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CASE REPORT

A palsied recurrent laryngeal nerve should be explored and evaluated by intraoperative neuromonitoring during secondary thyroidectomy: report of two cases

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Abstract Introduction: Our aim was to evaluate the findings of intraoperative nerve monitoring (IONM) in two cases with preoperative vocal cord palsy. Case 1: a 61-year-old female with recurrent goiter underwent secondary thyroidectomy. The preoperative evaluation of the vocal cords revealed right vocal cord paralyses without atrophy. The right recurrent laryngeal nerve (RLN) was found to be anatomically intact and preserved. The electrical responses of the vocal cords were elicited via IONM. Case 2: a 26-year-old male, who presented with preoperative right vocal cord palsy with atrophy, underwent completion thyroidectomy secondary to papillary carcinoma. The right RLN was explored and found to be tied and interrupted. There was no signal from the RLN with IONM. Conclusion: Even in cases with vocal cord palsy detected preoperatively, the nerve should be explored intraoperatively, and should never be sacrificed before an evaluation by nerve monitoring. A palsied RLN which has electrical activity should be protected to maintain the vocal cord's neural tone and to prevent its atrophy.

Keywords Palsied recurrent laryngeal nerve · Intraoperative neuromonitoring · Secondary thyroidectomy

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Introduction

Recurrent laryngeal nerve (RLN) palsy is the most important complication of thyroid surgery, which also leads to medicolegal issues. Bilateral nerve injuries give rise to catastrophic results due to glottic obstruction; unilateral injuries can cause voice impairment and dysphagia, especially for liquids. The RLN injury rates in thyroidectomies are reported to be less than 1 % for permanent injuries in expert hands, but transient nerve palsy occurred in up to 25 % of cases in some reports [1, 2].

Many factors, such as the type of thyroid disease, extent of surgical resection, presence of previous intervention, anatomical variations of the RLN and the surgeon's experience are associated with the risk of nerve injury [3]. Although routine visual identification of the RLN is the gold standard for thyroid surgery, intraoperative nerve monitoring (IONM) has been proposed as an adjunct to facilitate nerve identification and dissection to diminish the rate of nerve palsy and to determine the prognosis in terms of the postoperative neural function [4]. Although there is no consensus regarding the routine use of IONM during each thyroid operation, it is especially advocated in challenging interventions, such as cases of malignancy, revision surgery, substernal goiter, surgery after external beam radiotherapy and in cases with Graves disease [5, 6].

In this report, we aimed to evaluate the findings of IONM in two cases with preoperative vocal cord palsy during a secondary thyroidectomy.

Case 1

A 61-year-old female who underwent bilaterally subtotal thyroidectomy 20 years earlier was admitted to our

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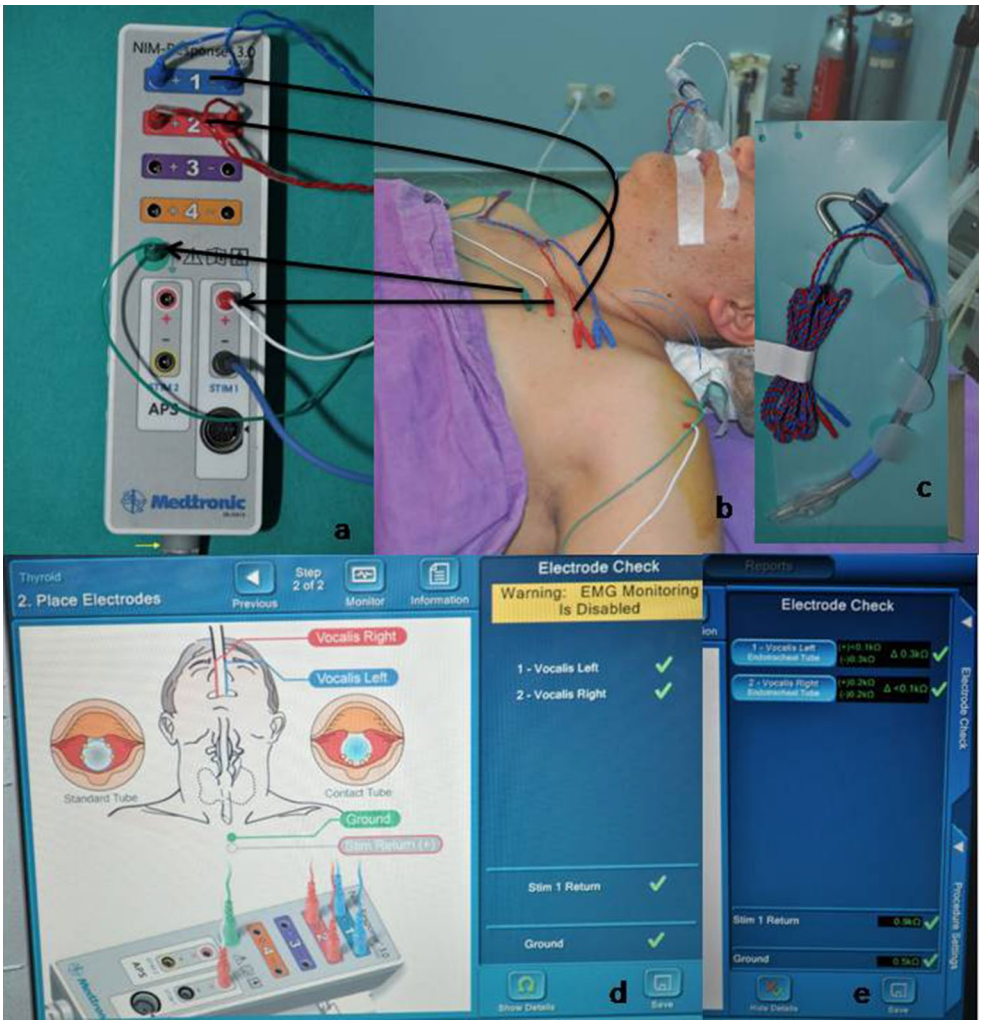


Fig. 1 The intubation of the patient, case 1; the monitoring setup and checking of the electrodes. **a** Inter-face connector box, **b** the patient intubated with the tube shown in figure **c** and demonstration of the recording and stimulation ground electrodes on her left shoulder, **c** Xomed Nerve Integrity Monitor Standard Reinforced Electromyography Endotracheal Tube (7 mm), **d** the checking of all the electrodes placed through the monitor screen, **e** the checking of the resistance of the electrode

clinic with recurrent bilateral multinodulary goiter. She underwent secondary thyroidectomy because of a suspicion of malignancy based on the fine needle aspiration biopsy (FNAB) from the left 2 cm thyroid nodule. She was asymptomatic and euthyroid in the laboratory. She had mild hoarseness. A preoperative evaluation of vocal cords revealed right vocal cord paralyses without atrophy.

The NIM 3.0 Nerve Monitoring System (Medtronic Xomed, Jacksonville, FL, USA), which is used with an endotracheal surface electrode, was used to test the nerve intraoperatively. The patient was placed under general anesthesia with a low-dose short-acting neuromuscular blockade (recronium 0,3 mg/kg) and was intubated with a Medtronic Xomed Nerve Integrity Monitor Standard Reinforced Electromyography Endotracheal Tube (7 mm) that contained 3 cm blue-marked exposed stainless steel contact electrodes for monitoring both vocal cords (Fig. 1c). The tube was placed in the middle of the blue-marked part in contact with the true vocal cords under direct laryngoscopy. The recording and stimulation ground electrodes were placed through subdermal needle electrodes in the left shoulder (Fig. 1b). After neck extension and patient positioning, the tube was secured in place with tape. A sterile single-use pulse-generated monopolar stimulator probe (Medtronic Xomed, Jacksonville, FL, USA) was used for nerve stimulation in the surgical field. The endotracheal tube electrodes, the probe electrode and the grounding electrodes were plugged into the inter-face connector box (Fig. 1a). The monitor was set up, and the electrodes were checked for contact and impedance (the impedance of each electrode should be <5.0 kΩ and the impedance imbalance <1.0 kΩ.) (Fig. 1d, e). The stimuli were generated from the

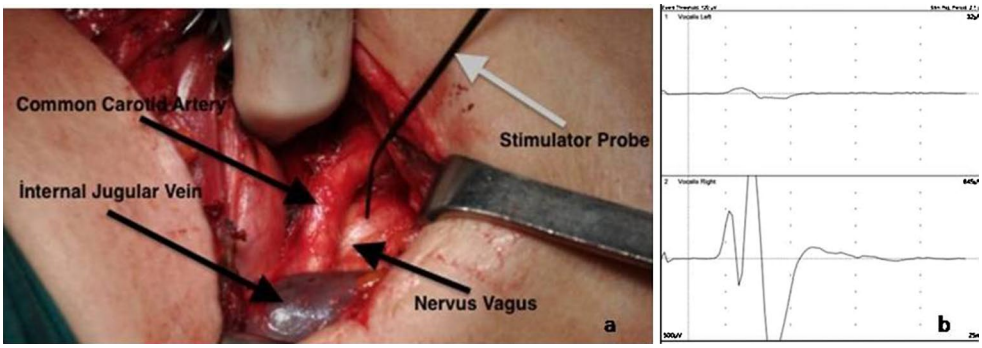


Fig. 2 **a** The right vagal nerve stimulated by the IONM probe, **b** EMG waveform obtained by the IONM stimulation

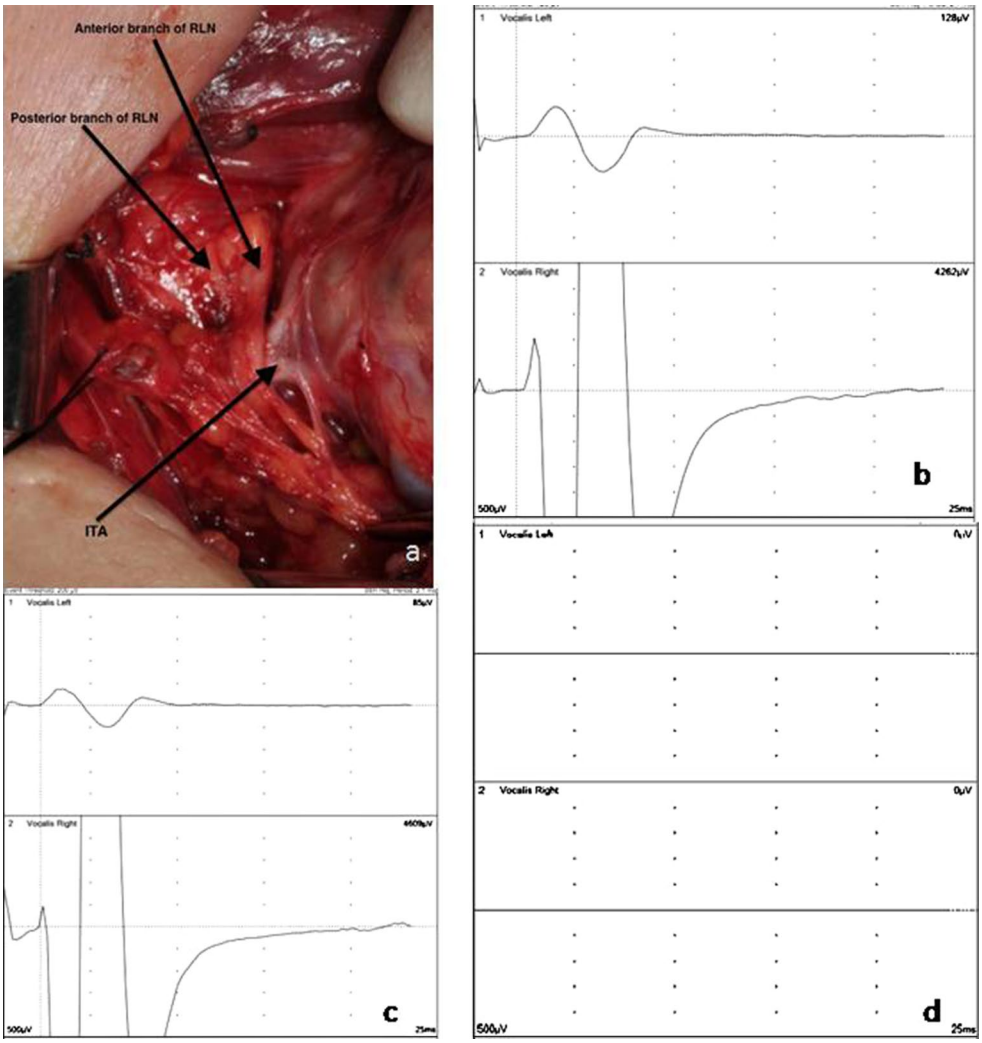


Fig. 3 **a** The demonstration of the bifurcating right RLN, **b** the EMG waveform obtained by stimulating the main trunk of the right RLN by IONM, **c** the EMG waveform obtained by stimulating the anterior branch of the RLN, **d** the EMG waveform obtained by stimulating the posterior branch, representing the negative IONM response. *ITA* Inferior thyroid artery

monitor and were set at 1.0 mA for nerve stimulation. The stimulation duration was set at 100 μs, the current at a frequency of 3 Hz and the event threshold at 100 μV.

Bilateral completion thyroidectomy was performed by a lateral approach through the anterior border of the sternocleidomastoid (SCM) muscle. The dissection was initially performed through the right side of the thyroid. First, the right nervus vagus, which was located between the internal jugular vein and common carotid artery, was identified and stimulated by IONM (Fig. 2a). The evoked electromyography (EMG) activity and acoustic signal were received from the paralytic right vocal cord (Fig. 2b). Then, the right RLN was identified, dissected carefully along its paratracheal course to its entry into the larynx. It showed that the right recurrent nerve was anatomically intact and bifurcated 1.5 cm before its entry (Fig. 3a). The main trunk and

the anterior and posterior branches of the right RLN were stimulated with the nerve monitoring probe. Acoustic signals were received, and the electrical responses of the vocal cord were recorded from both the main trunk and anterior branch of the RLN via electromyography (Fig. 3b, c), and the laryngeal twitch was palpated from the posterior cricoarytenoid muscle. The posterior branch of the RLN had no motor activity detected with IONM (Fig. 3d). A similar lateral approach was applied to the opposite thyroid lobe. The left nervus vagus and left RLN, which had no division, were visually identified. They were stimulated with the monitoring probe; the acoustic signals were received and electrical responses of the vocal cord were recorded from both nerves via electromyography.

At the end of the operation, stimulating response was obtained from both vagus nerves, the bilateral main trunks of the RLN and the anterior branch of the right RLN. The patient was discharged on the first postoperative day. On the first postoperative day, the quality of the voice and vocal cord examination was found to be the same as in the preoperative findings. A pathological examination of the resected specimen revealed benign goiter. A postoperative evaluation found a steady state voice, and the fiberoptic laryngoscope showed continued immobility, but no atrophy of the right vocal cord at the 6 month follow-up examination.

Case 2

A 26-year-old male patient was admitted to our clinic following bilateral subtotal thyroidectomy due to a multinodular goiter performed three months earlier. His pathological exam revealed a 1 cm papillary carcinoma on the right side nodule. He had a breathy voice postoperatively, and right vocal cord paralysis was detected during his postoperative laryngeal evaluation. During the postoperative ultrasonographic exam, bilateral remnant thyroid tissue and a suspected nodule with microcalcification and an irregular border 1 cm in diameter on the left side were detected. Fine needle aspiration biopsy of the suspected nodule showed a second papillary carcinoma. A fiberoptic laryngoscopic exam showed vocal cord palsy and atrophy, as well as paramedian fixation.

Bilateral completion thyroidectomy was performed via a lateral approach using IONM. The IONM setup was the same as that in case 1. It revealed a negative response from the vagal and RLN on the right side (Fig. 4), whereas there were positive responses on the left side. The RLNs were completely explored, and the right RLN was found to be tied and interrupted 1 cm before the entry point used for the first operation. Since there was no electrical activity on the distal side of the interruption point of the nerve, no nerve repair technique could be applied.

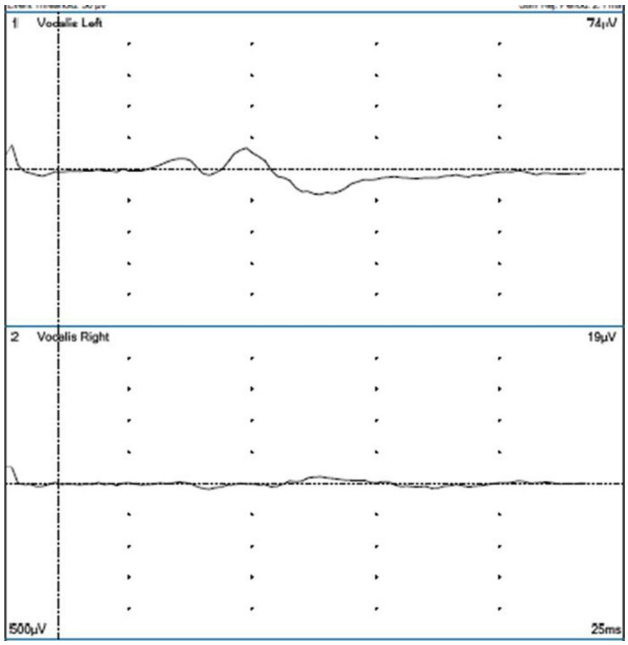


Fig. 4 The EMG waveform, obtained by stimulating the right RLN of case 2 representing the negative response

The patient's postoperative course was uneventful. He was discharged 2 days after the operation. A pathological examination revealed papillary cancer that was 1 cm in diameter on the left remnant lobe. A postoperative evaluation showed the same voice and vocal cord condition with atrophy at the three-month follow-up examination as had been observed preoperatively.

Discussion

Secondary thyroidectomy is highly related to the risk of RLN injury. Several investigators have shown the lack of reliability of clinical symptoms in patients with vocal cord paralysis [1]. It is generally believed that up to 30–40 % of patients with unilateral RLN palsy are asymptomatic. The discrepancy in symptoms results from variations in the degree of injury, cord position, contralateral cord compensation and the evaluation over time in the position of the paralyzed cord. Therefore, preoperative laryngeal examination of the vocal cords is an important diagnostic tool, which is also beneficial in the evaluation of the surgical strategy.

IONM is proposed as an adjunct to visual identification in patients whose thyroidectomy is thought to be difficult [5, 6]. Many studies have shown that nerve monitoring decreases the incidence of RLN damage by improving the identification of the RLN [2, 7]. It may also provide prognostic information with regard to the postoperative

outcome of the vocal cord function. Under physiological conditions, RLN stimulation causes vocal fold mobility via activation of the laryngeal muscle, which is converted into audible and electromyographic signals. These signals are delineated to indicate that there is at least a partial continuity of the RLN-thyroarytenoid muscle axis. However, nerve monitoring does not guarantee adequate power, contraction or elimination of fatigue in a partially denervated or deconditioned thyroarytenoid muscle. Therefore, an intact signal response may still be present in patients with postoperative vocal cord palsy, which is determined as a false negative of this technique. Fortunately, many studies have shown a high negative predictive value and low false negative value for nerve monitoring [5, 8]. Moreover, vagal nerve stimulation optimizes the IONM technology by diminishing its false negative results [9].

Permanent nerve injury is less likely to occur if the nerve is clearly visualized during the operation. In most instances, surgeons are not aware of nerve injury during the procedure, because its detection rate is only between 7.5 and 15 % by the surgeon's visual inspection [10–12]. Rather than complete transection of the RLN; partial injuries secondary to edema, traction, crushing, compression, contusions, pressure and electro-thermal injury, as well as due to ischemia, are more common [13]. Snyder et al. [14] revealed that the major cause of RLN injury during thyroid and parathyroid surgery is traction of its anterior motor branch near the ligament of Berry. Nerve monitoring aids in the demonstration of a loss of RLN function intraoperatively, even when it is still visually intact.

Positive electromyographic activity of the laryngeal muscles in patients with laryngeal paralysis may be observed. Animal experiments have shown a strong propensity for reinnervation after laryngeal nerve injury [15]. Hermann et al. [8] prospectively evaluated 502 nerves in 328 patients by IONM to detect the relationship between the neuromonitoring and postoperative outcome. They recorded the electrical field response by an electrode placed in the vocal muscle in 14 of 21 patients with preoperative RLN palsy whose nerves were detected as anatomically intact on their entire cervical course without any macroscopic damage. In addition, Chi et al. [16] confirmed that there was evoked EMG activity by monitoring and found anatomically intact nerves in their three patients with preoperative vocal cord paralysis. The right recurrent nerve of our first case had no macroscopic damage and it bifurcated 1.5 cm before its entry into the larynx. Similarly, an evoked EMG activity from both main trunks of the RLN and its anterior branch were still elicited by intraoperative neuromonitoring in that patient.

The positive electrophysiological response means that there may be residual nerve function in the laryngeal muscles despite overall vocal cord paralysis [16]. It is theorized that incomplete nerve regeneration can occur within an anatomically intact, but functionally insufficient, recurrent nerve, which is able to conduct an impulse when stimulated [17]. Despite the functional insufficiency of the RLN; the acquisition of an electrical signal during the operation is an important clue to the laryngeal activity, which may help to prevent atrophy of the laryngeal musculature. Functional recovery is associated with the medial position of the vocal cord over time. The position of the postoperative paralytic vocal cords may change according to the laryngeal muscles' activity, depending on the completeness of injury and the residual innervation of the RLN [1]. When the vocal cord becomes atrophic after denervation, it loses contact with the contralateral cord and the voice weakens [16]. In our first case, the patient had mild hoarseness and her voice quality was relatively good. An evaluation of the vocal cords showed no overt atrophy on the palsied side compared to the nonparalytic side. In contrast, the RLN was interrupted in the second case, and vocal cord atrophy was evident. He had a striking breathy voice and the quality of phonation did not improve during the follow-up. The findings of both cases are important proof which shows that electrical activity may be effective for preventing vocal cord atrophy.

Nerve monitoring should be used in secondary thyroidectomies. Even a palsied RLN should be evaluated by IONM. Even if there is RLN palsy, the nerve should be meticulously explored in secondary thyroidectomies to determine whether it is anatomically intact or not, and should never be sacrificed before the evaluation by nerve monitoring. An electrical response can be achieved from vocal cords, particularly in anatomically intact nerves which might have incomplete injury and residual innervation. A palsied RLN which is electrically active should be protected to maintain the vocal cord's neural tone and to prevent its atrophy.

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