We Asked the Experts: How Can One Troubleshoot Loss of Intraoperative Nerve Monitoring During Head and Neck Surgery?

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Published online: 29 January 2020
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Introduction

Intraoperative monitoring of the recurrent laryngeal nerve (RLN) has become a widely accepted adjunct to visual nerve identification during head and neck surgery. While it has not been shown to reduce definitively the risk of RLN injury, it can be helpful in early identification of the nerve, detection of nonrecurrent RLN on the right side, and in high-risk cases (i.e., reoperations and Graves' disease) where visual identification of the RLN may be difficult. It can also help prevent bilateral RLN injury. Here, we discuss practical tips and potential pitfalls that may aid surgeons in using the monopolar nerve stimulator for laryngeal neuromonitoring with a device that transforms laryngeal muscle activity into audible and visual electromyographic (EMG) signals.

Preoperative considerations

Ensuring success of intraoperative nerve monitoring (IONM) starts with intubation. We recommend using a tube that is one size larger than standard selection to optimize electrode contact with the vocal cords [1]. When the patient is being intubated, it is crucial to confirm that the endotracheal tube is deep enough so that the surface electrodes abut the vocal cords. Lubricants should not be applied to the tube as these can affect signal transduction.

The anesthesiologist should only use a short-acting neuromuscular blockade during induction and then use other anesthetic agents during the operation to keep the patient sufficiently deep and to prevent spontaneous vocal cord movement, which may cause a false-positive signal, and could lead to perpetual fibrillation of the vocal cords, creating a loud continuous noise.

Practical tip We use a video laryngoscope so that members of both the anesthesiology and surgery teams can visually confirm appropriate tube placement.

Potential pitfall Surgeons typically extend the neck and/or turn the head for optimal positioning, but this maneuver may cause loss of contact between the surface electrodes and vocal cords if the tube pulls out. The endotracheal tube follows the chin of the patient as the neck is extended (out) or flexed (in). If the endotracheal tube pulls out, the cuff balloon may cause direct injury to the vocal cords. Therefore, once the patient is in final position, we recommend performing an electrode check to confirm that the nerve monitoring system is intact. Assuring that the tube does not rotate, checking the position of the left and right (blue and red, respectively) wires will help keep the tube in correct apposition. If the cuff has an audible air leak, the tube may likely have migrated out between the vocal cords, and this should be repositioned, not just have the cuff overinflated, which can lead to cord injury.

Intraoperative troubleshooting

Once the operation is underway, loss of signal, defined as low or absent EMG activity when stimulating the vagus or RLN can be divided into (1) true or (2) false positives.

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Distinguishing between these two can be challenging, but very important. When this occurs, one should have a standard protocol. The most common causes of equipment malfunction are endotracheal tube displacement, electrodes' malposition, and stimulating probe problems.

If there is no or poor signal from the nerve monitor, the equipment should be checked. An electrode check should be performed to confirm that the nerve monitoring system is adequate. If the system is not intact, first check the electrodes and the ground wires, which may not be appropriately connected to the monitor, or may be inadvertently touching below the skin (impedance will be too low, $< 0.1 \text{ k}\Omega$); second, check the positioning of the endotracheal tube. The red and blue electrodes should be located on the patient's right and left, respectively. Assure the tube has not moved with positioning. (Impedance will be too high if the tube electrodes are in poor apposition to the vocal cords, or electrodes not firmly inserted into the interface, $> 7.5 \text{ k}\Omega$.)

Practical tip The vagus nerve should be tested at the beginning of the procedure before the thyroid gland is medially rotated. Placing the blunted stimulator between the carotid and the jugular and having it set on higher amperage (2 mA) can stimulate the vagus without dissecting out the carotid sheath. This will assure full continuity of function of the RLN. This maneuver should be done at the end of the surgery as well, to assure full length integrity of the nerve. Testing the right vagus nerve high in the neck (above the level of the cricoid) and having positive laryngeal stimulation, but losing the stimulation if the vagus is tested lower in the neck, will alert the surgeon to the possibility of a non-recurrent laryngeal nerve. This will help plan identification and prevent injury before dissection is even begun.

Practical tip Place your index finger over the posterior aspect of the cricoid and stimulate the vagus or RLN. The laryngeal twitch should be palpated vigorously, which indicates adequate nerve function. If the EMG and sound are not reporting proper stimulation, but the larynx has a palpable twitch, check the sensitivity, which may need to be lowered to record a true event.

Once the RLN is identified, the amperage should be turned down to avoid repetitive stimulation injury to the RLN. If there is a positive signal at the beginning but this is lost during the operation, and the electrodes appear to be in good apposition, the surgeon should remain vigilant to the possibility of RLN injury. Testing the contralateral vagus for adequate signal can help distinguish between tube displacement versus real nerve injury. Loss of palpable laryngeal twitch can also denote RLN injury.

Potential pitfall Inadvertently touching the live cautery to the nerve stimulator tip will lead to blowing out the fuse inside the connector box. All sounds will be lost if this happens. The fuse will need to be replaced for function. The connector box should have a backup fuse in it.

Loss of nerve signal is defined as an EMG change from an initial satisfactory EMG to low ($\leq 80 \mu\text{V}$ with stimulation at 1–2 mA) or no response, and no laryngeal twitch and/or observed glottis twitch upon digital palpation of the posterior cricoid. There are various types of nerve injury: type 1 is the classic segmental injury, while type 2 is a more global type injury [2].

When there is a loss of signal, the surgeon should “map” the RLN by starting at the most distal point of the RLN and stimulating it distal to proximal. By testing the entire length of the nerve, the surgeon may be able to identify the injured segment of nerve. In a type 1 injury, the surgeon may find a clip or suture on the nerve that could be released to avoid permanent injury. Alternatively, if both nerve endings can be identified in a complete transection, a tension-free RLN–RLN reanastomosis or reinnervation using ansa cervicalis is the option for repair [3]. If stimulation of both the entire RLN and vagus demonstrates that the RLN is nonconductive, this suggests a type 2 injury consistent with an intralaryngeal focus, or stretch injury [2].

Practical tip Consider administering intravenous dexamethasone if there is a loss of signal. In a 2020 prospective, nonrandomized study of 702 patients undergoing thyroid surgery, patients who had loss of signal and received a single 4-mg IV dexamethasone injection within 10 min from loss of signal experienced greater intraoperative signal recovery and less vocal cord palsy, compared to patients who experienced loss of signal but did not receive dexamethasone [4].

Intraoperative loss of nerve function on the one side during a bilateral operation should prompt the surgeon to delay operating on the contralateral side to avoid bilateral RLN injury until recovery of the ipsilateral vocal cord function can be documented with indirect laryngoscopy.

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