Intraoperative Laryngeal Nerve Monitoring

Lisa A. Orloff, M.D.
Department of Otolaryngology/Head & Neck Surgery
University of California, San Francisco

Cranial Nerve Monitoring

- Otologic and Neurotologic surgery: the norm
- Parotid Surgery: common
- Thyroid/parathyroid surgery: growing awareness/use

Reasons to Monitor

1. Aid in identification of RLN (speed, accuracy)
2. Aid in dissection (or avoidance) of RLN
3. Neural prognostic evaluation during and at end of surgery (avoid bilateral VC paralysis)

RLN (vocal fold) Paralysis

- Dralle et al, Surgery 2004: 29,998 nerves at risk: no SS difference in paralysis rates between visual nerve ID only vs. RLNM
- 0.84% permanent RLN paralysis (historically 1-3%)
- Visual nerve identification = gold standard
- For low volume surgeons (<45/year), but not for high volume surgeons, RLNM reduced permanent RLNP rate (1.06% overall)

- Difficult to demonstrate a difference given low overall rate of RLNP
- RLNM is a “promising tool for nerve identification and protection”
RLNM: Updated Evidence-Based Assessment

- Dralle et al, World J Surg 2008:
  6 studies with > 100 NAR each, RLNM vs. visual ID only: permanent RLNP tended to be lower with IONM (not SS), rates ranged from 0-11%

- RLNP rates are so low that prohibitively large numbers of pts need to achieve statistical power

- No prospective multicenter trial, as no one willing to accept randomization to a non-IONM control group

Intraoperative Nerve Monitoring – Exploding Myths

- Use of laryngeal nerve monitoring does not suggest that one doesn’t know how to find the nerves without it

- Even if one has been performing thyroid surgery successfully, adding monitoring can provide useful information

Intraoperative Nerve Monitoring - Myths

- Conversely, use of nerve monitoring is not a substitute for careful dissection and a cautious approach to identifying the laryngeal nerves

Whether to Monitor?

- Improved patient outcomes

- Surgeon and patient peace of mind

- In case of injury, you’ve used the available safety-minded technology

- Question is not should we monitor, but HOW to monitor
Importance of laryngoscopy

- Pre- and post-op laryngeal exam goes hand-in-hand with IONM and is ESSENTIAL IN ALL CASES
- Informs surgeon of his or her technique
- Represents the only objective, accurate outcome measure
- Well-known lack of relation between vocal symptoms and glottic function


Preoperative laryngoscopy

- Establish baseline function
- Operative planning and recognition of disease aggression
- Patient counseling
- Management of the nerve found invaded depends on preop functional status
- Symptomatic assessment is unreliable due to variation in vocal cord position and contralateral cord compensation

Flynn 94, Cunning 55, Happen 56

Postoperative laryngoscopy

- Advantage to patient requiring future cervical surgery
- Informs patient re possible aspiration
- Those with superior results report them.
- Rates of VCP for expert surgeons are low, but many reports in the 6-8% exist, some as high as 23%.

Tsang 98, Cohn 94, Wanebo 98, Wilson 71, Wanger 94, Samaan 83
Indications for Laryngeal Nerve Monitoring

1. Malignancy
2. Concomitant lymph node dissection
3. Graves’ disease and/or thyroiditis
4. Substernal goiter
5. Revision surgery
6. Surgery after XRT
7. Only one functioning RLN
8. Any case of bilateral surgery
9. All cases

State-of-the-Art Noninvasive Monitoring

Surface electrodes:
Postcricoid PCA monitoring
Endotracheal tube-based TA monitoring
Passive and evoked EMG

Postcricoid PCA monitoring
Equally sensitive, reliable, and safe to ETT
+: ease of placement, low cost, commercial availability
-: does require 2nd laryngoscopy
Better to insert PCA electrodes before intubation

Endotracheal tube-based monitoring
Low pressure cuffed ET tube with integrated wire electrodes, insulated except for 30 mm at glottic level
Left and right electrode pairs skewed anteriorly for optimal VC contact
ETT cuff in lower subglottis/proximal trachea
Nerve Integrity Monitoring System

- EMG electrode **endotracheal tube**
- **NIM** 2 (Medtronic) oscilloscope with audio
- Ground and stimulator anode **surface electrodes**
- Hand-held **pulse generator**

Probes and Electrodes

- **Probe**: stimulates nerves
- **Electrodes**: "listen" for a response

EMG

- Electromyography
- Measurement of **Muscle Activity**
- Audio supplement to visual EMG display on monitor

Intubation with nerve-monitoring tube

- Short-acting, nondepolarizing agent (succ)
- No long-term paralytic or local anesthetic agents
- Visualize electrode/VC contact
- If using postcricoid electrode, place it first
Intubation (cont.)

- Ground, recording, stimulator electrodes to shoulder, all electrodes to box
- May need to rotate tube clock/counterclockwise
- Position patient before taping tube
- Witness normal respiratory EMG activity (30-70 uV) as succ wears off
- Choose event threshold ≥100 uV
- Stim at 0.5-1 mA

Electrode Placement – Proper Position

RLN Injury during Thyroidectomy

Stretch/traction, pressure, crush, electrical injury, ischemia, suction injury – all without transection – all invisible to the surgeon’s eye

RLN Injury during Thyroidectomy

- Surgeons significantly underestimate RLN injury
- Electrical testing is better than visual inspection
- If unilateral RLN injury is detected, bilateral surgery may be delayed

Lo C-Y et al, Arch Surg 2000: 6.6% VCP by postop lx exam; only 1.1% of injured nerves were recognized visually during surgery
Stimulation Technique

- Dry environment is best
- Place probe perpendicular to tissue
- Hold probe on for at least 1s
- Set stimulus level based on specific procedure needs

**“EMG RESPONSE”**

- Stimulus = 0.40 mA
- Threshold = 100 µV

120 µV — “Beep Beep”

Rules of Thumb

- Don’t regard a negative response to stimulation as a true negative until a true positive has been identified
- Use 1x palpation to confirm/backup EMG
- Repetitive passive EMG activity may indicate injury, or lightening of anesthesia

Prognostic Function

At end of procedure, stim at ≤ 0.4 mA predicts normal RLN function postop

Randolph, Normative Data
Total pts = 1086, NAR = 1430, thyroid surgery EMG analysis
All pts-normal larynx exam post op, stimulation @ 1 mA
### Summary – IONM and Thyroidectomy

- Can be a “noisy” surgery
- EMG Tube placement is essential
- Monitoring Goals:
  - Identify the nerve(s)
  - Control manipulation during dissection
  - Verify integrity: Prior to other side or closing

Stimulus: 0.4 - 2.0 mA  
Threshold: 100μV

### Applications of Laryngeal Nerve Monitoring

- Thyroid surgery
- Parathyroid surgery
- Zenker’s diverticulum surgery
- Carotid endarterectomy
- Esophagectomy
- Laryngotracheal stenosis surgery
- Anterior approach to cervical spine
- Skull base procedures
- Chest procedures

### Thank you

- Consider whether to insert videos of vcp – probably not as Courey will show
Intraoperative monitoring of the recurrent laryngeal nerve in thyroid surgery.

Drahl H, Sekulla C, Lorenz K, Brauckhoff M, Machens A; German IONM Study Group Collaborators (11)

BACKGROUND: Recurrent laryngeal nerve (RLN) palsy ranks among the leading reasons for medicolegal litigation of surgeons because of its permanent collection at an equity of 10. As a risk minimization test, vagal neuromonitoring (VNM) has been introduced in the RLN function monitoring in patients undergoing extended thyroidectomy or total thyroidectomy. METHODS: The present study was based on a systematic appraisal of the literature using evidence-based criteria. RESULTS: 13 papers were identified in this search. These studies evaluated RLN palsy risk factors (odds ratios, ORs), 4.7, and 6.7, and variable positive predictive values (PPV; 10%-90%) for IONM, limiting its utility for intraoperative identification (OR, 1.4), low or medium volume hospitals (OR, 1.3), and low volume surgeons (OR, 1.2). CONCLUSIONS: Based on these data, visual nerve identification was identified to be the gold standard of RLN treatment in thyroid surgery. RLNM is a promising tool for nerve clarification.

Validity of intra-operative neuromonitoring signals in thyroid surgery.

Thomusch O, Sekulla C, Machens A, Neumann HJ, Timmermann W, Drahl H

Department of General, Visceral and Vascular Surgery, Martin Luther University of Halle-Wittenberg, Halle, Germany. o.thomusch@gmx.de

BACKGROUND: Although intra-operative neuromonitoring (IONM) is widely used in thyroid surgery, the validity of the received IONM signals are still unknown. METHODS: Prospective collection of data forms in 29 hospitals from 8,534 patients with 15,403 nerves at risk, who underwent surgery for benign and malignant goiter disorders between August 1999 and January 2001. IONM was performed by indirect stimulation via the vagal nerve and by direct recurrent laryngeal nerve (RLN) stimulation in 12,486 cases. IONM signals were compared with early (<14 days) and late (6 months) postoperative vocal cord function findings. RESULTS: The transient and permanent RLN palsy rate was 2.8% and 0.7%, respectively. Monitoring of the RLN function was significantly more reliable via the indirect IONM stimulation route than via the direct IONM stimulation route (specificity 8%, sensitivity 99.6%). However, a changed IONM was insufficient to predict permanent RLN palsy (sensitivity 45.9%, positive predictive value 11.6%). IONM was not associated with increased general morbidity. CONCLUSIONS: Apart from optimizing the signals through challenging anesthetics, IONM rate and risk as a consequence to the gold standard of visual nerve identification. To further reduce the number of false negative IONM signals, the causes underlying its relatively low PPV require additional clarification.