

THE VISIBLE VOICE

**A Newsletter for Physicians, Speech-Language Pathologists,
Professional Voice Users, and People with Voice Disorders**

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LARYNGEAL ELECTROMYOGRAPHY

Laryngeal electromyography (LEMG, EMG) provides essential clinical information about the neuromuscular status of the larynx that no other test can provide for patients with presumed neuromuscular disorders of the larynx. The state of the art of clinical LEMG has evolved at a faster pace than the otolaryngologic literature, such that many clinicians still underuse LEMG. The most important clinical applications of LEMG are:

- 1) Diagnosis and prognosis for vocal fold paresis
- 2) Prognosis and site-of-lesion testing for vocal fold paralysis
- 3) Differentiation of vocal fold fixation from paralysis
- 4) Diagnosis of neurological diseases and laryngeal movement disorders

LEMG is also important for muscle localization for therapeutic Botulinum toxin injections for spasmodic dysphonia and cricopharyngeal achalasia.

LEMG can be performed in the office setting without any anesthesia and it is well-tolerated by the vast majority of patients. The author has been performing LEMG on a daily basis since 1987 without a single complication to date. Jamie Koufman MD, Editor (jamie@voiceinstituteny.com)



CLINICAL LARYNGEAL ELECTROMYOGRAPHY (LEMG)

Jamie A. Koufman, MD

Technique of LEMG

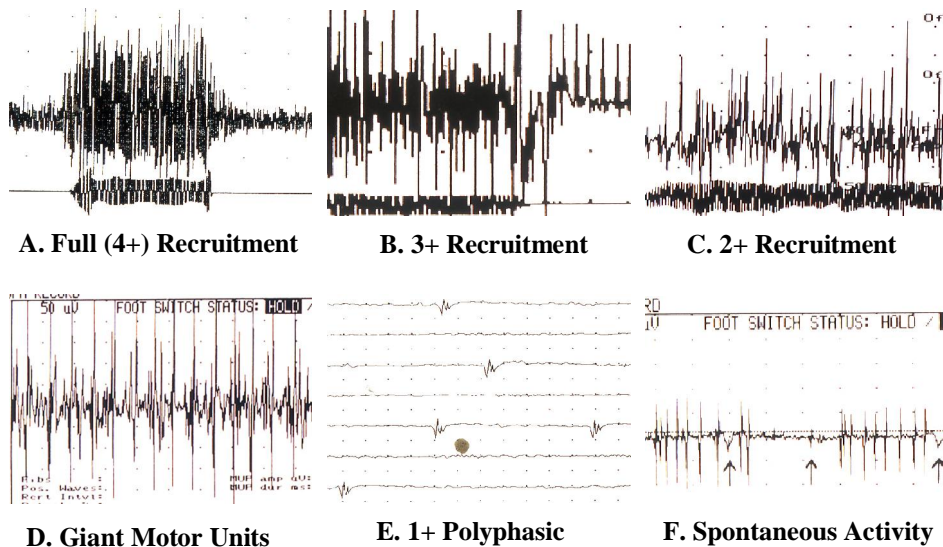
Many different methods and types of equipment are available, but I recommend a Nicolet Viking Electromyograph (Nicolet Biomedical) and disposable *monopolar needle electrodes*. Voice recordings are made with an *accelerometer* taped over the skin of the neck in the submandibular triangle. The right and left cricothyroid and thyroarytenoid muscles are routinely tested; thus testing the *superior laryngeal nerves* (SLN) and the *recurrent laryngeal nerves* (RLN) bilaterally.

In EMG, recruitment is defined as the successive activation of the same and additional motor units with increasing strength of voluntary muscle contraction. Recruitment describes overall neural health or disease. Normally, many different *motor unit potentials* (MUPs) fire during maximal activation; however, this number is reduced in patients with a loss of nerve fibers. Recruitment from 0-4+ as follows:

- 0+ No (zero) MUPs,
- 1+ 1-2 MUPs
- 2+ 3-5 MUPs
- 3+ Nearly full recruitment, but a diminished number of MUPs
- 4+ Full recruitment; individual MUPs are not identifiable; see below

For the experienced electromyographer, the auditory features of the EMG recording are often more informative than the oscilloscopic record. With 4+ recruitment, all repeating motor units blend together in a white-noise-like cacophony, whereas with 3+ recruitment the distinctive audio-characteristics of individual MUPs can be audibly appreciated. **Figure 1A** shows full (4+) recruitment; **Figure 1B** shows 3+ recruitment; **Figure 1C** shows 2+ recruitment; and **Figure 1D&E** show 1+ recruitment. **Figure 1F** shows (0 recruitment) and *spontaneous activity*; the electrical potentials seen are not associated with phonation, i.e., they are manifestations of spontaneous activity, *fibrillations*, *positive waves* (arrows), and *myokymia* (group *fasciculations*).

LEMG: GRADING OF RECRUITMENT



Interpretation of LEMG Findings

LEMG interpretation requires assessment of four parameters: (1) recruitment; (2) wave form morphology of MUPs; (3) presence or absence of spontaneous activity; and (4) presence or absence of *synkinesis*. The possible combination of LEMG findings is limited in number, and interpretation is usually unambiguous.

The waveform morphology of the MUPs has prognostic significance. The finding of long-duration, low-amplitude, tiny *polyphasic* motor units, sometimes called *nascent units*, implies ongoing regeneration. On the other hand, large-amplitude motor units imply a more long-standing neurogenic process. As time passes, the nascent sprouts become fully *myelinated* and the muscle fibers rebulk, leading to consolidated and larger MUPs than before the injury. Large-amplitude motor units imply an old, chronic neuropathy.

The presence of spontaneous activity, fibrillations, positive waves, myokymia, and *complex repetitive discharges* (CRDs) implies ongoing muscle degeneration. The finding of spontaneous activity implies that the disease process or event that caused the neuropathy is currently active or relatively recent (on the order of weeks to months). Spontaneous activity is usually seen in progressive disease, such as tumor infiltration of a laryngeal nerve. In the case of prior neural trauma or injury, spontaneous activity may imply only that denervation has occurred, and that partial or complete recovery may or may not subsequently occur.

In general, spontaneous activity with reduced recruitment after an insult to a nerve has occurred is not a good prognostic feature. In our experience, if it is accompanied by “0 recruitment,” no MUPs whatsoever, the prognosis for subsequent neural recovery is usually poor.

LEMG interpretation is based upon recruitment, waveform morphology, and spontaneous activity. These variables offer five interpretations:

Class I (normal recruitment, morphology, and no spontaneous activity), normal EMG; vocal fold hypomobility in the face of this finding implies that vocal fold fixation is the likely etiology.

Class II (decreased recruitment with low-amplitude polyphasic (nascent) MUPs and no spontaneous activity) indicates a relatively recent injury. Nascent motor units indicate ongoing reinnervation. Although the prognosis with this pattern is relatively favorable, the finding of a Class II LEMG does not insure that full functional recovery will occur. Because the patient may make a full recovery, the clinician should consider delaying surgical treatment. With the passage of time, LEMG may portend a different prognosis, either better or worse than the initial LEMG.

Class III (decreased recruitment with large MUPs and no spontaneous activity) indicates a chronic injury, i.e., very large motor units indicate that an old injury that has finished regenerating and further neural recovery is not expected.

Class IV (decreased recruitment with polyphasic MUPs and spontaneous activity) indicates both ongoing denervation and reinnervation (recovery). This is an equivocal LEMG. With a Class IV LEMG, the clinician does not know if the neuropathy is getting better or worse. Class IV LEMG is sometimes seen with degenerative neurological diseases, e.g., amyotrophic lateral sclerosis.

Class V (spontaneous activity without any MUPs) indicates denervation. We almost never see complete recovery of vocal fold movement in a patient with who presents with a Class V LEMG. Part of the explanation for the poor prognosis is that aberrant regeneration occurs during healing, so that synkinesis results.

Table: Interpretation and Classification of LEMG Findings

Class	Spontaneous activity	Recruitment of motor units	Individual motor unit morphology	Interpretation (prognosis)
I	Absent	Normal	Normal MUPs	Normal
II	Absent	Reduced	Small Polyphasic MUPs	Reinnervation
III	Absent	Reduced	Very large MUPs	Old injury
IV	Present	Reduced	Polyphasic MUPs	Equivocal
V	Present	Absent	Fibrillations, etc.	Denervation

In conclusion, LEMG is an important diagnostic test for evaluation of neuromuscular disorders, particularly vocal fold paresis and paralysis. The technique isn't difficult, and interpretation requires assessment of recruitment, waveform morphology, spontaneous activity, and synkinesis. LEMG aids in decision-making with regard to the subsequent radiographic evaluation of patients with vocal fold paresis and paralysis of unknown cause, and it may influence the timing and type of surgical intervention.

CASE OF THE MONTH – (RIGHT VOCAL FOLD) WHAT IS IT?



- A. Rheumatoid nodule
- B. Vocal prenodule
- C. Reinke's edema
- D. Mixed tumor
- E. Leukoplakia

Answer next month. [Answer for February 2008 – D. Pseudocyst]

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