Laryngeal Electromyography for Prognosis of Vocal Fold Paralysis

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Summary: Objective. This study aimed to determine the value of laryngeal electromyography in the prognosis of vocal fold paralysis.

Study Design. This is a retrospective descriptive study.

Materials and Methods. This study included 80 patients diagnosed with unilateral or bilateral vocal fold paralysis on flexible laryngoscopy between 2002 and 2014 in a tertiary medical center. Laryngeal electromyography using a standardized protocol was performed; the outcome measures were classified and analyzed into two groups according to the degree of injury. Group 1 included patients with mild to moderate injury, and group 2 included patients with severe to complete injury. Prognosis was correlated with vocal fold motion recovery status with a minimum of 6 months of follow-up since the symptoms onset using positive and negative predictive values.

Results. Sixty patients showed acute or chronic recurrent laryngeal neuropathy in laryngeal electromyography. Twelve of 41 patients included in group 1 recovered motion, and 30 of 35 patients included in group 2 did not recover, resulting in 88.2% of positive predictive value and 35.7% of negative predictive value.

Conclusions. Our data confirm that laryngeal electromyography is a useful clinical tool in predicting poor recovery in patients with vocal fold paralysis. It allows identification of candidates for early intervention.

Key Words: laryngeal electromyography–vocal fold paralysis–vocal cord paralysis–laryngeal synkinesis–electromyography.

INTRODUCTION

The impairment of laryngeal nerve function may be the result of heterogeneous conditions. According to the majority of authors, idiopathic paralysis and iatrogenic injury are the most frequent causes. Data for spontaneous recovery based on cause have been reported in some studies, but statistical analysis of prognosis from these two common causes is still lacking.[1,2]

Laryngeal electromyography (LEMG) was introduced in 1944 by Weddel, and their principles and techniques were established in the 1950s.[3] Since then, it has been used traditionally for the evaluation of vocal fold motion abnormalities and as a guide for therapeutic injections into the intrinsic muscles of the larynx. In the evaluation of vocal fold paralysis (VFP), LEMG is particularly helpful in differentiating paralysis from other causes of vocal fold immobility.[4,5]

The EMG examination is evaluated in four parts: Insertional activity is the burst of electrical signal that is produced as the needle is introduced into the muscle. The needle produces a mechanical stimulus in the muscle membrane, causing a local and transitory change of potential. Early nerve and muscle injuries produce prolonged insertional activity, whereas late nerve and muscle injuries cause a decrease in the insertional activity. The second one is the spontaneous activity, which refers to the presence of electrical activity in a resting muscle. The presence of spontaneous activity implies that the muscle has an acute/inflammatory disease or that the nerve has been injured and the process that caused the injury is ongoing. Another parameter is the waveform morphology, which refers to the shape, amplitude, and duration of the motor unit potentials (MUPs), which are the electrical signals produced by the activation of the motor unit (spinal motoneuron, motor axon, and muscle fibers) and registered by EMG. The recruitment refers to the activation of motor units during increased voluntary muscle contraction.[6,7] Synkinesis is another parameter that can be assessed by EMG: as a result of aberrant reinnervation, a voluntary contraction produces inappropriate muscular activation and MUPs are registered in several muscles not related to the desired activity.

Recruitment reduction pattern during the thyroarytenoid (TA) maximum voluntary contraction allows determination of the degree of severity of the recurrent laryngeal nerve injury.[5,6] Based on this and with the aim of answering the question most frequently asked by patients with VFP about whether laryngeal function will return to normal, we performed this study to assess the use of LEMG for the prediction of the outcome in cases of VFP.

MATERIALS AND METHODS

A retrospective descriptive study was performed, including all patients evaluated in the voice clinic (n = 80) between 2002 and 2014 with unilateral or bilateral vocal fold immobility who had a LEMG evaluation. Diagnosis of vocal fold immobility was made by videoendoscopic evaluation. Recovery of motion was defined as ≥70% of normal motion compared with the healthy side, with obvious abduction during inspiration, and an increase of ≥50% in glottis space during abduction in cases of bilateral VFP. All the examinations were recorded and revised by two different otolaryngologists. Patients with a normal LEMG were excluded from the study, as were those with less than 6 months' follow-up.

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No other people contributed to the study.

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The LEMG was performed by an otolaryngologist and a neurophysiologist at least 3 weeks after the endoscopic diagnosis (mean 8 months with a standard deviation of 2.1).

Electromyographic characteristics and record

The EMG was performed with a two-channel electromyograph (Medelec Synergy, VYASIS Healthcare, Surrey, UK). Coaxial needle electrodes are used and the acquisition parameter screens are:

- Rest: Sweep 100 ms and gain of 100 µV/division
- Voluntary contraction (MUPs and recruitment): Sweeping 300 ms and gain of 100 µV–2 mV/division

Our protocol for LEMG has been described previously by García-López et al.[5] The cricothyroid and thyroarytenoid (TA) muscles were both approached transcutaneously without local anesthesia. Only the recurrent laryngeal nerve function obtained from the TA muscle activity was used to determine prognosis of vocal fold palsy.

The four categories of LEMG parameters registered were spontaneous activity, morphologic characteristics of MUPs, recruitment pattern, and presence of synkinesis. First, we asked the patient to breathe easy to see if there was any spontaneous activity at rest such as fibrillation potentials or positive sharp waves to determine if there was an acute (presence of spontaneous activity) or chronic injury. After this, we recorded the morphologic characteristics of MUPs and the motor unit recruitment by asking the patient to phonate the vowel /i/ with unit reach maximum voluntary contraction. Finally, we asked the patient to do a sniff maneuver to detect the presence of synkinesis defined by the presence of MUPs during respiration. The evaluation of the degree of the injury was made by the neurophysiologist as follows:

- Rich mixed pattern: mild axonal injury
- Poor mixed pattern: moderate axonal injury
- Simple pattern: severe axonal injury
- Absence of voluntary activation: very severe axonal injury (apparently complete).

For the purpose of analysis, we classified patients according to the degree of injury into high-grade injury (severe and complete) and low-grade injury (mild and moderate).

Statistical analysis

The outcome measurements of vocal fold motion were dichotomized into persistent VFP or recovered vocal fold mobility. Recovery was defined as return of appropriate gross motion of the paralyzed vocal fold on subsequent laryngoscopy and revised by two different laryngologists separately.

A multivariate logistic regression analysis was used to test the statistical significance of association between recovered vocal fold motion with different variables included. The positive predictive value (PPV) was calculated by dividing the number of patients who had positive results and disease outcome by the total number of patients with positive results. This quotient determines the percentage of patients with positive test results (poor prognosis) who actually had a persistent VFP. The negative predictive value (NPV) was calculated by dividing the number of patients who had a negative test result and normal outcome by the total number of patients with a negative test result. This percentage determines the amount of patients with negative test results (good prognosis) who actually recovered vocal fold motion.

TABLE 1.
Etiology of Vocal Fold Immobility

Etiology	N (%)
Iatrogenic	36 (60%)
Idiopathic	13 (21%)
Tumor in the thoracic cavity	4 (6.6%)
Skull base lesion	3 (1.8%)
Trauma	3 (1.8%)
CREST syndrome (X cranial nerve mononeuritis)	1 (1.65)

RESULTS

Twenty patients were excluded for statistical analysis because they did not fulfill the inclusion criteria: those who recovered mobility before doing the LEMG (10 patients), patients with normal LEMG (six patients), and lost to follow-up (four patients).

Of the remaining 60 patients, 36 (60%) were women. The average age was 59 years (18–83 years). The videoendoscopic diagnosis was 13 patients with right vocal fold immobility, 33 (55%) with left vocal fold immobility, and 14 with bilateral vocal fold immobility. Regarding the etiology, 36 cases (60%) were iatrogenic and 13 (21%) were idiopathic. Other causes are summarized in Table 1.

Complete recovery of vocal fold motion was achieved in 18 (23.6%) of 76 vocal folds, whereas 58 vocal folds (76.3%) remained immobile. The timing of vocal fold motion recovery after the onset of the paralysis ranged from 2 to 12 months, with a median of 5 months.

The multivariate logistic regression analysis did not show statistical significance in the association between recovering vocal fold motion and any of the studied variables (Table 2).

TABLE 2.
Multivariate Logistic Regression Analysis

Recovery Motion	Odds Ratio	$P > \|z\|$	[95% Conf. Interval]
Sex	0.5	0.368	0.16–1.95
Age	0.9	0.670	0.94–1.03
Etiology	0.7	0.587	0.27–2.07
Side	0.5	0.362	0.19–1.82
Severity lesion degree RRLN	0.9	0.801	0.57–1.52
Severity lesion degree LRLN	1.1	0.667	0.66–1.87
Synkinesis	1.1	0.847	0.27–4.74

Abbreviations: LRLN, left recurrent laryngeal nerve; RRLN, right recurrent laryngeal nerve.