

Intraoperative Recurrent Laryngeal Nerve Monitoring in a Patient with Contralateral Vocal Fold Palsy

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Recurrent laryngeal nerve injury can develop following cervical or thoracic surgery; however, few reports have described intraoperative recurrent laryngeal nerve monitoring. Consensus regarding the use of this technique during thoracic surgery is lacking. We used intraoperative recurrent laryngeal nerve monitoring in a patient with contralateral vocal cord paralysis who was scheduled for completion pneumonectomy. This case serves as an example of intraoperative recurrent laryngeal nerve monitoring during thoracic surgery and supports this indication for its use.

Key words: 1. Vocal cord paralysis
2. Intraoperative monitoring
3. Recurrent laryngeal nerve injuries

Case report

Recurrent laryngeal nerve (RLN) paralysis occurs in up to 31% of patients who undergo left-lung resection for lung cancer [1]. As the risk of RLN paralysis is high in thoracic operations, intraoperative neuromonitoring (IONM) should be considered. Here, we describe a case in which a single intact vocal fold was preserved using IONM.

A 57-year-old man presented with metastatic squamous cell carcinoma at the left hilar lymph node and left lower lobe of the lung diagnosed by biopsy (Fig. 1). He had undergone left upper lobe sleeve lobectomy for squamous cell carcinoma 1 year previously. The pathologic stage after the operation was pT2aN0M0 according to the TNM classification of lung cancer, seventh edition. He had also undergone laser cordectomy for laryngeal cancer 2 years pre-

viously and an extended vertical partial laryngectomy 3 months previously. He had not received any neoadjuvant or adjuvant therapy. Although the final procedure for completion pneumonectomy was scheduled, 2 problems were encountered: (1) severe adhesions were expected in the left hemithorax due to the prior operation and (2) the right vocal fold was already fixed in the paramedian position. He occasionally experienced hoarseness and aspiration. Additional left vocal fold palsy (VFP) after completion pneumonectomy would exacerbate this condition. Hence, we decided to use IONM to reduce the probability of RLN injury. Informed consent was obtained from the patient prior to performing completion pneumonectomy, which was carried out without any injury to the left RLN. A postoperative vocal fold examination confirmed that the left vocal fold was intact. The patient was discharged without any ag-

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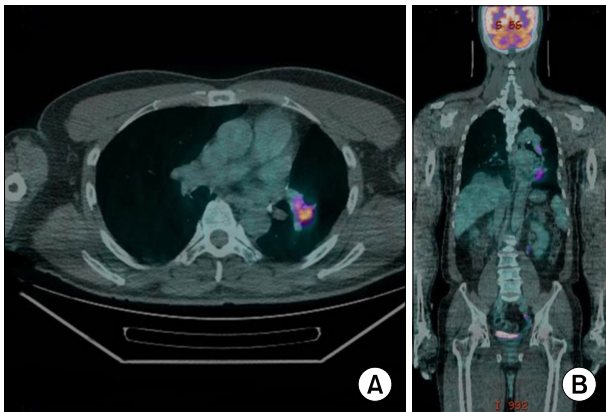


Fig. 1. (A, B) Axial and coronal view of the patient's positron emission tomography scan shows increased ^{18}F -fluorodeoxyglucose uptake in the left hilar area.

gravation of hoarseness or aspiration, and was monitored for an 18-month follow-up period.

The NIM-Eclipse nerve monitoring system (Medtronic, Minneapolis, MN, USA) was used in this case. During IONM, if the RLN was irritated, the intrinsic laryngeal muscle innervated by the nerve showed a different pattern of compound muscle action potential (CMAP) activity and free running electromyography. Intraoperatively, CMAP and free running electromyography were monitored. The operator was notified regarding any irritation, and then altered the direction of tissue dissection.

The stimulating probe, an APS Electrode (Medtronic, Minneapolis, MN, USA), resembled forceps and could be easily maintained in contact with the nerve. For intrinsic laryngeal muscle electromyography, a surface electromyography electrode was glued to a double-lumen endotracheal tube (E-tube) that was maintained in contact with the vocal fold above the cuff (Fig. 2A). To ensure appropriate positioning, the distance from the true vocal fold to the carina was measured during preoperative computed tomography, and videolaryngoscopy was used during intubation.

Neuromuscular blockers were used during intubation, and reversal agents were used before IONM, since muscle relaxants upregulate the threshold level for proper stimulation. After injecting muscle relaxant reversal agents, total intravenous anesthesia with propofol and remifentanyl was used, which is frequently adopted for thymectomy of myasthenia gravis patients in the field of thoracic surgery.

The left vagus nerve was located above the dia-

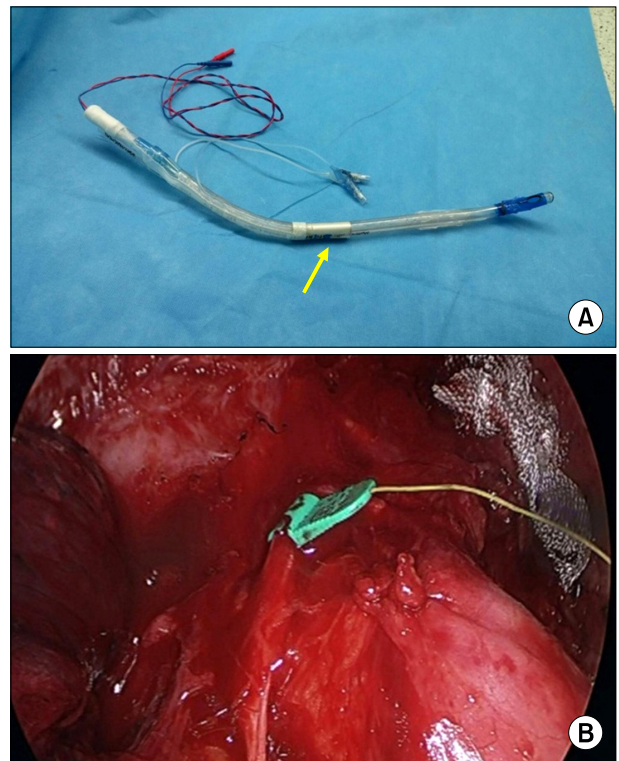


Fig. 2. (A) A surface electromyography electrode (arrow) was glued to a double-lumen endotracheal tube that was kept in contact with the vocal fold above the cuff. (B) A stimulating probe was placed on the vagus nerve, proximally to the recurrent laryngeal nerve in the operative field.

phragm level, and dissection was continued along the vagus nerve towards the aortic arch level, where the RLN originates from the vagus nerve. After locating the origin, the stimulating probe was placed on the vagus nerve, proximally to the RLN (Fig. 2B).

The remaining left lower lobe was adhered to the mediastinum. The left hilum was dissected and pericardiectomy was performed at the hilum. The left lower lobe pulmonary vein and previous left upper lobe pulmonary vein stump were identified. The left main pulmonary artery was carefully dissected away from the vagus and RLN with Metzenbaum scissors. The left pulmonary artery was dissected away from the left main bronchus. The pulmonary vein and pulmonary artery were stapled and divided intrapericardially. The left bronchus was dissected to the carina level and divided after stapling. The left lower lobe specimen was retracted and the completion pneumonectomy was finished. No definite nodule around the RLN could be seen intraoperatively. The

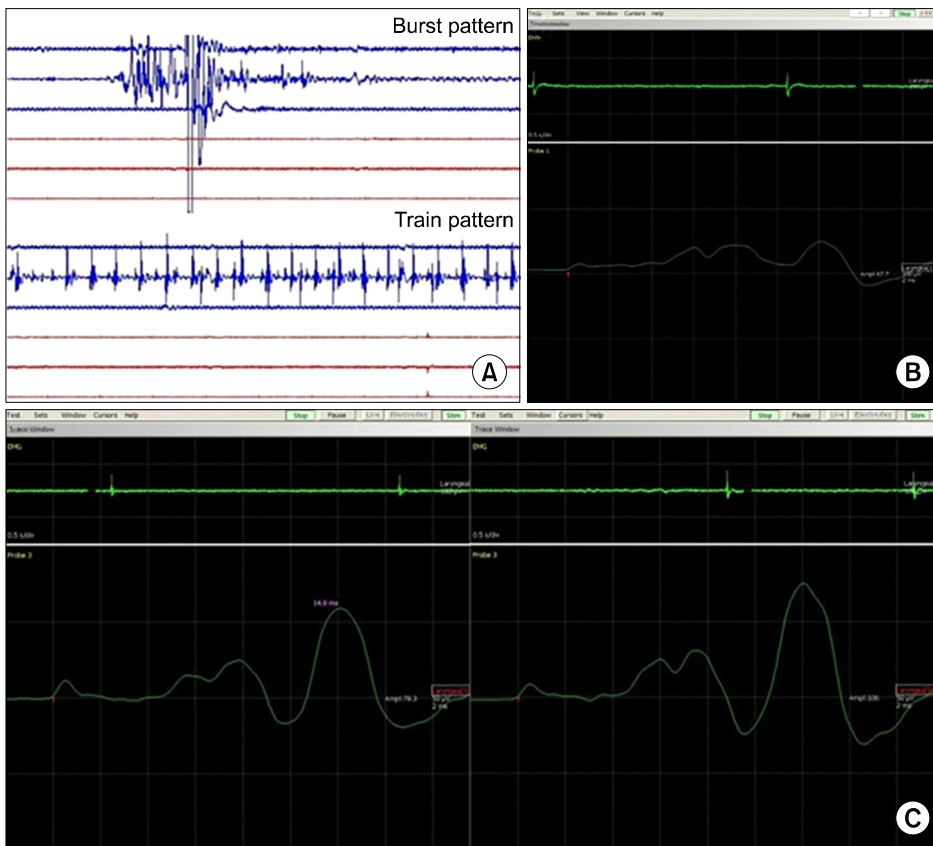


Fig. 3. (A) Free running electromyography exhibits 2 patterns, the burst pattern and the train pattern. (B) The amplitude decreased twice, warning the operator of a possible injury of the recurrent laryngeal nerve. (C) The wave in the nerve conduction study conducted after surgery did not differ from that observed before surgery.

paraortic lymph nodes were resected en bloc with the anterior mediastinal lymph nodes and thymic tissue.

Free running or spontaneous electromyography exhibits 2 patterns on the background electromyogram. A phasic (burst) pattern is observed when direct contact is made with the nerve, whereas a tonic (train) pattern persists for several minutes in the event of traction or ischemic injury. The phasic pattern is rather tolerable, but the tonic pattern represents a powerful warning sign of nerve injury (Fig. 3A) [2], particularly when stretching is the major mechanism of the injury of the RLN during the operation [3]. Free running electromyography was measured continuously throughout the operation and did not show a tonic pattern.

CMAP was recorded after each stimulation, and was repeated every 3 seconds. During the operation, the amplitude decreased twice (Fig. 3B), at which time the monitoring individual informed the operator of a possible injury to the RLN. The operator altered the course of the dissecting plane. The CMAP wave

after the operation did not differ from the wave observed before it (Fig. 3C).

Discussion

Our case shows that IONM may be beneficial for patients at a high risk of RLN paralysis and who must avoid RLN paralysis for medical or occupational reasons. Cooperation among a skilled thoracic surgeon, an anesthesiologist, and an electromyography team can more effectively prevent VFP.

IONM is limited by its ability to detect neurotonic discharges during periods of electrocautery. In our case, electrocautery was used when dissecting structures remote from the vagus nerve and RLN. Sharp scissors were employed when dissecting tissue adjacent to the nerves. We did not use ultrasonic devices to avoid thermal injury to the nerves. Theoretically, ultrasonic devices do not generate any electrical current flow to the patient. However, electromagnetic artifacts from ultrasonic devices can sometimes cause significant interference in IONM [4].

Another limitation relates to the complete section of a nerve and nerve ischemia, both of which may not exhibit neurotonic discharges. Hence, a normal IONM signal does not always indicate the absence of VFP risk. Instead, the patient should be assessed by indirect laryngoscopy to evaluate vocal fold movements postoperatively [5].

Unlike during thyroid surgery, the cuff electrode cannot be relocated to the true vocal fold during 1-lung ventilation, as it would jeopardize adequate ventilation and interfere with the operative field. Some cases in which the E-tube balloon completely blocked the airway during operation have been reported [6].

Some case reports and series have discussed the use of IONM during thoracic surgery. All previously published articles in the field of thoracic surgery described stimulation neuromonitoring as a method of detecting neurologic damage, and free running electromyography was not used. CMAP was measured before and after surgery and only when tracheal intubation was suspected [7].

In our case, an APS Electrode probe enabled frequent CMAP monitoring without disturbing surgical maneuvers. APS Electrode probe use is becoming popular during thyroid surgery for continuous IONM, although the term “continuous” really means “intermittent but frequent and periodic” [8]. In our case, adding free running electromyography enabled continuous and instant monitoring of nerve irritation, and helped to detect and avoid traction injury. The combination of CMAP assessed every 3 seconds and free running electromyography can contribute to a more reliable method of preserving the RLN. Introducing free running electromyography is simple and easily achievable by a minor modification of previously used IONM techniques, and is not restricted to certain types of monitoring systems. No randomized controlled trials have compared the usefulness

of even preliminary IONM during thoracic surgery. Further research into free running electromyography would be valuable. Until then, we believe that IONM should be used for patients with contralateral VFP who are scheduled to undergo thoracic surgery.

Conflict of interest

No potential conflicts of interest relevant to this article are reported.

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