Current Practice Parameters for the Use of Laryngeal EMG from the Beaver Creek Conference—July 2007

Convened by the Neurolaryngology Study Group

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Background

• 2004 evidence-based review of 584 articles by Sataloff, Mandel, Mann, and Ludlow concluded that of the 7 proposed uses LEMG was only, "possibly useful for the injection of botulinum toxin"
• Evidence on specificity and sensitivity and reliability of LEMG for other 6 uses is lacking
• This contrasts with the clinical use of LEMG by some in the community.

Purpose of this Report

• Not to conduct another evidence-based review
• To define current practice parameters
• To set the stage for future development
  – Identify parameters for use in necessary prospective controlled blinded assessments of LEMG sensitivity, specificity and reliability for identification, assessment and prognosis for neurolaryngological disorders.

Peripheral vs Central Neurological Disorders to be Evaluated

• Peripheral neurolaryngological disorders affect
  – Motor nerves
  – Afferent/sensory neurons/axons,
  – Neuromuscular junctions
  – Muscle fibers (in myopathies),
• Central neurolaryngological disorders affect
  – the firing rates of motor neurons, upper motor neurons,
  – central sensory and motor pathways in the corticobulbar pathway, brainstem, or basal ganglia
Peripheral Nervous system

Motor Units—A Group of Muscle Fibers Innervated by a Single Motor Neuron

Motor Unit Action Potential

Confluence and Proximity of the Thyroarytenoid and Cricothyroid Muscles

Must be able to selectively record from THYROARYTENOID—RLN & CRICOTHYROID—SLN
Electrode Types
Schematic to scale

- Monopolar: Commercially Available
- Hooked wires
- Concentric: Commercially Available
- Bipolar concentric

Non-selective
Quite Selective
Highly selective

Qualitative EMG

Is judgmental and depends upon operators' experience with the particular muscles being studied
Difficult for others to replicate without well-defined rules

Normal EMG Recording during counting

Speech onset
Thyroarytenoid muscle activation

Denervation - reduced axonal input
get insertional activity & spontaneous firing of muscle fibers

- Fibrillation potentials < 2ms
- Positive sharp waves
- Insertional activity
- Complex repetitive discharges
Reinnervation - increased size & duration of MUAPs

Axonal sprouting innervates additional fibers

Polyphasic

Giant potential

Need 10 firings of same exact pattern

Signs of denervation/re-innervation

- Complex repetitive discharges
- Large motor unit peak to peak = 350µV
- Positive sharp waves
- Qualitative EMG

Quantitative EMG

Quantitative is depends upon extraction and measurement of MUAP

Automatic MUAP recognition programs in EMG system to measure several units' characteristics

None of the commercially available machines have these normative values for Laryngeal muscles

Qualitative EMG

Signs of denervation/reinnervation

(from 3 samples per muscle)

- Duration of insertional activity past (> 300 ms)
- Presence of Fibrillation potentials (+/−)
- Presence of positive sharp waves (+/−)
- Presence of complex repetitive discharges (CRDs) (+/−)
- Presence of fasciculations (+/−)
- Presence of polyphasics (+/−)
- Syrkininess (+/−) co-contraction of PCA and TA

Requires

- Extensive experience with laryngeal MUAPs
- Extensive knowledge of normal LEMG patterns for movement to determine synkinesis as Laryngeal muscles normally co-activate
Normative data for Quantitative measures of Motor Unit Amplitudes and Duration with a Concentric Needle

Based on 40 normal volunteers  
No mention of age  
Sex differences in motor unit action potential amplitude

<table>
<thead>
<tr>
<th>Measures</th>
<th>CT amp µV</th>
<th>TA Amp µV</th>
<th>CT dur ms</th>
<th>TA dur ms</th>
<th>CT % polyphasic</th>
<th>TA % polyphasic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men Mean/S.D.</td>
<td>331.3/ 86</td>
<td>385.0/ 97</td>
<td>4.5/ 0.56</td>
<td>4.4/ 0.47</td>
<td>2.2/ 1.79</td>
<td>2.0/ 1.70</td>
</tr>
<tr>
<td>Women Mean/S.D.</td>
<td>232.0/ 51.7</td>
<td>307.4/ 97.3</td>
<td>4.7/ 0.8</td>
<td>4.7/ 0.7</td>
<td>1.50/ 0.75</td>
<td></td>
</tr>
<tr>
<td>All Mean/S.D.</td>
<td>282.0/ 86.1</td>
<td>349.4/ 100.6</td>
<td>4.6/ 0.7</td>
<td>4.5/ 0.6</td>
<td>1.82/ 1.23</td>
<td>2.0/ 1.73</td>
</tr>
</tbody>
</table>

Quantitative EMG

- MUAP peak to peak amplitudes
- MUAP durations
- Rate of firing of individual MUAPs
- Estimates of the numbers of MUAPs firing (turns analysis)

Requires
- EMG equipment with automatic MUAP detection and analyses
- Standardized electrodes
- Normative mean and SD for MUAPs in each muscle at different decades
- Methods for standardizing degree of muscle recruitment (% of Max)

MUAP Characteristics Change with Age over 60 in normal subjects

Greater and earlier change in motor units from the left thyroarytenoid muscle  
Suggests earlier denervation in left thyroarytenoid with age  
From Takeda et al., 2000

Current uses of Laryngeal EMG is a Qualitative Examination

1. May assist in diagnosis of disorders of laryngeal movement
2. Guiding injections of botulinum toxin into laryngeal muscles
3. As a useful tool for laryngeal research
Procedures for reducing variability

- Standardize Electrodes
  - **Concentric needles** for motor unit action potential analysis will provide a uniform recording field for waveform analysis
  - **Monopolar needles** for localization of botulinum toxin injection in muscles
  - **Bipolar hooked wires** for multiple muscle recordings and/or repetitive tasks

Procedures for reducing variability

- Standardize techniques
  - A team of an otolaryngologist and an electromyographer is useful in diagnostic laryngeal electromyography
  - use a reliable set of gestures for examining muscle recruitment e.g. counting, sniff

Procedures for reducing variability

- A basic exam should include:
  - TA/ LCA complex bilateral (RLN)
  - Cricothyroid bilateral (SLN)
  - Additional muscles as clinically indicated
- The examination should include
  - Adequate sampling of insertional activity
  - Spontaneous activity different norms for laryngeal muscles
  - Recruitment including numbers of units, amplitude and firing rates at prescribed gestures
  - MUAPs peak to peak amplitudes and durations

Procedures for reducing variability

- When evaluating for neuropathy
  - Multiple criteria must be used and abnormalities must be concordant across several aspects
  - Multiple samples in 2 or 3 different locations per muscle are needed to evaluate recruitment, spontaneous activity and fibrillation potentials
A Report should include:

- The reason for the study
- Procedures performed
  - anesthetic agents, electrodes, muscles sampled, adequacy of examination
- Data Tables with normative values if available
- Findings
- Interpretation
- Clinical Comments

Future Directions for Laryngeal Electromyography

- Need to verify techniques for electrode placement (visual vs physiologic)
- Quantify inter-rater and intra-rater reliability for qualitative and quantitative
- Measurement parameters
  - MUAP amplitude and duration
  - Serial EMGs for prediction of recovery
  - Set tasks to identify and measure synkinesis

Future Directions for Laryngeal Electromyography

- Future work should lead to quantitative testing
- Prospective blinded studies are needed to determine the clinical utility of laryngeal EMG for prediction of outcome
- Need to correlate of electro-diagnostic findings with voice and upper airway functions