Role of Laryngeal Electromyography in Predicting Recovery After Vocal Fold Paralysis

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Abstract Accurate prognostication of the outcome of vocal fold immobility assumes great importance in the management. This study aimed to evaluate the prognostic efficacy of Laryngeal electromyography in cases of vocal fold immobility. A nonrandomized prospective study was carried out from Sep 2009 to Jun 2011. Patients were evaluated using Fiberoptic laryngoscopy and Laryngeal electromyography over a period of 24 weeks. 51 subjects participated in the study, comprised of 22 males and 29 females. All patients underwent detailed clinical examination including Fiberoptic laryngoscopy on the first visit and Laryngeal electromyography testing on the second visit. Subsequent neuromonitoring was carried out at 04, 12 and 24 weeks from date of initial recording. Outcome measures of vocal fold motion were dichotomized into persistent vocal fold immobility (unilateral or bilateral) or resolved vocal fold motion (normal). Approximately 24 weeks after onset of palsy, mobility of the paralyzed vocal cord was restored in 31 (60.78 %) of 51 cases, while 20 (39.22 %) remained immobile. Sensitivity of laryngeal electromyography was 92.53 % ; specificity 93.33 %, positive predictive value 98.77 % and negative predictive

value 68.29 %. This study confirmed the utility of Laryngeal electromyography in predicting prognosis for recovery of vocal fold motion after laryngeal nerve injury. The results supported the hypothesis that Laryngeal electromyography data can be used effectively to determine a prognosis for recovery of vocal fold motion.

Keywords Voice disorders · Hoarseness · Laryngeal electromyography · Vocal fold immobility

Introduction

Reduced or absent abductor or adductor movement of the true vocal folds, as observed on indirect laryngoscopy or transnasal Fiberoptic laryngeal examination, is termed as Vocal Fold Immobility (VFI). Disability ranges from hoarseness of voice to life-threatening dyspnoea. Numerous treatment options exist for patients with VFI which can drastically reduce the social and economic disability incurred by them.

Clinical evaluation of the larynx includes diagnostic procedures such as indirect and direct laryngoscopy, rigid and flexible (Fiberoptic) laryngeal endoscopy, stroboscopy or videostroboscopy for visualization of the larynx, as well as subjective perceptual assessment by various questionnaires (e.g. Voice Handicap Index) and tests such as inverse filtering, photoelectric glottography, spirometry and acoustic analysis of voice signals, to establish the cause of the voice disorder and the degree of phonatory deficit. None of these tests however help in the prognostication of vocal fold immobility.

Herein lies the role of Laryngeal electromyography (LEMG), a procedure for recording the electrophysiological phenomena occurring in the intrinsic laryngeal muscles using various types of electrodes [1–4].

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Materials and Methods

A prospective study to evaluate the prognostic value of LEMG in subjects with vocal fold immobility was carried out from Sep 2009 to Jun 2011. 51 subjects reporting with voice disorders and confirmed to have vocal fold immobility on indirect laryngoscopy (IDL) were chosen without age or gender bias.

Subjects with unilateral or bilateral vocal fold immobility reporting within 24 weeks of onset of symptoms were included in the study while those with vocal nodules or polyps, acute or chronic laryngitis, and bleeding or coagulation disorders were excluded.

Fiberoptic laryngoscopy was carried out after the initial clinical examination which included IDL to detect the pathology. A normal FOL was one in which the vocal folds were structurally and functionally normal with no phonatory gap and an adequate glottis chink. Abnormal FOL findings showed unilateral or bilateral impaired vocal fold immobility.

Initial LEMG recording was undertaken on the second visit using 37 mm concentric needle electrodes and a strap electrode over one arm for grounding. All LEMG examinations were carried out using a VikingQuest Master electrodiagnostic system (Nicolet Biomedical; Madison, WI, USA). Signals of LEMG were monitored visually and acoustically. The thyroarytenoid and cricothyroid muscles were evaluated after transligamental (Cricothyroid ligament) electrode insertion.

Subsequent FOL and LEMG testing was done at 04, 12 and 24 weeks from date of initial recording.

Results

The 51 patients tested comprised 22 males (mean age 50 years; range 24–75 years) and 29 females (mean age 46 years; range 22–70 years)—Table 1.

Data regarding cause of vocal fold immobility showed that iatrogenic trauma, especially surgery involving the thyroid and neck, contributed the most to the overall number, followed by idiopathic lesions—Table 2.

All 51 subjects displayed vocal fold dysfunction in the form of impaired mobility on FOL during the first visit (Table 3). However, 49 subjects had normal LEMG recordings in spite of vocal fold immobility (Table 4). While one patient was subsequently confirmed to have cricoarytenoid joint fixation, the other recovered full vocal fold functionality within 12 weeks of onset of symptoms.

Signs of recovery on LEMG preceded clinical signs of recovery in all 20 patients who had a favourable outcome. (Fig. 1).

Table 1 Age and gender wise distribution of subjects

Age (Years)	Gender		Total (%)
	Male (%)	Female (%)	
0–15	0	0	0
16–30	3.9	17.7	21.6
31–45	0	23.5	23.5
46–60	25.5	13.7	39.2
61–75	13.7	2	15.7
Total	43.1	56.9	100

Table 2 Causes of vocal fold im-mobility

Etiology	No of cases	Percentage (<i>n</i> = 50)
Iatrogenic trauma	20	39.2
Endotracheal intubation	08	15.7
Blunt trauma	03	5.9
Idiopathic	16	31.4
Malignancy	04	7.8

Table 3 Cases with vocal fold dysfunction on FOL [*N* = 204 (4 visits × 51 subjects)]

Vocal fold dysfunction	Visit 1	Visit 2	Visit 3	Visit 4	Total
Present	51	50	41	32	174
Absent	0	01	10	19	30

Table 4 Cases with vocal fold dysfunction on LEMG testing [*N* = 204]

Vocal fold dysfunction	Visit 1	Visit 2	Visit 3	Visit 4	Total
Present	49	47	39	29	164
Absent	02	04	12	22	40

Signs of persistent dysfunction too were predicted reliably in LEMG recordings. However, LEMG accuracy was better in predicting a positive test result with a fair or poor prognosis (persistent vocal fold immobility = 98.77 %) than in predicting a negative test result with excellent prognosis (resolved motion = 68.3 %) [5–7].

The results of the study indicated that electrophysiological changes could be detected in dysfunctional laryngeal muscles as early as 1 week after injury [8]. Initial patterns of indeterminate reinnervation/denervation (ongoing reinnervation and denervation) persisted for a period less than 12 weeks from onset of symptoms and usually followed the path of either recovery or complete palsy thereafter [9, 10].

Fig. 1 Recovery in cases of vocal cord palsy measured by Laryngeal electromyography and Fiberoptic laryngoscopy

Earliest appearance of normal potentials induced by regeneration was at ~80 days, which was consistent with earlier studies, a finding which has lead to the postulation that surgical intervention should be postponed until at least 80 days after the onset of paralysis [11].

Approximately 24 weeks after onset of palsy, mobility of the paralyzed vocal cord was restored in 31 (60.78 %) of 51 cases, while 20 (39.22 %) remained immobile.

Kappa co-efficient was 0.75 and accuracy was 0.93. Sensitivity of the test was 92.53 % while specificity was 93.33 %. Positive predictive value of LEMG was 98.77 % while negative predictive value was 68.29 %.

Discussion

Data from the LEMG study can be useful in diagnosing and managing laryngeal disorders. If patients have a good LEMG prognosis in the presence of significant vocal dysfunction, temporary measures such as gelfoam or botox injections or voice therapy can be instituted. If the prognosis is poor, more definitive permanent surgery can be done sooner to help the patient speak and swallow.

Koufman et al [3] published a large retrospective series showing that LEMG data altered the diagnostic imaging evaluation in 11 % of patients but no imaging modality was shown to be definitely superior to the other (magnetic resonance imaging (MRI) versus computed tomography (CT)). They also reported that LEMG changed the timing and/or type of surgical procedure in 63 %. Of these, 12 % were useful in differentiating paralysis from fixation, although the criteria were not provided and the change in patient care was not detailed.

This study confirmed the utility of LEMG in predicting prognosis for recovery of vocal fold motion after laryngeal nerve injury. The results supported the hypothesis that LEMG data can be used effectively to determine a prognosis for recovery of vocal fold motion [4, 5, 8, 9]. The

prognosis derived from LEMG predicted 68.3 % of patients who had resolved vocal fold movement.

The importance of the prognostic value of LEMG will finally be decided on application of this data to actual surgical decisions for the subjects involved in the study and on evaluation of whether such LEMG-guided surgical outcomes are superior to other management approaches for vocal fold paralysis.

In conclusion, in patients with vocal fold palsy, the detection of well-defined signs of neural degeneration on LEMG allows for the prediction of poor functional outcome with a high degree of reliability in an early phase of the disease process.

The earliest appearance of normal potentials induced by regenerated axons occurs ~80 days following onset of denervation. Surgical intervention should, therefore, be postponed until at least 80 days after onset of paralysis.

In the presence of signs of neural degeneration detected by LEMG, the decision for definitive surgical interventions such as thyroplasty or vocal fold augmentation in unilateral or partial cordectomy in bilateral vocal fold paralysis can be made safely in an earlier stage of the disease process. Thus, LEMG can help to significantly shorten the process of voice rehabilitation.

If LEMG shows some signs such as polyphasic potentials within 6 months, which suggest a potential reinnervation, there is no requirement of a laryngeal nerve anastomosis right away.

It should be noted however, that absence of degenerative alterations in LEMG does not necessarily indicate recovery to a normal or near-normal functional level. To confirm a diagnosis, LEMG information must be integrated with results of clinical features and other laryngeal tests.

In conclusion, LEMG is a valuable tool in the workup of patients with vocal fold palsy. Using LEMG, the laryngologist can make more rational decisions regarding the type and timing of phonosurgery in patients with laryngeal paralysis.

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