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Laryngeal nerve monitoring and endoscopic thyroidectomy

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After more than 100 years of approaching thyroid surgery in the manner described by Theodore Kocher in the 19th century, thyroidectomy has undergone tremendous change during the past 6 to 8 years. Chief among them have been the development of minimally invasive surgical methods and the emergence of reliable laryngeal nerve monitoring techniques. The author describes a logical approach that exploits these complementary technologies.

A variety of technological innovations, particularly Harmonic technology,[1] have facilitated the advent of minimal access surgery, and even endoscopic thyroidectomy. Although endoscopes afford a magnified view of the operative field, the reduced access yielded by minimally invasive surgery makes the concomitant use of laryngeal nerve monitoring particularly attractive.

While the fundamental principles of anatomic dissection of the thyroid gland during thyroidectomy remain unchallenged, and the importance of meticulous dissection and identification of the recurrent laryngeal nerve unchanged, a growing body of evidence suggests that continuous intraoperative laryngeal nerve monitoring may be beneficial, particularly in the hands of low-volume surgeons.[2] Its use in minimal access surgery has only recently been described.[3]

The nerve integrity monitoring device (NIM-2.0) offered by Medtronic-ENT (Jacksonville, FL) has emerged as the industry leader for nerve monitoring, in part because the system is user-friendly and straightforward. Nevertheless, those unaccustomed to nerve monitoring will benefit from a careful description of the technique, and there are some technical considerations worthy of note for even the experienced user, particularly as it relates to endoscopic thyroid surgery.

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Procedural technique

The details regarding the endoscopic thyroidectomy have been described elsewhere[4,5] and will be further discussed in another article in the current issue; therefore, they are mentioned only briefly in this description.

Nerve monitoring device

Surface electrode laryngeal EMG devices are currently available from 2 different sources, the Medtronic-ENT nerve integrity monitoring system (NIM-2.0) and the Neurovision system (Neurolocator SE; Neurovision Medical, Ventura, CA). The author has experience only with the NIM-2.0 system, which will be described. This system is user-friendly in that the laryngeal EMG endotracheal tube has integrated surface electrodes (Figure 1A), and is compatible with the NIM-2.0 device that is commonly available in most modern hospitals (Figure 1B).

The endotracheal tube is somewhat more compliant than a standard endotracheal tube, and the use of a stylet is strongly recommended (prebent with a sharp hockey-stick shaped angulation approximately 4-6 cm from the tip of the tube to facilitate intubation). It is important that the exposed surface electrodes, demarcated by either a blue or white band on the endotracheal tube, be positioned so that they are bridging the vocal cords (Figure 2A). It is occasionally useful to confirm this positioning videoendoscopically. Similarly, the electrodes should be aligned rotationally so that the red electrodes are on the

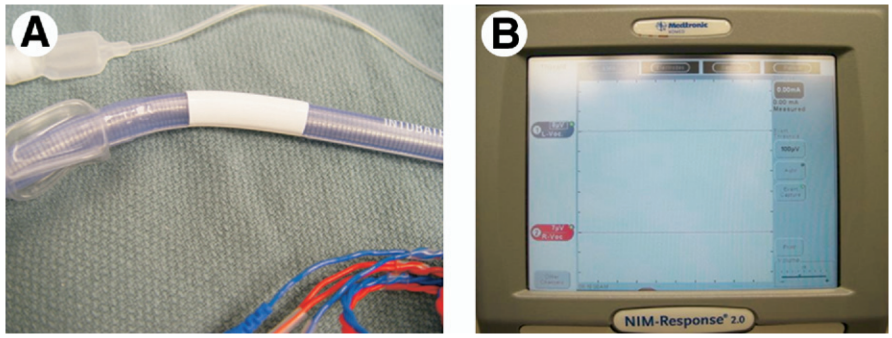

Figure 1 Medtronic-ENT laryngeal EMG endotracheal tube (A) has integrated surface electrodes demarcated by either a blue or white surface. (B) The monitor itself (Nerve Integrity Monitor-2, NIM-Response 2.0, Medtronic-ENT) is versatile in that it can be used for monitoring of a number of cranial nerves, including most commonly the fifth, seventh, tenth, eleventh, and twelfth. (Color version of figure is available online.)

right and the blue on the left, to maximize the likelihood of contact between the electrodes and the vocal cords (Figure 2B). The integrity of the system can be confirmed by eliciting a signal when tapping on the anterior neck or by assuring an impedance level that is less than 10 KΩ with a difference of less than 1 KΩ between the left and

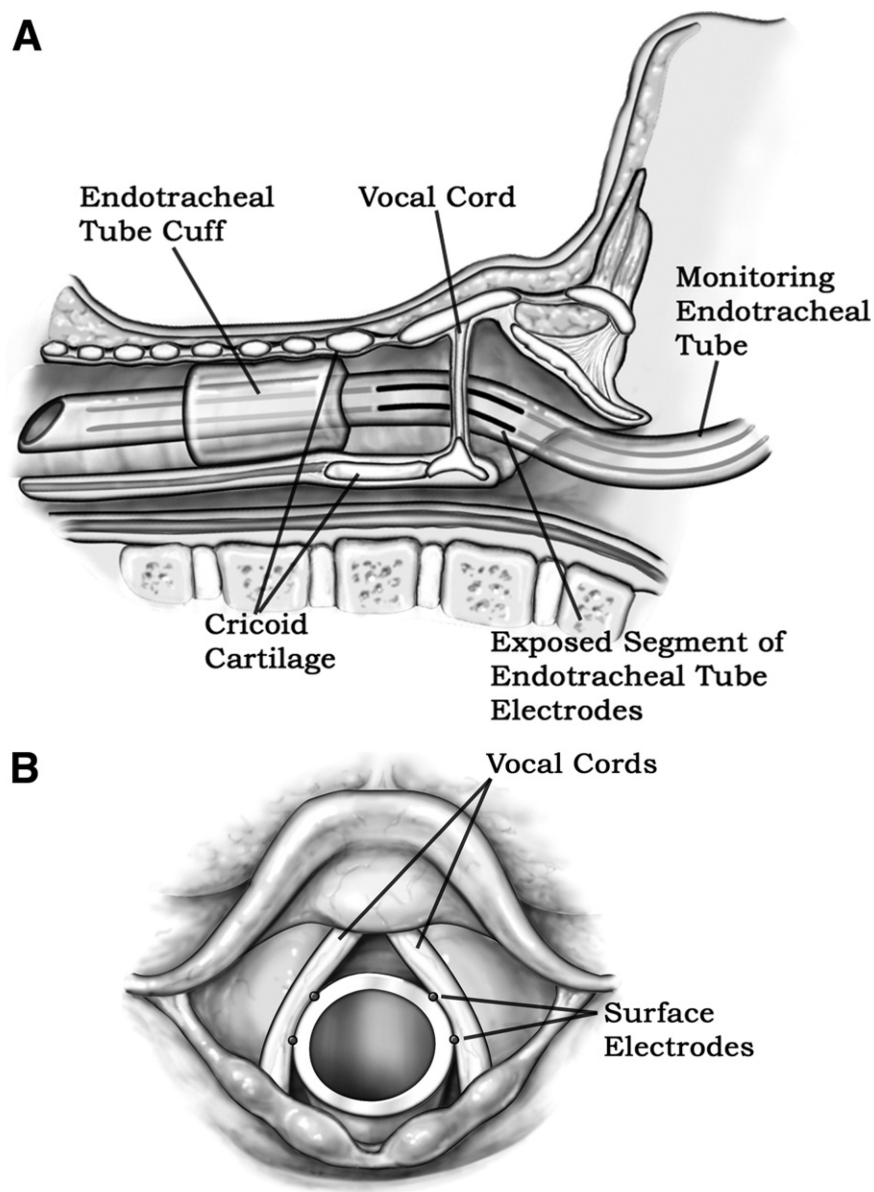

Figure 2 A longitudinal representation of the positioning of the laryngeal EMG endotracheal tube is depicted (A). Of note, the surface electrodes must be bridging the vocal cords to make contact, and therefore complete the electrical circuit. When properly positioned, the endotracheal tube cuff is located below the cords. An axial representation (B) emphasizes the importance of the proper rotational positioning of the endotracheal tube, to optimize the likelihood of contact between the surface electrodes and the vocal cords.

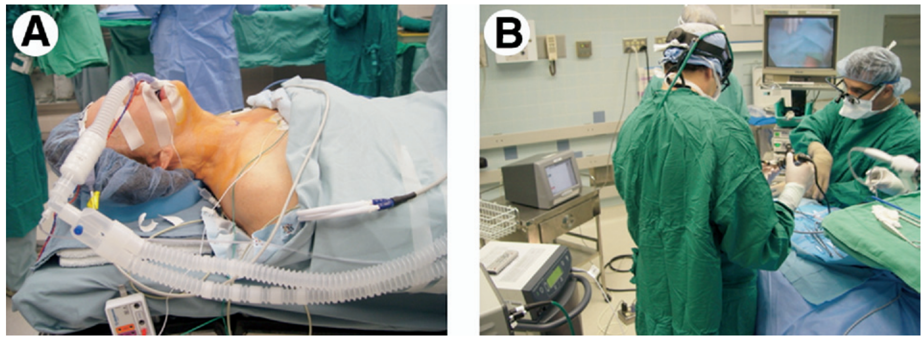

Figure 3 The patient is placed in the supine position with only minimal extension (A) and typically rotated 180° from the anesthesiologist, with measures taken to minimize the chance of traction on the endotracheal tube. The room is organized in such a fashion that adequate access to the Harmonic generator, the nerve monitoring device, and the television monitor is maintained (B). (Color version of figure is available online.)

right channel. It is important that the patient not be paralyzed during the surgery.

Although some clinicians use a technician to independently monitor the EMG waves, this is cost-prohibitive in most environments and probably an unnecessary added measure. Instead, the audible and visual signals associated with the monitoring device are adequate to alert the operative surgeon to the status of the nerve integrity.

Patient positioning

The patient is positioned supine with minimal extension, and with the head rotated 180° from the anesthesiologist (Figure 3A). Steps should be taken to prevent twisting or pulling on the endotracheal tube during surgery (the author prefers to tape the anesthesia circuit hoses to the bed itself), and the Harmonic generator, the nerve monitor, and the video monitor should be properly positioned for optimal access (Figure 3B).

Endoscopic thyroidectomy

These steps have been described in detail elsewhere. Essentially, the thyroid gland is bluntly mobilized through a 15- to 20-mm low midline cervical incision. The superior pole is mobilized and ligated endoscopically (5-mm 30° laparoscope angled upward) with the Harmonic shears. The laparoscope is then rotated downward, and the recurrent laryngeal nerve is identified in the tracheoesophageal groove. The parathyroid glands are identified and mobilized away from the thyroid, the gland is exteriorized, and the recurrent nerve is followed to its entrance in the larynx as would be accomplished in open surgery.

The author prefers to use the NIM-2.0 primarily as a passive monitor. On occasion, stimulation of the recurrent laryngeal nerve with the Prass monopolar probe (Figure 4A) can be helpful. This probe is long and slender, so that it lends itself to endoscopic techniques (Figure 4B). Circumstances in which stimulation of the nerve may occasionally be appropriate are in reoperative cases where confirmation

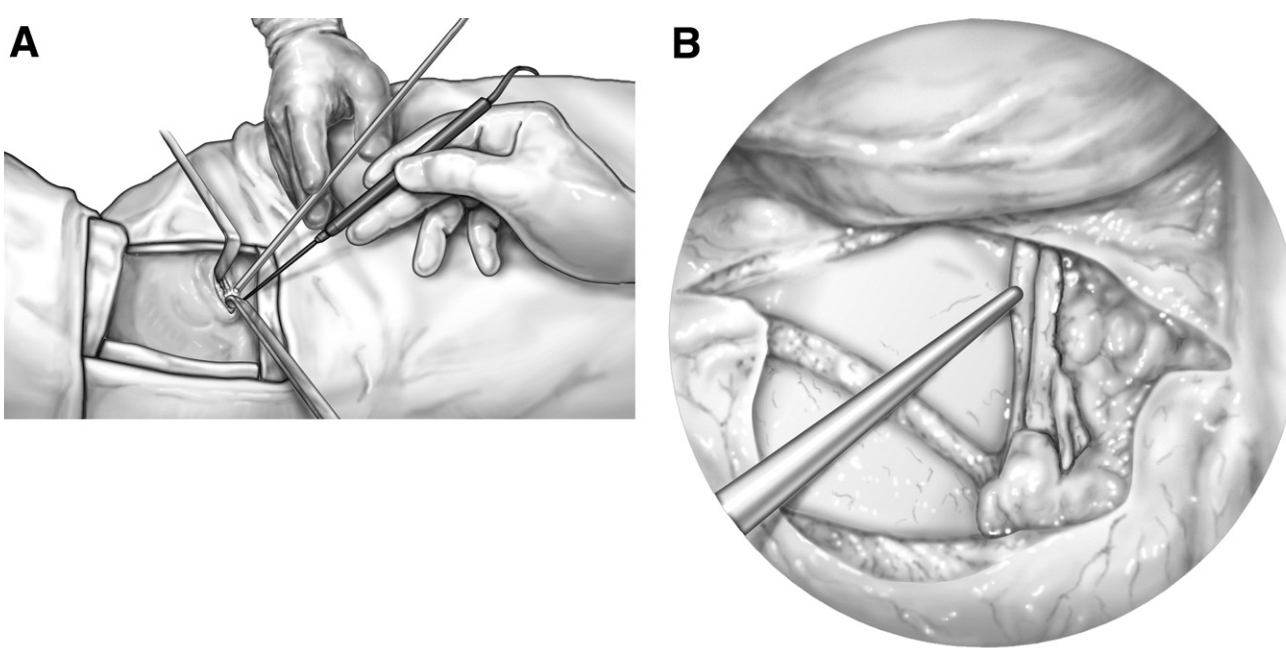

Figure 4 In a typical endoscopic thyroidectomy, the Prass monopolar probe (A) is introduced through the minimal access incision and utilized to stimulate the recurrent laryngeal nerve (B).

that a structure is in fact the nerve can be challenging, or when concern regarding the integrity of the nerve at the end of a procedure or before moving to the other side in a bilateral case prompts the need for assurance. A typical electrical response yielded with stimulation of the nerve at a low amplitude is depicted in Figure 5.

Results

The author has experience with monitoring in more than 300 thyroidectomies. An increasing proportion of thyroidectomies are performed with laryngeal nerve monitoring, and it has reached the point of routine use (Figure 6). A comparison of minimal access cases in which the nerve monitoring was used versus those in which no monitoring was used yielded a nonstatistically significant difference in the rate of temporary nerve dysfunction (6.0% in unmonitored cases versus 4.6% in monitored cases). There is no difference in the rate of permanent recurrent laryngeal nerve paralysis, which was zero in both groups.

Discussion

Nerve monitoring for surgical procedures has been available for a number of years. Only recently, however, has a straightforward, user-friendly system for laryngeal nerve monitoring emerged. Although unlikely to ever reach the threshold of "standard of care," there are a number of potential benefits to this technology that may provide value in the hands of some surgeons.

Passive laryngeal nerve monitoring provides meaningful feedback regarding nerve traction, has the ability to alert the surgeon to the proximity of the recurrent laryngeal nerve during dissection, and can assist in distinguishing nerve tissue from blood vessels, scar, fat, or other nonvital structures, especially in reoperative surgery.

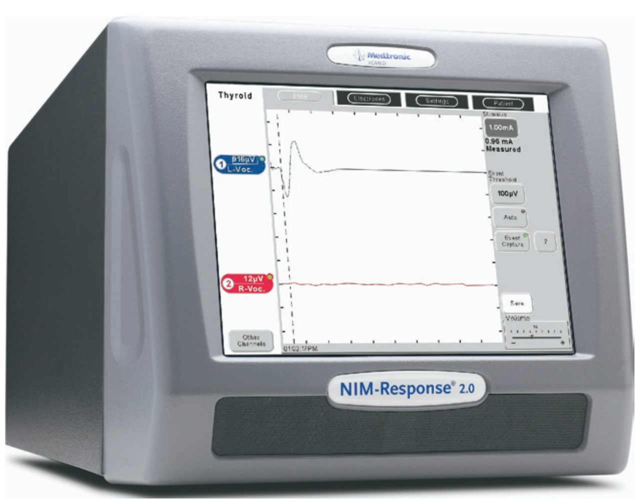

Figure 5 On direct stimulation of the recurrent laryngeal nerve at a low stimulus level, a typical electrical signal will be evoked. The audible response that accompanies this signal is more useful to the operating surgeon. (Color version of figure is available online.)

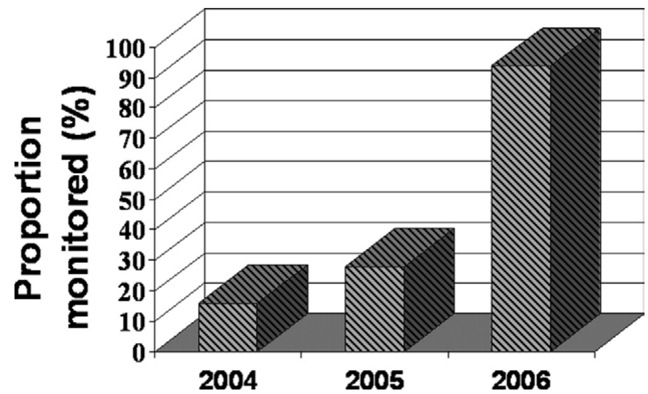

Figure 6 There is a growing belief that if one is going to monitor, one should monitor the laryngeal nerves routinely during thyroid surgery. This concept has been embraced by the author, as reflected in the significant increase in proportion of cases monitored during the years 2004 to 2006.

It is doubtful that a prospective, randomized clinical trial will be undertaken to "prove" the benefit of laryngeal nerve monitoring. This is true because of the low rate of RLN injury (particularly in the hands of those most likely to conduct such a study) and consequently the vast numbers of patients who would be required, based on a number of independent power analyses. The multiple retrospective studies failing to show a significant impact with monitoring all suffer from Type II statistical error (insufficient population size to demonstrate a difference, should a difference exist).

Finally, endoscopic and minimally invasive thyroid surgeries continue to emerge as preferred approaches for some patients with selected thyroid conditions.[6,7] It is a logical step to incorporate nerve monitoring into surgical techniques for which the operative aperture is reduced.

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