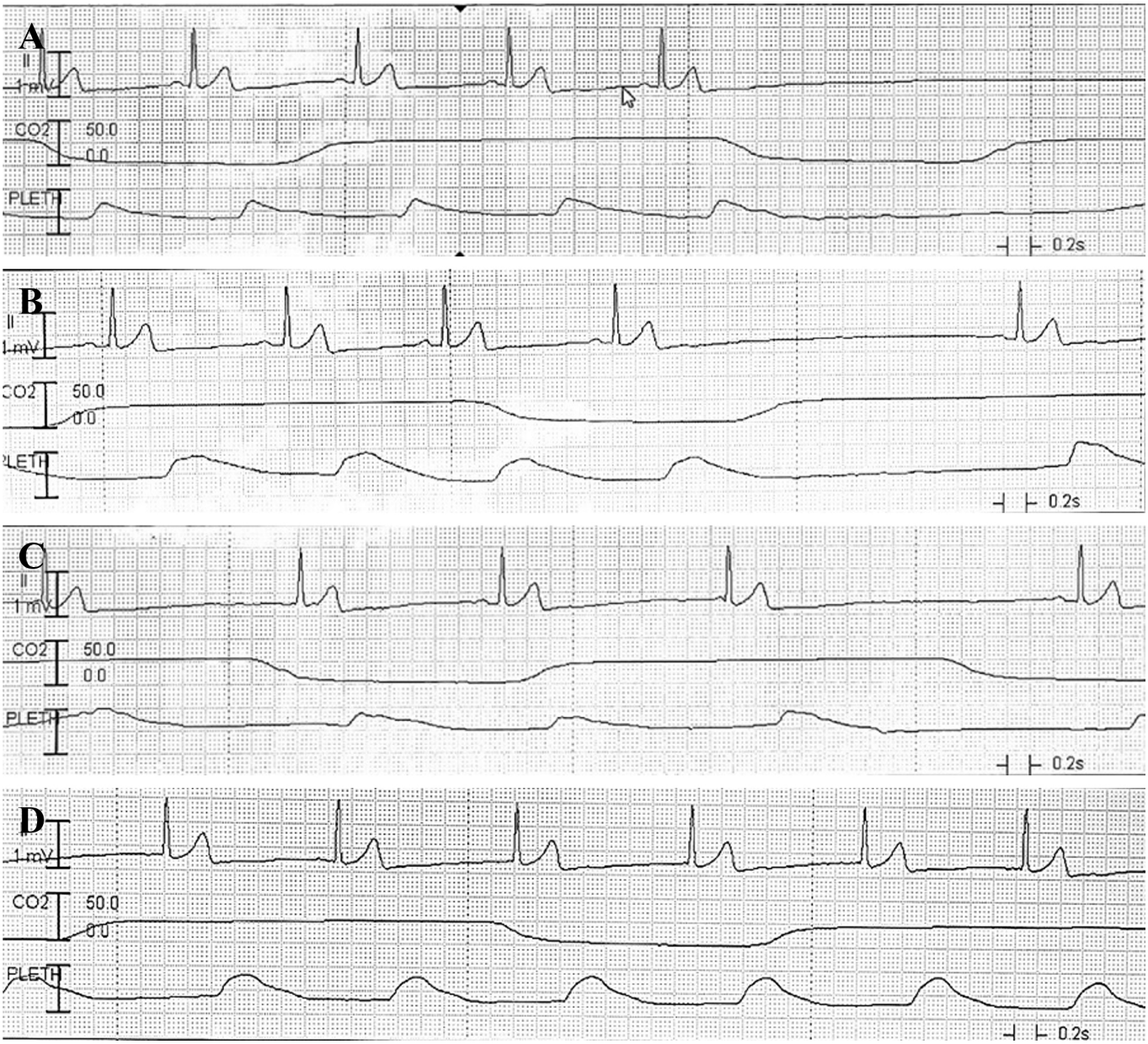

FIGURE 2. Telemetry electrocardiogram (top) and plethysmography (bottom) demonstrating multiple sinus pauses during suspension laryngoscopy for the laryngeal microsurgery. (A) A sinus pause was detected for approximately 5 s when external laryngeal manipulation (ELM) was applied. (B) The heart rate was restored as the ELM was discontinued. (C) When adjusting the neck position and applying the ELM, several sinus pauses recurred following the initial 3.5 s sinus pause. (D) After good laryngeal visualization was achieved and the ELM was no longer required, the heart rate returned to the normal range. PLETH: Plethysmography.

the further occurrence of either severe bradycardia or arrhythmia. A thyroid pillow was placed under the patient's shoulder for subsequent thyroid surgery to carefully adjust for Rose's position. Based on the biopsy result, the surgeons decided to proceed with total thyroidectomy, which was successfully performed without any cardiac complications. No arrhythmic symptoms were detected after surgery and hospital discharge. As the clinical data were deidentified, no ethical approval was required for this study and the patient provided informed consent for publishing this case report.

3. Discussion

In suspension laryngoscopy, a commonly observed hemodynamic change is an increase in blood pressure and heart rate, in line with the increase in plasma catecholamine levels upon laryngoscopy. To attenuate such changes, opioids or anesthetic drugs are sometimes used. However, an opposite reaction may occur if such drugs are used in excess. Notably, remifentanil may directly inhibit sinus node function or suppress the heart rate *via* central vagal stimulation. There have been reported cases of sinus arrest in patients with abnormal sinus function or those on an antihypertensive drug. Remifentanil has also been shown to cause severe bradycardia upon bolus

administration, even in healthy individuals [4]. Ultimately, bradycardia or asystole could be caused by an increase in vagal response through the parasympathetic nerve fibers from the vagus nerve to the sinoatrial node. Thus, even in the absence of the previously mentioned opioid dose problems, several other conditions could increase vagal tone, that is, induce vagal stimulation and reflex upon laryngeal manipulation, resulting in severe reflexive bradycardia and asystole [5–7].

One suspected mechanism is the direct stimulation of the vagus nerve, also known as the laryngo-cardiac reflex [8]. It is often triggered in suspension laryngoscopy when the blade tip lifts the supraglottic area or laryngeal surface of the epiglottis [5, 6]. Following stimulation through mechanical irritation to areas innervated by an internal branch of the superior laryngeal nerve, a sensory branch of the vagus nerve, the afferent signal through the vagus nerve is received by the solitary nucleus of the medulla, and the resulting efferent parasympathetic signal through the vagus nerve leads to bradycardia. Continuous intense stimulation has been reported to cause asystole [5]. Due to the required stimulation level, simply placing the laryngoscope on the laryngeal surface of the epiglottis without any significant tension would not lead to bradycardia [7, 9]. However, with significant tension, bradycardia can result in irrespective of epiglottic contact [9]. Another suspected mechanism is believed to originate in the carotid sinus reflex, which is a type of baroreceptor reflex. This phenomenon is caused by swelling, stretching, or compression of the carotid sinus, located just above the bifurcation of the carotid artery. This is the same mechanism as that of the carotid sinus massage used in the treatment of tachyarrhythmia. In the arterial adventitia of the carotid sinus, baroreceptors maintain blood pressure, through which afferent signals are relayed to the solitary nucleus of the medulla through the glossopharyngeal nerve and efferent signals through the vagus nerve, ultimately exerting net effects such as vasodilation, bradycardia, and hypotension. Neck manipulation or neck extension towards the Boyce-Jackson position before suspension laryngoscopy could induce distension of the carotid sinus [7]. Similarly, a case of asystole due to carotid sinus hypersensitivity (CSH) during the positioning in preparation for thyroid surgery was reported [10, 11]. Such CSH cases occur due to an exaggerated response to the pressure imparted on the carotid sinus, regardless of the spontaneous symptoms, in the presence of a positive response to the carotid sinus massage [12, 13]. Notably, patients may exhibit a form of carotid sinus syndrome (CSS) characterized by induced or spontaneous symptoms of dizziness or syncope in patients with head and neck tumors. CSS has been reported to occur when the carotid sinus is affected by massive multinodular goiter [14], enlarged lymph node, or post-irradiation fibrosis [15, 16].

Considering the previously mentioned mechanisms and the various influencing conditions affecting them, it was determined that ELM was the key factor inducing sinus pauses in this present case. They are presumed to have occurred during ELM rather than immediately after the placement of the rigid laryngoscope at the opening of the glottis. Similarly, in the second episode, despite the potential effect of glycopyrrolate administration, the discontinuation of ELM once the surgical exposure had been ensured led to restoring the heart rate. Assuming that the main mechanism of exaggerated vagal response is the laryngo-cardiac reflex, it is likely that while the initial tension upon the placement of the laryngoscope was not sufficient, the addition of the ELM created a more intense stimulation that triggered the vagal reflex. It is also plausible that the carotid sinus reflex, previously mentioned as another possible mechanism, might have played a major role. The thyroid tumor does not seem to have impacted the carotid sinus due to its size or location. Although benign enlarged LNs were found in the level II loci of both sides of the neck on the preoperative thyroid ultrasonography (Fig. 3), it is improbable that they are the sole key contributors to the sinus pauses observed in this patient because there was no bradycardia at the time of neck extension for LMS and thyroidectomy or a history of syncope. Nonetheless, they could be counted as one of the numerous influencing factors. Particularly, laryngeal manipulation with hyperextension of the neck and the presence of enlarged LNs may affect the carotid sinus. Ultimately, regardless of which mechanism was predominant, whether the main mechanism was the laryngo-cardiac reflex or the carotid sinus reflex, it is presumed that the ELM acted as a decisive additional factor in conditions with various coexisting internal and external potential factors that may exaggerate the vagal response.

The most effective way to manage bradycardia caused by vagal stimulation or reflex is to instantly remove the causal stimulation. In this present case, external factors such as suspension laryngoscopy and hyperextended neck position, in addition to ELM, could have been the cause of bradycardia. In addition, while the probability of CSS is relatively low without a history of syncope, CSS may appear in a patient with head and neck tumors if previously mentioned external stimulation simultaneously occurs with internal factors such as post-irradiation fibrosis, the tumor itself or cervical lymphadenopathy. In patients suffering from CSS, the definite treatment is to surgically remove the tumor, while radiotherapy may be used as an alternative option if complete surgical resection is impossible or is necessary, as per lymph node staging [16]. However, no specific treatment is recommended for patients with asymptomatic CSH [16]. Therefore, in patients with a head and neck tumor without spontaneous symptoms of CSS, similar to the patient reported here, it is necessary to antecedently determine whether they have precipitating factors of CSS through thorough preoperative evaluation. Prior administration of an anticholinergic drug such as atropine or glycopyrrolate has been shown to prevent bradycardia in suspension laryngoscopy [9], which could be therapeutically used if bradycardia occurs. In cases accompanied by a decrease in blood pressure, it would be helpful to use a sympathomimetic drug, *i.e.*, ephedrine, which should be prepared in advance for patients at risk to allow immediate administration if required.

4. Conclusions

In conclusion, when performing suspension laryngoscopy, external factors such as head and neck positioning, the procedure itself and laryngeal manipulation may induce an excessive vagal response. Notably, patients with head and neck tumors may also have various internal factors that deteriorate vagal re-

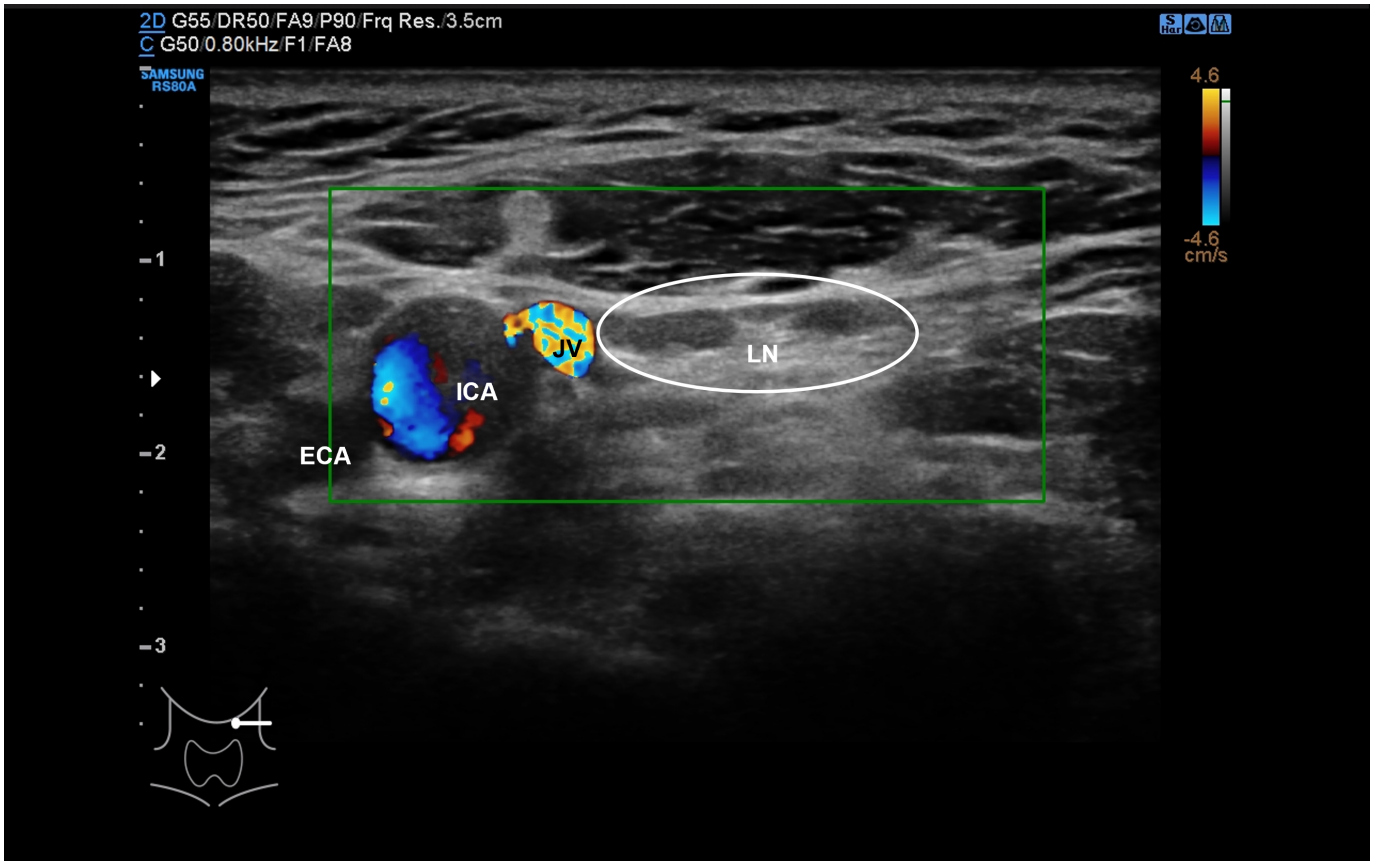

FIGURE 3. Preoperative ultrasound of the left side of the neck showing enlarged lymph nodes in level II. ECA: external carotid artery; ICA: internal carotid artery; JV: jugular vein; LN: lymph node.

sponses. Such factors should be identified in advance through thorough preoperative evaluation, and care should be taken to minimize the additional influence of external factors.

AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available on reasonable request from the corresponding author.

AUTHOR CONTRIBUTIONS

SHB—collected and analyzed the data and drafted the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

As the clinical data were deidentified, the study was granted an exemption from ethical approval by the Institutional Review Board of Kyungpook National University Chilgok Hospital in Daegu, Korea (KNUCH 2022-11-009). The patient provided informed consent for the publication.

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CONFLICT OF INTEREST

The author declares no conflict of interest.

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