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Safeguarding the Voice: The Role of Intraoperative Neurophysiological Monitoring (IONM) in Total Thyroidectomy

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INTRODUCTION

Intraoperative neuromonitoring (IONM) is an advanced surgical technique designed to safeguard and identify critical nerves during surgical procedures. This sophisticated method uses electrical stimulation and specialized feedback devices to monitor nerve signals in real time [1].

During the surgical procedure, strategically placed electrodes are attached to the muscles innervated by the monitored nerves. These electrodes record electrical activity and muscle contractions, providing valuable clues about nerve function. As the surgeon or neurophysiologist gently stimulates the nerve with a mild electrical current, the recording system captures the muscle's response.

A robust, normal response indicates that the nerve is healthy and intact, while a weak or absent response serves as an essential warning signal. This alert allows the surgical team to intervene promptly, reducing the risk of nerve injury and optimizing patient outcomes. Overall, IONM plays a critical role in enhancing the safety and effectiveness of various surgical interventions.

Intraoperative neuromonitoring (IONM) is essential for enhancing safety and outcomes in several surgical procedures:

- **Spine Surgery:** During spinal operations, IONM tracks the integrity of the spinal cord and nerve roots. This real-time monitoring helps prevent neurological impairments due to surgical manipulation.
- **Brain, Ear, and Parotid Surgery:** IONM aids in preserving motor and sensory functions during brain tumor resections and monitors facial nerve function in ear and parotid surgeries, reducing the risk of postoperative paralysis.
- **Vascular Surgery:** IONM plays a vital role in various vascular procedures. Such as Carotid Endarterectomy (CEA), Aortic repairs, Coronary Artery Bypass Grafting (CABG), etc.

- **Thyroidectomy and Parathyroidectomy:** IONM monitors the recurrent laryngeal nerve, which is crucial for preserving vocal cord function and minimizing the risks of complications, such as voice changes.

Incorporating IONM enhances surgical precision and significantly improves patient outcomes. Total Thyroidectomy is the surgical removal of the entire thyroid gland due to benign and malignant pathologies of the gland [2]. Damage to the associated nerves is one of the most common adverse effects of this surgical procedure. The rate of damage to recurrent laryngeal nerves (RLN) in total thyroidectomy remains at 0-2.1% and is significantly higher when the nerve is poorly identified (4-6.6%). Moreover, the injury rate of the external branch of the superior laryngeal nerve (SLN) can go as high as 58%, but it remains variable in the literature [3]. Thus, advances in surgical procedures are significant for protecting and monitoring the associated nerves.

IMPORTANCE OF THE LARYNGEAL NERVES

Recurrent Laryngeal Nerve (RLN):

Small Nerve, significant impact on your voice and breathing. Tucked deep in your neck, the recurrent laryngeal nerve (RLN) plays a starring role in how you speak and breathe. It powers nearly all the intrinsic muscles of the larynx, the ones responsible for shaping your voice, except for one (the cricothyroid, which handles pitch).

When the RLN is injured, the consequences can be dramatic. Loose vocal cords may cause hoarseness, making your voice sound breathy or strained [4]. If the cords can't meet at the midline, aspiration becomes a risk, as food or liquid may slip into the airway instead of the esophagus. And in rare but severe cases, both vocal cords may slam shut, leading to life-threatening airway obstruction.

In short, this nerve is tiny, but its job is mighty. Whether you're belting out a song or simply breathing easy, the RLN is working behind the scenes to keep things running smoothly.

External and Superior Laryngeal Nerve (SLN):

Why might you struggle to hit high notes after a nerve Injury? Ever wonder how your voice shifts so effortlessly? One key player is the cricothyroid muscle, a small yet mighty muscle in your neck that fine-tunes the tension in your vocal cords. It's controlled by the external branch of the superior laryngeal nerve (SLN), which acts like a precision dial for pitch modulation.

When this nerve is damaged, say, during thyroid surgery or trauma, the cricothyroid muscle can't tighten the vocal cords properly. The result? Difficulty producing high-pitched sounds and a voice that tires easily.

Singers, teachers, and public speakers often notice this change first, as their vocal ranges narrow and stamina declines.

In short: tight cords = high pitch. Lose the tension, and your upper register fades away.

Anatomical Pathways of the Laryngeal Nerves: A Tale of Two Branches

The laryngeal nerves, key players in voice and airway control, are branches of the Vagus nerve and emerge just above the carotid bifurcation. From there, each takes a distinct route, tailored to its function [5].

Superior Laryngeal Nerve (SLN)

This nerve quickly splits into two branches:

- **External branch:** Travels alongside the superior laryngeal vessels and tucks beneath the thyroid gland. It innervates the cricothyroid muscle, which fine-tunes vocal cord tension to control pitch.
- **Internal branch:** Descends with the superior laryngeal artery, pierces the thyrohyoid membrane, and enters the larynx to provide sensory input to the mucosa above the vocal cords, a crucial zone for airway protection.

Recurrent Laryngeal Nerve (RLN)

The RLN takes a longer, looped journey:

- **Right RLN:** Loops around the right subclavian artery, then ascends obliquely behind the common carotid artery.
- **Left RLN:** Swings under the aortic arch, then climbs upward in the tracheoesophageal groove.

Both branches ultimately reach the larynx, innervating all intrinsic muscles except the cricothyroid, making them essential for phonation and airway patency.

General difficulties in Identification:

Even for seasoned surgeons, locating the laryngeal nerves during neck procedures can be a challenge. Their variable anatomical course and proximity to major blood vessels make them tricky to isolate. Add scarring from prior surgeries or pathological thyroid enlargement, and the nerves may be buried beneath distorted tissue planes, virtually invisible to the naked eye.

This is why technologies like Intraoperative Neurophysiological monitoring (IONM) have become essential tools in modern thyroid and parathyroid surgery. They help map out these delicate structures in real time, reducing the risk of nerve injury and preserving voice and airway function.

Why Intraoperative Nerve Monitoring (IONM) Is a Game-Changer in Thyroid Surgery?

Thyroid surgery demands precision, especially when protecting the delicate laryngeal nerves that control voice and airway function. That's where Intraoperative Neurophysiological Monitoring (IONM) steps in.

During the procedure, specialized electrodes are positioned to detect muscle activity in the vocal cords or cricothyroid muscle. When the surgeon delivers a gentle electrical stimulus to the nerve, the system listens for a response. If the nerve is intact, the monitor provides auditory and visual feedback, a reassuring signal that everything's working as it should.

Key Benefits of IONM in Thyroid Surgery:

- **Protects the voice:** By identifying and monitoring the laryngeal nerves in real-time, IONM helps prevent one of the most common complications —nerve injury leading to hoarseness or vocal cord paralysis.
- **Saves time:** Nerves can be hard to spot with the naked eye, especially in scarred or enlarged thyroid tissue. IONM accelerates identification, streamlining the process.
- **Boosts surgeon confidence:** With instant feedback on nerve integrity, surgeons can operate with greater assurance and precision.

In short, IONM transforms nerve protection from guesswork into guided precision, making thyroid surgery safer and smarter.

CASE SPOTLIGHT: THE NERVE OF GALLI-CURCI

Amelita Galli-Curci was a famous Italian soprano in the early 20th century. In 1935, she underwent surgery to remove a large goiter affecting her voice. Dr. Arnold Kegel performed the surgery under local anesthesia in the United States [6].

The surgery was successful, but when Galli-Curci returned to the stage in 1936, her fans were disappointed. She could no longer reach her high notes, and her vocal agility was reduced. Many believe this occurred because the surgery injured the external branch of the superior laryngeal nerve (EBSLN), which controls pitch.

This case gained widespread recognition, and the EBSLN is sometimes referred to informally by surgeons as "the nerve of Galli-Curci". Her story serves as a warning about the importance of carefully identifying and monitoring nerves during thyroid surgery, especially for those who rely on their voice for their profession.

The story of Amelita Galli-Curci reminds us that the voice is more than sound; it's an identity, a livelihood, and a legacy. Her post-thyroidectomy vocal loss, likely due to injury to the external branch of the superior laryngeal nerve, became a cautionary tale that still echoes in surgical education today.

CONCLUSION

Thanks to modern advances like Intraoperative Nerve Monitoring (IONM), we now have the tools to protect what matters most. Whether you're a singer, speaker, or simply someone who values their voice, IONM transforms thyroid surgery from a blind procedure into a guided performance, preserving nerve integrity, reducing complications, and restoring confidence in every step.

In the end, safeguarding the laryngeal nerves isn't just good medicine, it's good humanity.

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