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ORIGINAL ARTICLE

Exclusive real-time monitoring during recurrent laryngeal nerve dissection in conventional monitored thyroidectomy

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Abstract During conventional intermittent intraoperative neuromonitoring (IONM) in thyroidectomy, recurrent laryngeal nerve (RLN) injury is detected by an electromyographic (EMG) loss of signal (LOS) after the nerve dissection. Exclusive continuous monitoring during the phase of RLN dissection may be helpful in detecting adverse EMG changes earlier. A total of 208 RLNs at risk were enrolled in this study. Standardized IONM procedures were followed. We continuously stimulated the RLN at the lower exposed end with a stimulator to exclusively monitor the real-time quantitative EMG change during RLN dissection. Once the amplitude decreased by more than 50% of the initial signal, the surgical maneuver was paused and the RLN was retested every minute for 10 minutes to determine amplitude recovery before restarting the dissection. The procedure was feasible in all patients. No LOS was encountered in this study. Nineteen RLNs had an amplitude reduction of more than 50%. Eighteen nerves showed gradual amplitude recovery (16 nerves had a traction injury and two nerves had a compression injury). After 10 minutes, the recovery was complete (i.e., >90%) in eight nerves, 70–90% in seven nerves,

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and 50—70% in three nerves. Among these 18 nerves, only one nerve developed temporary vocal palsy because it was exposed to unavoidable repeated nerve traction after restarting the dissection. Another nerve showed no gradual recovery from thermal injury, and developed temporary vocal palsy. The temporary and permanent palsy rates were 1% and 0%, respectively. During intermittent IONM, exclusive real-time monitoring of the RLN during dissection is an effective procedure to detect an adverse EMG change, and prevent severe RLN injuries that cause LOS.

Introduction

Intraoperative neuromonitoring (IONM) during thyroid surgery has gained widespread acceptance as an adjunct to the gold standard of visually identifying the recurrent laryngeal nerve (RLN) [1—6], detecting RLN anatomic variations [7—9], and elucidating RLN injury mechanisms [3,4,10,11]. In addition, IONM can help clinicians predict vocal cord function outcome and plan intra- and postoperative treatment [12,13]. However, RLN injuries still occur with the application of IONM. Recurrent laryngeal nerve injury often occurs during dissection. Chiang et al. [3] reported that 8.6% of nerves developed loss of signal (LOS) after complete RLN dissection. Snyder et al. [10] reported that 3.8% of nerves in their study had LOS after nerve dissection. Dionigi et al. [11] reported that 6.9% of RLNs experienced LOS after the resection of the thyroid in video-assisted thyroidectomy. These results suggest that the RLN is at high risk of injury during the phase of its dissection.

Conventional IONM administers intermittent stimulation with a handheld stimulation probe. The functional integrity of the RLN is limited to the short-time interval of the direct nerve stimulation and the site of stimulation, if distal to the nerve injury. The RLN is still at risk for damage during the time gap between two nerve stimulations, and nerve injury is detected by the LOS [14,15]. Several varieties of electrodes used to stimulate the vagus nerve (VN) have been designed for continuous IONM (*C*-IONM) technology; however, several issues limit its widespread use such as the need to open the carotid sheath [16], the 360° circumferential dissection of the VN [15], the difficulty of implanting the electrode in some complicated surgical cases [15], the potentially adverse effects of VN stimulation [17], and the necessity of having to use a handheld stimulating probe, its availability, and its cost-effectiveness [15]. Therefore, there are some surgeons who feel discouraged from performing C-IONM and question whether monitoring the whole course of operation is truly needed.

Because most intraoperative RLN injuries occur during the combined phase of medial thyroid traction and RLN dissection [3,10,11], a simple and safe procedure for the real-time monitoring of nerve function during this period would be the most important issue for surgeons. There is no doubt that C-IONM technology can provide seamless monitoring of nerve function during the whole course of surgery [14,15,18]. However, because current C-IONM may not be very popular and available in some areas, an alternative simple and safe method to apply conventional intermittent IONM is crucial for monitoring nerve function continuously during the risky phase of RLN dissection. This study aimed to investigate the feasibility of detecting an adverse change in the EMG signal earlier, and thereby prevent severe nerve injuries that cause LOS, by continuously stimulating the RLN at the lower exposed end with a stimulating probe to exclusively monitor the real-time quantitative EMG amplitude change during RLN dissection.

Methods

Patients

The study was approved by the Institutional Review Board of China—Japan Union Hospital of Jilin University (Changchun City, China; grant no. 20160101). 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 to assess its function during the operation. No financial or professional association exists between the authors and the commercial company whose neuromonitoring product was studied.

From April 2014 to September 2014, 120 consecutive patients (33 men and 87 women; aged 14—66 years; mean age, 44.1 years) who underwent thyroid operations for various thyroid diseases (99 malignancies, 21 benign lesions, 20 reoperations, 100 primary operations) were prospectively enrolled in this study. They were treated by the same surgery group. In total, 18 unilateral lobectomies and 102 bilateral total thyroidectomies were performed. Fourteen nerves were excluded from this study (12 nerves with preoperative vocal palsy, and two nerves were non-RLNs). Thus, there were 208 nerves at risk in this study.

Setup of the intraoperative nerve monitoring system

The anesthesia and equipment setup followed the standard procedures [1] and were accomplished by the IONM team of China—Japan Union Hospital of Jilin University (Changchun City, China). All patients were intubated with a standard reinforced electromyography (EMG) endotracheal tube (internal diameter of 6.0 mm and 7.0 mm for women and men respectively; Medtronic Xomed, Jacksonville, FL, USA)