Intraoperative Neuromonitoring for Early Localization and Identification of Recurrent Laryngeal Nerve During Thyroid Surgery

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Early and definite identification of the recurrent laryngeal nerve (RLN) is an important step to avoid inadvertent nerve injury during complicated thyroid operations. This study aimed to determine the feasibility of routine use of intraoperative neuromonitoring (IONM) to localize and identify the RLN at an early stage of thyroid surgery. This prospective study enrolled 220 consecutive patients (333 RLNs at risk) who underwent thyroid operations with application of IONM. The RLN was localized and identified routinely with a nerve stimulator after opening the space between the thyroid and carotid sheath. The success rates of early RLN localization and identification were evaluated. The current for localization and the amplitude of evoked laryngeal electromyographic signals were also recorded and analyzed. All RLNs, including 87 (26%) nerves that were regarded as difficult to identify, were successfully localized and identified. The stimulation level for RLN localization was 2 mA in 315 nerves (95%) and 3 mA in the other 18 nerves (5%). The signal obtained from RLN localization (amplitude = 932 ± 436 μV) showed a clear and reliable laryngeal electromyographic response that was similar to that from direct vagus (amplitude = 811 ± 389 μV) or RLN stimulation (amplitude = 1132 ± 472 μV). The palsy rate was 0.6% and no permanent palsy occurred. RLN injury is rare if the nerve is definitely identified early in the thyroid operation. The conclusion of this study is that IONM is a reliable tool for early RLN localization and identification, even in complicated thyroid operations.

Key Words: intraoperative neuromonitoring, laryngeal electromyography, recurrent laryngeal nerve, thyroid surgery
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Visual identification of the recurrent laryngeal nerve (RLN) during thyroid surgery has been proven to be associated with lower permanent palsy rates, and it has been recommended in many studies as the gold standard of RLN treatment [1–20]. With regard to identification of the RLN, several nerve approach methods have been reported [17–19]. In most instances, the RLN can easily be identified or even encountered at the tracheoesophageal groove after the thyroid lobe is retracted medially and elevated out of the wound. Nevertheless, the RLN might be difficult to identify intraoperatively because of anatomical variations [21], typically non-recurrent laryngeal nerve (non-RLN), or in complicated thyroid operations, such as those for recurrent goiter, large goiter with substernal extension, or thyroid cancer with significant paratracheal node metastasis. The position of the RLN can be significantly abnormal and the nerve can be fixed to the undersurface of a large goiter. In these circumstances, the RLN can be injured before nerve identification, due to excessive medial traction on the thyroid, or the nerve can be inadvertently clamped or transected during lateral dissection of the thyroid because of misidentification (the parallel artery can be mistaken for the RLN, or the posterior sensory branch can be mistaken for the entire RLN) [2,21,22]. Therefore, early and definite identification of the RLN during thyroid surgery, especially in difficult cases, is an important step to prevent RLN injury.

In the present study, we aimed to determine the feasibility of routine use of intraoperative neuromonitoring (IONM) to localize and identify the RLN at an early stage of thyroid surgery.

Methods

Subjects

From September 2007 to October 2009, we prospectively enrolled 220 consecutive patients who underwent thyroid operations with application of IONM, and all had been treated by the same surgeon (Dr FY Chiang). There were 97 total lobectomies and 123 total thyroidectomies. Ten nerves were excluded from this study (8 with preoperative palsy and 2 with intentional transection due to cancer invasion). Finally, 333 nerves were at risk in this study. Among these 333 nerves, 98 nerves (29%) were dissected for thyroid malignancy and 19 (6%) for revision operations.

Anesthesia and IONM system

For general anesthesia, all patients were intubated with Nerve Integrity Monitor (NIM) Standard Reinforced Electromyography (EMG) Endotracheal Tube (6.0 mm internal diameter for women and 7.0 mm for men) (Metronic Xomed, Jacksonville, FL, USA). The position of the electrodes was routinely checked by laryngofibroscopic examination after the neck was placed at full extension to ensure that the middle of the blue marked region (3 cm of the exposed electrodes) was in good contact with the true vocal cords. A Prass monopolar stimulation probe (Medtronic Xomed) was used for nerve stimulation during thyroidectomy. EMG activity was recorded on an NIM-response 2.0 monitor (Medtronic Xomed).

Procedure for early RLN localization and identification

Vagal stimulation

After mobilization of the superior pole, the thyroid lobe and laryngotracheal complex were retracted medially as one unit to open the space between the thyroid and carotid sheath. The vagus nerve was routinely tested to ensure the monitoring system was working and the normal pathway of the RLN. The vagus nerve was typically stimulated in the midneck region with a current of 2 mA, and the evoked EMG signals were defined as V_1 signals.

RLN localization

After opening the space between the thyroid and carotid sheath, we localized the position of the RLN with a stimulating probe at the tracheoesophageal groove. Initially, we tried to localize the RLN near the level of the inferior thyroid artery. In some cases, such as recurrent goiter, large goiter with substernal extension, or thyroid cancer with significant paratracheal node metastasis, neural localization near the level of the inferior thyroid artery might be impeded; thus, RLN localization was performed at the upper or lower portion of the tracheoesophageal groove. The stimulation current used was 2 mA, and was increased to 3 mA if RLN localization failed with 2 mA. The EMG signals obtained from RLN localization were defined as *L* signals.

RLN identification and dissection

After the RLN was localized and identified, we tested it with a stimulation current of 1 mA for definite confirmation; then the nerve was dissected meticulously to the entry of the larynx. In the case of large goiter with substernal extension, or thyroid cancer with paratracheal node metastasis, the RLN was dissected to the thoracic inlet until the nerve was well separated from the thyroid. The EMG signals obtained from direct RLN stimulation were defined as R_1 signals. The success rates of early RLN localization and identification were evaluated. The localization current, the position, and the evoked EMG signals (V_1, L, and R_1) were recorded and analyzed.

Pre- and postoperative work-up

All patients received pre- and postoperative examination of cord mobility with flexible laryngofibroscopy. When asymmetric cord movement was found postoperatively, a comparison with the preoperative recording was performed. When vocal dysfunction was identified, a follow-up of 2 weeks initially and then every 4 weeks thereafter until recovery was achieved. Dysfunction was considered as permanent if it persisted for 6 months after surgery. This study was approved by the Institutional Review Board of Kaohsiung Medical University Hospital and ClinicalTrials.gov (NCT00629746). Written informed consent was obtained from each patient. Patients were informed of the intent to use this monitoring system potentially to aid in the localization and identification of the RLN, and in the assessment of its function during surgery. There was no financial or professional association between the authors and the commercial company whose nerve-monitoring product was utilized.

Results

As shown in the Table, all nerves were successfully localized and identified early at the tracheoesophageal groove, with the application of IONM. Among 333 RLNs, 315 (95%) were localized with a stimulation current of 2 mA and 18 (5%) with 3 mA. Eighty-seven (26%) nerves were regarded as difficult to identify (10 were dissected from the capsule of large recurrent goiters, 40 were dissected from thyroid cancer with significant paratracheal node metastasis, 35 were dissected from large goiters with substernal extension, and 2 were non-RLN).

Table. Characteristics of 333 recurrent laryngeal nerves with early localization and identification by intraoperative neuromonitoring during thyroid operation

RLN (NAR = 333)	*n* (%)
Successful localization and identification	333 (100)
Stimulation current	
2 mA	315 (95)
3 mA	18 (5)
Difficult identification	87 (26)
Etiology	
Recurrent goiter with nerve adherent on thyroid capsule	10 (3)
Cancer needs paratracheal LN dissection	40 (12)
Large or substernal goiter needs extensive dissection	35 (11)
Non-RLN	2 (0.6)

RLN = recurrent laryngeal nerve; NAR = nerve at risk; LN = lymph node.

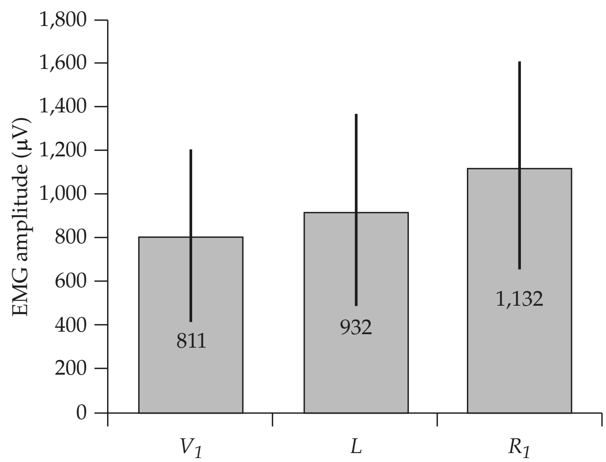

Figure. *Mean amplitude of electromyography signals obtained from vagus stimulation (V_1 signal), recurrent laryngeal nerve localization (L signal) and direct recurrent laryngeal nerve stimulation (R_1 signal).*

The signal obtained from RLN localization (L signal) showed a clear and reliable EMG response that was similar to that from direct vagus (V_1) or RLN (R_1) stimulation; the mean amplitudes of each signal (V_1, L and R_1 signals) were 811 ± 389 μV, 932 ± 436 μV and 1,132 ± 472 μV, respectively (Figure). Two nerves (0.6%) developed temporary palsy and both were associated with inevitable stretch injury (one nerve was dissected from the large recurrent goiter which underwent the 3rd operation; the other nerve was meticulously dissected from thyroid cancer to which the nerve was adherent). No permanent RLN palsy occurred.

Discussion

For identification of the RLN during thyroid surgery, some landmarks, such as inferior thyroid artery, tracheoesophageal groove, Berry's ligament and the inferior cornu of thyroid cartilage, are used. Several authors [12,23–26] have reported that the laryngeal entry point represents the most constant position of the RLN in the neck, and that the inferior cornu of the thyroid cartilage is a consistent and reliable landmark that indicates the laryngeal entry point. The laryngeal entry point of the RLN is approximately 1 cm below and just anterior to the inferior horn of the thyroid cartilage, which can be easily palpated, and the nerve is always found here. Therefore, the operative procedure for RLN identification, described by Harness et al in 1986 [19], is commonly used. They emphasized that the RLN is not identified early in the operative procedure and the thyroid lobe is dissected along its capsule. When dissection proceeds to the area of Berry's ligament, the RLN is identified or even encountered where it runs through the ligament or close to it. It has been suggested that this procedure has several potential advantages, including less chance of disrupting the blood supply to the inferior parathyroid, and dissection of a shorter segment of the RLN with less risk of contusion injury.

However, using this RLN approach, we experienced higher palsy rates in our previous study [5], and found several pitfalls that could cause nerve injury. (1) The thyroid lobe must be retracted medially and upwards, and excessive retraction of the thyroid can put the RLN at high risk of stretch injury in the region of Berry's ligament. We have experienced eight nerves with stretch injury [5], and Snyder et al [2] also reported seven nerves with injury caused by over-traction near the region of Berry's ligament. (2) The posterior branch of the RLN can be mistaken for the entire nerve under circumstances of partial nerve exposure. We have experienced one clamping injury of the anterior motor branch for this reason [5]. (3) The RLN in a large goiter can be displaced in any direction and might even be adherent to the thyroid capsule at a lateral position, especially in a large recurrent goiter [21]. We have experienced one transecting injury during lateral dissection of a large goiter. The distorted RLN appeared to run vertical to the trachea; the RLN was mistaken for the inferior thyroid artery and it was transected inadvertently. (4) It is difficult to approach the RLN from the distal segment in the case of recurrent goiter, large goiter with substernal extension, or thyroid cancer with significant paratracheal node metastasis.

After ascertaining the mechanism of RLN injury with the application of IONM, we changed our RLN approach to early identification. In this study, all RLNs were localized and identified early with a nerve stimulator after opening the space between the thyroid and the carotid sheath. Most nerves were localized and identified at the tracheoesophageal groove near the level of the inferior thyroid artery. We found that there were several advantages with this RLN approach: (1) stretch injury caused by excessive traction of the thyroid can be avoided; (2) extralaryngeal branches of the RLN, typically anterior and posterior branches, can be identified if they are present; and (3) the inferior parathyroid gland and its feeding vessels can be visualized and preserved.

The operations for recurrent goiter, large goiter with substernal extension, or thyroid cancer with significant paratracheal node metastasis have been reported to be associated with higher RLN palsy rates [27–29]. In our experience, abnormal RLN position plays an important role in the occurrence of nerve injury. Randolph [30] also emphasized that goitrous enlargement can be associated with fixation and splaying of the RLN to the undersurface of the enlarged thyroid lobe, and RLN identification might be more difficult if there is significant paratracheal RLN chain nodal disease. In these situations, blunt dissection without nerve identification puts the nerve at high risk of injury. Therefore, identification of the RLN in such cases is a necessary initial step to prevent nerve injury. In the present study, among 19 nerves dissected for recurrent goiter, 10 were found to be adherent to the thyroid capsule, and these nerves could have been injured or even transected inadvertently if early localization and identification of RLN with IONM had not been performed. Temporary palsy occurred in one nerve that was undergoing its third operation. The nerve injury was caused by over-traction during dissection of the nerve from the capsule of a large recurrent goiter. Among 98 nerves operated upon for thyroid cancer, 39 were dissected from thyroid cancer with significant nodal metastasis. After localization and identification of the RLN, the nerve was dissected completely to the entry of the larynx, and then dissected downwards to the thoracic inlet until the nerve was well separated from the metastatic nodes. We experienced one nerve with temporary palsy that was also caused by over-traction of the thyroid. The nerve was found to be adherent to the thyroid cancer, and the EMG signal was lost after the nerve was meticulously dissected from the tumor. Another 35 nerves were dissected for large goiter with substernal extension, and all of these were localized and identified before tumor dissection. No nerve palsy occurred in these 35 nerves, although long exposure of the RLN was needed.

Vagal stimulation before RLN localization is a necessary step to confirm that the monitoring system is working, to ensure the normal pathway of the RLN, and to provide reference data for the EMG signal [5]. Two non-RLNs were recognized as the signal from vagal stimulation could not be elicited, and both were localized and identified at the upper tracheoesophageal groove. High EMG amplitude is the key to successful RLN localization. In this study, we routinely checked that the electrodes were in the optimal position by laryngofibroscopic examination after the neck was placed at full extension. In our previous studies, we have found that suboptimal EMG tube position (too deep, too shallow, or rotating) can result in equipment failure or reduce amplitude response [31,32]. In the present study, no equipment failure was encountered, and the signal obtained from RLN localization showed a clear and reliable EMG response that was similar to that from direct vagus or RLN stimulation.

Several authors have reported that most nerve injuries are unexpected, and the actual causes of nerve injury are unknown in those with visual integrity of the nerves [33,34]. In our experience, anatomical variations of the RLN, such as extralaryngeal branches, distorted RLN, non-RLN, or intertwining between branches of the RLN and inferior thyroid artery, can cause visual misidentification, and can result in unrecognized clamping or transecting injury of the RLN or the motor branch [21]. In this study, we found that early and definite identification of the RLN with IONM was a reliable way to prevent nerve injury caused by visual misidentification. Furthermore, when facing a patient with preoperative cord palsy, or when undertaking an operation in which one RLN has been invaded by thyroid cancer (10 patients in the present study), the surgeon can be more confident about avoiding the risk of postoperative bilateral cord palsy with this procedure.

In the present study, all RLNs, including 87 (26%) that were regarded as difficult to identify, were successfully localized and identified at an early stage of surgery. Furthermore, similar to direct vagus or RLN stimulation, a clear and reliable EMG response was obtained from RLN localization. No permanent palsy occurred. Only two nerves (0.6%) that were associated with inevitable stretch injury developed temporary palsy. These results confirmed that IONM is a reliable tool to localize the RLN and facilitate its early identification during thyroid operations, especially in difficult cases. Using this procedure during thyroid operation, RLN injury rarely occurs.

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References

1. Barczynski M, Konturek A, Cichon S. Randomized clinical trial of visualization versus neuromonitoring of recurrent laryngeal nerves during thyroidectomy. *Br J Surg* 2009;96:240–6.
2. Snyder SK, Lairmore TC, Hendricks JC, et al. Elucidating mechanisms of recurrent laryngeal nerve injury during thyroidectomy and parathyroidectomy. *J Am Coll Surg* 2008;206:123–30.
3. Miller MC, Spiegel JR. Identification and monitoring of the recurrent laryngeal nerve during thyroidectomy. *Surg Oncol Clin N Am* 2008;17:121–44.
4. Dralle H, Sekulla C, Lorenz K, et al. Intraoperative monitoring of the recurrent laryngeal nerve in thyroid surgery. *World J Surg* 2008;32:1358–66.
5. Chiang FY, Lu IC, Kuo WR, et al. The mechanism of recurrent laryngeal nerve injury during thyroid surgery—the application of intraoperative neuromonitoring. *Surgery* 2008;143:743–9.
6. Shindo M, Chheda NN. Incidence of vocal cord paralysis with and without recurrent laryngeal nerve monitoring during thyroidectomy. *Arch Otolaryngol Head Neck Surg* 2007;133:481–5.
7. Randolph GW, Kamani D. The importance of preoperative laryngoscopy in patients undergoing thyroidectomy: voice, vocal cord function, and the preoperative detection of invasive thyroid malignancy. *Surgery* 2006; 139:357–62.

8. Chan WF, Lo CY. Pitfalls of intraoperative neuromonitoring for predicting postoperative recurrent laryngeal nerve function during thyroidectomy. *World J Surg* 2006; 30:806–12.
9. Acun Z, Cinar F, Cihan A, et al. Importance of identifying the course of the recurrent laryngeal nerve in total and near-total thyroid lobectomies. *Am Surg* 2005;71:225–7.
10. Randolph GW, Kobler JB, Wilkins J. Recurrent laryngeal nerve identification and assessment during thyroid surgery: laryngeal palpation. *World J Surg* 2004;28: 755–60.
11. Hermann M, Alk G, Roka R, et al. Laryngeal recurrent nerve injury in surgery for benign thyroid diseases: effect of nerve dissection and impact of individual surgeon in more than 27,000 nerves at risk. *Ann Surg* 2002; 235:261–8.
12. Bliss RD, Gauger PG, Delbridge LW. Surgeon's approach to the thyroid gland: surgical anatomy and the importance of technique. *World J Surg* 2000;24:891–7.
13. Mattig H, Bildat D, Metzger B. Reducing the rate of recurrent nerve paralysis by routine exposure of the nerves in thyroid gland operations. *Zentralbl Chir* 1998; 123:17–20. [In German]
14. Wagner HE, Seiler C. Recurrent laryngeal nerve palsy after thyroid gland surgery. *Br J Surg* 1994;81:226–8.
15. Jatzko GR, Lisborg PH, Muller MG, et al. Recurrent nerve palsy after thyroid operations—principal nerve identification and a literature review. *Surgery* 1994;115: 139–44.
16. Karlan MS, Catz B, Dunkelman D, et al. A safe technique for thyroidectomy with complete nerve dissection and parathyroid preservation. *Head Neck Surg* 1984;6:1014–9.
17. Lore JM Jr, Kim DJ, Elias S. Preservation of the laryngeal nerves during total thyroid lobectomy. *Ann Otol Rhinol Laryngol* 1977;86:777–88.
18. Thompson NW, Olsen WR, Hoffman GL. The continuing development of the technique of thyroidectomy. *Surgery* 1973;73:913–27.
19. Harness JK, Fung L, Thompson NW, et al. Total thyroidectomy: complications and technique. *World J Surg* 1986; 10:781–6.
20. Bellantone R, Lombardi CP, Bossola M, et al. Total thyroidectomy for management of benign thyroid disease: review of 526 cases. *World J Surg* 2002;26:1468–71.
21. Chiang FY, Lu IC, Chen HC, et al. Anatomical variations of recurrent laryngeal nerve during thyroid operation: how to identify and handle the variations with the application of intraoperative neuromonitoring. *Kaohsiung J Med Sci* 2010;26:575–83.
22. Casella C, Pata G, Nascimbeni R, et al. Does extralaryngeal branching have an impact on the rate of postoperative transient or permanent recurrent laryngeal nerve palsy? *World J Surg* 2008;33:261–5.
23. Shindo ML, Wu JC, Park EE. Surgical anatomy of the recurrent laryngeal nerve revisited. *Otolaryngol Head Neck Surg* 2005;133:514–9.
24. Wang C. The use of the inferior cornu of the thyroid cartilage in identifying the recurrent laryngeal nerve. *Surg Gynecol Obstet* 1975;140:91–4.
25. Riddell V. Thyroidectomy: prevention of bilateral recurrent nerve palsy. Results of identification of the nerve over 23 consecutive years (1946–69) with a description of an additional safety measure. *Br J Surg* 1970;57: 1–11.
26. Rustad WH, Morrison LF. Revised anatomy of the recurrent laryngeal nerves. Surgical importance based on the dissection of 100 cadavers; a preliminary report. *Laryngoscope* 1952;62:237–49.
27. Atallah I, Dupret A, Carpentier AS, et al. Role of intraoperative neuromonitoring of the recurrent laryngeal nerve in high-risk thyroid surgery. *J Otolaryngol Head Neck Surg* 2009;38:613–8.
28. Agha A, Glockzin G, Ghali N, et al. Surgical treatment of substernal goiter: an analysis of 59 patients. *Surg Today* 2008;38:505–11.
29. Pieracci FM, Fahey TJ 3rd. Substernal thyroidectomy is associated with increased morbidity and mortality as compared with conventional cervical thyroidectomy. *J Am Coll Surg* 2007;205:1–7.
30. Randolph GW. Surgical anatomy of the recurrent laryngeal nerve. In: Randolph GW, ed. *Surgery of the Thyroid and Parathyroid Glands*, edition. Philadelphia: Saunders, 2003:300–42.
31. Lu IC, Chu KS, Tsai CJ, et al. Optimal depth of NIM EMG endotracheal tube for intraoperative neuromonitoring of the recurrent laryngeal nerve during thyroidectomy. *World J Surg* 2008;32:1935–9.
32. Chiang FY, Lee KW, Chen HC, et al. Standardization of intraoperative neuromonitoring of recurrent laryngeal nerve in thyroid operation. *World J Surg* 2010;34: 223–9.
33. Chiang FY, Wang LF, Huang YF, et al. Recurrent laryngeal nerve palsy after thyroidectomy with routine identification of the recurrent laryngeal nerve. *Surgery* 2005;137:342–7.
34. Lo CY, Kwok KF, Yuen PW. A prospective evaluation of recurrent laryngeal nerve paralysis during thyroidectomy. *Arch Surg* 2000;135:204–7.

使用術中神經監測器於甲狀腺手術中早期定位及辨識喉返神經

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早期確實辨識出喉返神經的位置是在進行困難的甲狀腺手術過程中避免神經誤傷的一項重要步驟。本研究主旨在探討常規應用術中神經監測器於甲狀腺手術早期來定位及辨識喉返神經之實用性。本前瞻性研究連續收集 220 位接受甲狀腺手術並應用術中神經監測器病患（共 333 條喉返神經）進行分析。術中當打開甲狀腺體與頸動脈鞘間的空間後，我們常規使用神經刺激器嘗試去將喉返神經定位及辨識出來。我們評估成功將喉返神經早期定位及辨識的比率，並進一步記錄分析神經定位所需的刺激電流量及所誘發喉部肌電圖訊號之振幅反應。包括 87 條（26%）困難辨識的神經在內的所有喉返神經，均成功地應用術中神經監測器而被早期定位及辨識。其中 315 條（95%）神經需要 2 mA 的電流強度來定位神經，而其他 18 條（5%）神經需要 3 mA 電流量。此外我們也發現，定位神經時所誘發的訊號（振幅 = 932 ± 436 μV），與直接刺激迷走（振幅 = 811 ± 389 μV）及喉返神經（振幅 = 1,132 ± 472 μV）相似，均可呈現清楚且穩定的喉部肌電圖波形。本研究發生術後喉返神經麻痺的比率為 0.6%，並沒有任何永久性麻痺的情形發生。喉返神經若能在術早期被確實辨識出來，則很少會有受傷的情況發生。甲狀腺手術應用術中神經監測器來協助早期定位及辨識喉返神經是個可靠的方式，即使在遭遇困難手術狀態下。

關鍵詞：術中神經監測器，喉部肌電圖，喉返神經，甲狀腺手術

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