

Single Case

Combined Intraoperative Identification and Monitoring of Recurrent Laryngeal Nerve Paresis during Minimally Invasive Esophagectomy: Surgical Technique Using Nerve Integrity Monitoring for Esophageal Carcinoma

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Keywords

Minimally invasive esophagectomy · Recurrent laryngeal nerve paresis · Intraoperative nerve monitoring

Abstract

Recurrent laryngeal palsy occurs after No. 106 rec RL lymphadenectomy procedure, which is assumed to cause postoperative respiratory complications. A 71-year-old Japanese man with T1b N0 M0 stage 1 esophageal cancer was scheduled for thoracoscopic esophagectomy with two-field lymph node dissection using nerve integrity monitoring (NIM). The patient demonstrated an uneventful postoperative course with 56 days remission. Under general anesthesia conditions, a single-lumen intubation tube was inserted for NIM. The automatic periodic

stimulation electrode was placed on the bilateral vagus nerves on the left and right, respectively. The NIM had set and enabled the identification of the nerve accurately and continuous intraoperative nerve monitoring using impulses from the stimulation probe. The postoperative outcomes and comparison of the potential amplitudes of electromyography were observed while no postoperative vocal cord paresis was present. Combined intraoperative identification and monitoring of recurrent laryngeal nerve significantly changes the quality of the lymphadenectomy procedure and is a promising optical imaging technique. It has gained recognition for being able to reduce or prevent recurrent laryngeal nerve paralysis. It was considered a reasonable method, but it has been superseded by NIM, which is a novel technology.

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Introduction

Esophageal cancer is associated with a poor prognosis and poor survival rates [1]. According to a web-based Japanese national database study [2], esophageal cancer has an overall morbidity rate of 41.9% and 3-day and surgery-related mortality rates of 1.2 and 3.4%, respectively [2, 3]. To achieve better prognoses in patients with esophageal cancer, Japanese surgeons are exploring the usefulness of radical lymphadenectomy, especially for lymph nodes along the bilateral recurrent laryngeal nerve (BRLN) that frequently involve metastasis. Therefore, minimal invasiveness of radical lymphadenectomy is key to improving survival rates. However, the prevalence of recurrent laryngeal nerve paralysis is reported to be as high as 14–24% [4–6]. Recurrent laryngeal palsy occurs commonly following the No. 106 rec RL lymphadenectomy procedure [7] and is purported to cause pulmonary events related to postoperative complications such as aspiration pneumonia. Respiratory complications significantly affect the prognosis of esophageal carcinoma. Prevention of recurrent laryngeal nerve paralysis is the best way to improve its prognosis.

Herein, we introduce our novel surgical technique for treating recurrent laryngeal nerve paralysis following surgical resection of esophageal carcinoma by using nerve integrity monitoring (NIM) by combined intraoperative identification and monitoring.

Case Presentation

A 71-year-old Japanese man with a history of dysphagia visited our hospital. Endoscopic examination revealed a slight depression in his midthoracic esophagus (Fig. 1), an unstained area on Lugol iodine staining, and a brownish area on narrow-band imaging spread unevenly throughout the upper to lower thoracic esophagus. Esophagography was conducted and its findings revealed slight wall irregularities in the midthoracic esophagus. Laboratory findings on admission were unremarkable (Table 1), except that the CEA and SCC tumor markers were not detected. Computed tomography demonstrated slight lymph node swelling of the thoracic upper esophagus without radiological evidence of invasion and with no distant metastasis.

We diagnosed the esophageal cancer as T1b N0 M0 stage 1 (defined according to the Japanese Classification of Esophageal Cancer, 11th Edition). Subsequently, the patient was

scheduled for thoracoscopic esophagectomy with two-field lymph node dissection by using NIM for early esophageal carcinoma. Surgery was performed with a duration of 575 min; the intraoperative estimated blood loss was 80 mL. The patient demonstrated an uneventful postoperative course and no BRLN paralysis occurred. After being discharged from our hospital, he remained in remission for 56 days postoperatively even after experiencing a cerebrovascular infarction on postoperative day 17 (Clavien-Dindo grade II).

Surgical Technique

Under general anesthesia, a single-lumen intubation tube (electromyography [EMG] tube; Medtronic, Japan) was inserted via the nerve integrated monitoring system (NIM-Response® 3.0 system; Medtronic Xomed, Inc., USA). The electrode attached to the single-lumen intubation tube was fixed to the vocal cord by the EMG tube intubation. As a precaution, a collar cervical incision was created through the subcutaneous tissue. Then, we accessed the carotid sheath through the sternocleidomastoid muscle. The vagus nerve was dissected freely along the vessels and the automatic periodic stimulation electrodes were placed on the bilateral vagus nerves on the left and right (Fig. 2).

The NIM infrastructure was set and enabled the identification of the nerve and continuous intraoperative nerve monitoring (IONM) using the impulses by the stimulation probe. This stimulation probe was disposable (OPT2; Medtronic, Japan); it was connected to the NIM (Fig. 3), by which we could recognize the BRLN using this surgical equipment.

The postoperative outcomes and comparison of potential amplitudes of EMG were observed as follows: the EMG amplitude on the left side was 513 μ V preoperatively and 582 μ V postoperatively. The EMG amplitude on the right side was 638 μ V preoperatively and 396 μ V postoperatively. No postoperative vocal cord paresis was observed. Additionally, the motility of the vocal cords was evaluated by laryngoscopy after extubation. We reevaluated whether paresis was present or not. Owing to the continuous IONM of the BRLN (Fig. 4), we successfully performed the No. 106 rec RL lymphadenectomy, and respiratory complications were avoided consequently.

Discussion

Minimally invasive surgery has been preferred to open surgery owing to its benefits of reducing morbidity and mortality, in addition to being a cosmetic procedure. It has been specifically useful for treating malignancies since various studies evidenced its effects of reducing morbidity and mortality rates and improved prognosis. However, its effectiveness in treatment is expected to be similar to that of open surgeries.

Specifically, in the field of esophagectomy and lymphadenectomy for esophageal carcinoma, the application of minimally invasive esophagectomy (MIE) with thoracic and laparoscopic approaches is increasing and gaining recognition. Cuschieri et al. [8] first performed the MIE technique in the prone position in 1992. Various surgeons recently performed thoracic and laparoscopic esophagectomy in the prone position, providing sufficient evidence on its increased applicability.

This widespread change can be attributed to the increased surgical feasibility provided by the prone position, as good surgical fields are possible since the right lung rests on the

operating table due to gravity, and Japanese surgeons like us can preferably perform a right posterolateral thoracic incision.

Previous reports concluded that MIE reduces the rate of postoperative respiratory complications compared to open esophagectomy [9, 10]. Recurrent laryngeal palsy is assumed to be the underlying etiology for postoperative pulmonary complications. With MIE, surgeons achieve a wider surgical field and facilitate an improved visualization because of using the latest laparoscopy. Since we used the magnifying glass, we could easily detect the BRLN and identify the recurrent laryngeal nerve accurately by using NIM. Thus, we could avoid the occurrence and severity of recurrent laryngeal nerve palsy by using continuous IONM of the BRLN in performing No. 106 rec RL lymphadenectomy.

There are five advantages of performing IONM for localizing the BRLN, as reported by Dionigi et al. [11]: (1) IONM facilitates BRLN identification as described above. (2) It enables testing of BRLN function. (3) It enables corrective actions during the lymphadenectomy procedure. (4) It enables evaluation of BRLN function by vagus nerve stimulation. (5) The most significant advantage is that IONM provides enough support for novice surgeons so that their confidence in performing a thyroidectomy and even esophagectomy rises. We believe that this procedure has strengths for its application in esophagectomy, which can prevent BRLN palsy.

Combined intraoperative identification and monitoring of recurrent laryngeal nerve has significantly increased the quality of lymph node dissection. It is a promising optical imaging technique which has shown high potential in reducing recurrent laryngeal nerve paralysis. This procedure introduces the concept of image-guided surgery for BRLN, which can be performed in esophagectomy and was considered to be reasonable; however, the introduction of NIM has provided significantly greater advancements and gained widespread applicability.

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Statement of Ethics

This case report, including our surgical procedures, was approved by the Ethics Committee of Shiroyama Hospital (SH028-2019), and the participant provided written informed consent for publication of his case, including publication of images.

Conflict of Interest Statement

The authors declare that there are no conflicts of interest.

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Author Contributions

T. Nitta wrote the paper and all authors contributed to the medical treatment. All authors approved the manuscript.

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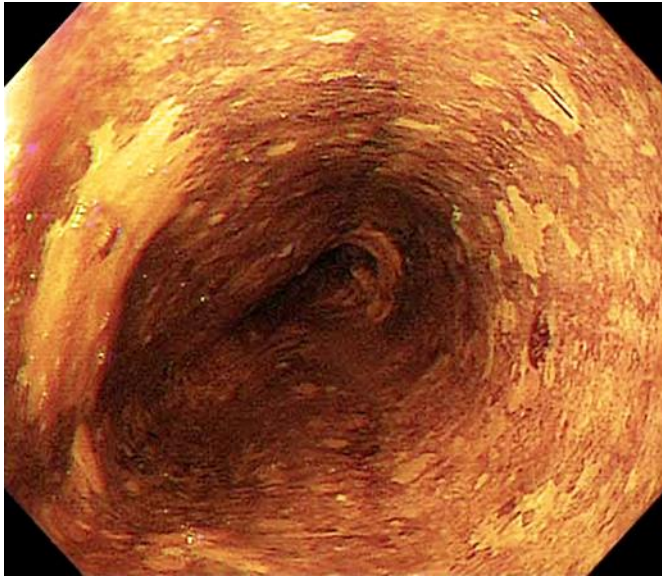


Fig. 1. Endoscopic examination detected a slight depression and unstained area on Lugol iodine staining in his midthoracic esophagus.



Fig. 2. The automatic periodic stimulation electrode was placed on the bilateral vagus nerve.



Fig. 3. The disposable OPT2 device was connected to the nerve integrated monitoring system.

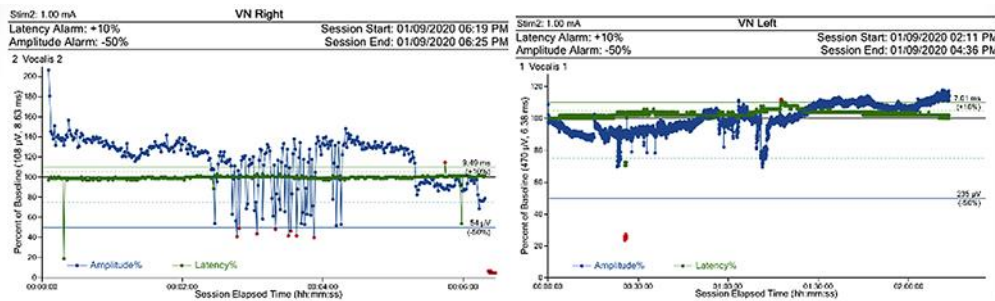


Fig. 4. With continuous intraoperative nerve monitoring of the bilateral recurrent laryngeal nerve, the No. 106 rec RL lymphadenectomy was performed successfully.

Table 1. Laboratory findings

Variable	Range	On admission	Variable	Range	On admission	Variable	Range	On admission
Peripheral blood			Blood chemistry			Serological tests		
WBC, / μ L	3,900–9,800	4,100	TP, g/dL	6.5–8.3	6.5	CRP, mg/dL	0–0.30	0.10
RBC, / μ L	430–570	334 \times 10 ⁴	ALB, g/dL	3.8–5.2	3.9	HBsAg		–
Hb, g/dL	13.5–17.6	12.7	T.Bil, mg/dL	0.2–1.2	1.2	HBsAb		–
Hct, %	40.0–52.0	38.0	AST, IU/L	10–40	20	HCVAb		–
Plt, / μ L	12.0–34.0	21.3 \times 10 ⁴	ALT, IU/L	5–45	8	Coagulation		
Tumor markers			ALP, IU/L	110–340	187	PT, s	10.5–13.5	12.5
CEA, ng/mL	0–5.0	2.7	γ -GTP, U/L	12–87	78	PT, %	70–130	87.5
SCC, ng/mL	0–1.5	1.0	LDH, IU/L	107–230	230	aPTT, s	25–40	25.3
			BUN, mg/dL	8.0–20.0	12.8	AT-III, %	82–132	99.9
			Cr, mg/dL	0.61–1.04	1.04			
			Na, mEq/L	135–147	142			
			K, mEq/L	3.3–5.0	3.9			
			Cl, mEq/L	98–108	101			
			CPK, IU/L	45–190	98			
			ChE, U/L	201–421	213			