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The utility of intraoperative nerve monitoring during thyroid surgery

Brian C. Brajcich, BS,[a] *and Christopher R. McHenry, MD*[a,b,*]

[a] *Case Western Reserve University School of Medicine, Cleveland, Ohio*
[b] *Department of Surgery, MetroHealth Medical Center, Cleveland, Ohio*

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ABSTRACT

Background: Damage to the recurrent laryngeal nerve (RLN) can lead to vocal cord paralysis, resulting in hoarseness, aspiration, stridor, and respiratory distress. The purpose of this study was to examine the impact of intraoperative nerve monitoring (IONM) on RLN injury during thyroidectomy when it is used as an adjunct to confirm the functional integrity of the RLN during delineation of its anatomic course after it has been visually identified.

Methods: A retrospective cohort study was performed comparing the rate of RLN injury in patients undergoing thyroidectomy with IONM, which was implemented in 2012, to patients who underwent thyroidectomy without IONM during the 3-year period immediately before IONM. Secondary analysis was performed to determine if there was a relationship between RLN injury and patient age, sex, substernal extension, central neck dissection, prior neck surgery, nodule size, gland weight, or pathology.

Results: A total of 627 patients underwent thyroidectomy, 315 with IONM and 312 without IONM. Of the 531 nerves at risk in the cohort with IONM, 4 (0.75%) were injured compared to 3 (0.58%) among the 517 nerves at risk in the cohort without IONM ($P > 0.05$). No secondary factor had a significant impact on RLN injury.

Conclusions: The use of IONM had no impact on the rate of permanent RLN injury during thyroidectomy. Because of the low rate of RLN injury, a much larger sample size is needed to determine if IONM will a valuable adjunct in thyroid surgery, especially in specific high-risk subgroups.

Introduction

Recurrent laryngeal nerve (RLN) injury is a major complication of thyroidectomy that can result in paralysis of the intrinsic muscles of the larynx, causing hoarseness and aspiration when the injury is unilateral and stridor with acute respiratory distress requiring tracheostomy when the injury is bilateral.[1] Paresis and paralysis of the RLN can be caused by excessive traction, thermal injury, crush injury by forceps, clamps or retractors, suture incorporation, and transection.[2,3] The reported incidence of RLN injury during bilateral thyroid surgery varies from 0.8% to 8.6%.[4-10] The risk of RLN injury has been reported to be higher in patients undergoing thyroidectomy for cancer, thyroidectomy with central

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* *Corresponding author*. Division of General Surgery, Department of Surgery, MetroHealth Medical Center, H-918, 2500 MetroHealth Drive, Cleveland, OH 44109. Tel.: (216)-778-8917; fax: (216)-778-3774.
E-mail address: cmchenry@metrohealth.org (C.R. McHenry).

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compartment neck dissection, and in patients undergoing reoperative neck surgery.[2] Injury rates are also increased when thyroidectomy is performed in low-volume centers or by less experienced surgeons.[11,12] Although in most cases, vocal cord function returns, permanent RLN injury is reported to occur in 0%-5.8%.[4-8,13-15] RLN injury can have a profound negative impact on a patient's life, underscoring the importance of evaluating potential ways of reducing its occurrence.

The current standard of care for RLN preservation is direct visualization of the nerve along its entire course as advocated by Lahey,[16] M.D., in 1938. Recently, devices allowing for intraoperative monitoring of RLN function have become available from multiple manufacturers. Intraoperative nerve monitoring (IONM) allows for confirmation of the identity and functional integrity of the RLN during thyroidectomy. Intraoperative nerve monitors typically use surface electrodes on an endotracheal tube or implanted probes which measure activity of the vocal cord muscles. A separate handheld probe is then available to stimulate the nerve, resulting in detectable motion of the vocal cords and confirmation of the functional integrity of the nerve.[17]

Prior studies have demonstrated mixed results regarding the effectiveness of IONM on the prevention of RLN injury.[18-27] A randomized controlled trial by Barczynski *et al.*[20] involving 1000 patients who underwent bilateral thyroid surgery demonstrated a decrease in RLN injury from 5.0% to 2.7% with use of an intraoperative nerve monitor. A large multicenter prospective cohort study by Dralle *et al.*[18] involving patients primarily with benign thyroid disease undergoing various thyroid procedures showed no significant difference in rates of nerve injury with or without the use of IONM. Similarly, a prospective study by Chan *et al.*,[21] consisting of patients operated on by a single surgical team, did not demonstrate a statistically significant difference in RLN injury with or without the use IONM. In some cases, IONM was used as a primary form of nerve identification rather than as an adjunct to confirm functional integrity after the nerve had been identified by direct visualization and during the dissection of the entire course of the nerve.[20] In addition, many studies use data obtained from multiple surgeons with different preferences for IONM, dissimilar patient populations, and variable degrees of thyroid operative volumes. It was our intent to investigate the use of IONM in a cohort of patients who underwent thyroidectomy by a single surgeon using a standard technique, which consisted of routine identification of the RLN followed by the use of IONM to determine the functional integrity of the RLN during the exposure of the RLN through its entire anatomic course.[28]

Materials and methods

Patient recruitment and study design

A retrospective cohort study was performed comparing patients undergoing thyroidectomy with IONM to patients who underwent thyroidectomy without IONM by a single surgeon at MetroHealth Medical Center in Cleveland, Ohio, between 2009 and 2015. The primary outcome measure was permanent RLN injury. Patients were identified, and data were obtained from the Surgeon Specific Registry of the American College of Surgeons, which is used to track the surgeon's cases, and a prospectively maintained endocrine surgery database. Inclusion criteria consisted of patients aged 18 years who underwent thyroid lobectomy and isthmusectomy, completion thyroidectomy, or total thyroidectomy identified by Current Procedural Terminology codes 60220, 60240, 60252, 60254, 60260, and 60271. Exclusion criteria included patients who were lost to follow up after the procedure and patients where nerve monitor malfunction was noted during the procedure.

The routine use of IONM was implemented in 2012. The intervention group consisted of patients who underwent surgery after implementation of routine IONM, whereas the control group consisted of patients who underwent surgery before this date. Postoperative laryngoscopy was performed in patients with clinical symptoms suspicious for RLN injury. RLN injury was confirmed by postoperative laryngoscopy showing paresis of one or both vocal cords. For patients with <1 year of follow-up, permanent RLN injury was defined as persistent vocal cord immobility on laryngoscopy at the last follow-up visit; otherwise, permanent RLN injury was defined as vocal cord immobility on laryngoscopy that persisted for >12 months after thyroidectomy.

Nerve monitor protocol

IONM was performed using the NIM 3.0 Nerve Monitoring System (Medtronic Xomed, Dublin, Ireland). After induction of anesthesia, a specialized electrode-embedded endotracheal tube was inserted using a GlideScope videolaryngoscope to confirm correct placement by direct visualization. The electrodes were positioned directly adjacent to the vocal cords. The endotracheal tube was connected to a Nerve Integrity Monitor (Medtronic Xomed, Dublin, Ireland) for electromyographic recording of vocal cord contractions after monopolar stimulation. During the mobilization of each thyroid lobe, the RLN was routinely identified and was traced through its course. While dissecting the RLN, IONM was used to confirm the functional integrity of the RLN. The handheld probe was used to intermittently stimulate the RLN with 1 mA of pulsed current, and the response of the laryngeal muscles was assessed from the tracings of the neural response on the monitor. The IONM was used only as an adjunct to visualization for confirmation of the functional integrity of the nerve.

Data collection

Data were collected from a prospectively managed endocrine surgery database and the electronic medical record. Data obtained included patient age, sex, body mass index, weight, and histopathology of the excised thyroid gland, presence of associated thyroiditis, size of largest thyroid nodule, history of prior neck surgery, presence of substernal thyroid extension, extent of thyroidectomy, number of nerves at risk, and whether a central compartment lymph node dissection was performed. The use of IONM was confirmed from the operative report for each patient. RLN injury was identified from the documentation of postoperative laryngoscopy, which was performed selectively in patients with new onset of hoarseness or a change in their voice.