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A KINESIOLOGICAL ASPECT OF MYASTHENIA GRAVIS — AN ELECTROMYOGRAPHIC STUDY OF VELAR MOVEMENTS DURING SPEECH —

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1. Introduction

We have previously reported on certain dynamic aspects of velar movements during speech, examining normal Japanese speakers by means of direct observation of the velum through a fiberscope and electromyography obtained from the levator palatini muscle (Sawashima and Ushijima, 1971; Ushijima and Sawashima, 1972; Ushijima and Hirose, 1974). Through our previous studies, the EMG processing system has been proven to be adequate for quantitative evaluation of muscle contraction and thus useful for kinesiological analysis of the speech organs. Our attempts were, then, directed to application of our EMG data system for various pathological conditions of the speech muscles.

In the present study, we deal with the results obtained from one patient of Myasthenia Gravis,[1)] with special reference to easy fatigability of the velum during speech.

2. Procedure

1) Patient

The patient was a 22 year-old female student. In June 1970 she first noted slight awkwardness of articulation during conversation. One month later voluntary tongue movements were slightly disturbed and hypernasality became manifest especially in the evening. She had occasional difficulty touching her molae with the tip of the tongue. In addition, she suffered

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1) Myasthenia Gravis, a disease of the muscular system, is physiopathologically due to abnormal metabolism of the chemical transmitter (Acetylcholine) between peripheral nerve endings and endplates of muscle fibers. The characteristic symptom of the disease is easy fatigability, mostly accompanied by progressive paralysis of muscles without sensory disturbances. It may affect any muscle of the body. According to the affected area it is classified into ocular, bulbar, limb, and general types. Some patients actually visit ENT doctors or speech pathologists first, when the disease begins with symptoms similar to those observed in bulbar palsy, e.g., rhinolalia, dysarthria, dysphonia, and dysphagia. Electromyography as well as a Tensilon test is the most useful for diagnosis of Myasthenia Gravis. Diagnosis is nearly established by detecting the phenomenon of waning and waxing on EMG during repetitive and supramaximal electrical stimulation to the nerve which innervates the examined muscle.

from nasal leakage of liquid food on swallowing. Misdeglutition occasionally occurred with passage failure of solid food.

In October 1970 when she first visited our clinic,[2] no muscle weakness was detected in the limb or the shoulder girdle. Although her vision was intact, forces for eye closure seemed decreased. Velar movement was still preserved, but its excursion was insufficient even at the moment of tense articulation. Careful evaluation of her voice and speech function revealed that certain vowels were nasalized. Articulatory gestures were so weak that the consonants were generally distorted. These findings became more manifest when the patient read long sentences; her voice quality remained unchanged, however.

In November 1970, diagnosis was ascertained by neurologists through a Tensilon test, showing short-lasting improvement in the symptoms outlined above. Medication was then started including peroral administration of Anticholinesterase. Most of the symptoms are well controlled at present, although the effect of the medication does not always last throughout the day.

2) Speech Materials

EMG was recorded in April 1976 at our institute. Two kinds of lists were prepared (Table 1). For List 1, the patient first uttered at various speaking rates, approximately 30 repetitions of a nonsense syllable sequence /teN/ continously within one breath. The sequence was composed of high-velum consonant /t/, vowel /e/, and syllable-final nasal /N/. The patient was next requested to read the randomized List 2 of 14 utterance types, 10 times for each at a conversational rate. Test words of List 2 were meaningful disyllabic words which contained various combinations of /t/, /e/, /N/, and syllable-initial nasal /n/.

3) Electrode Insertion and Data Reduction

The levator palatini muscle was selected as a representative muscle for velar elevation during speech. Conventional hooked-wire bipolar electrodes were inserted through a curved hypodermal needle perorally into the dimple of the velum (Hirose, 1971). Verification of electrode positioning was done by monitoring increased EMG activity for the production of continuous /ʃ/ and suppressed activity for breathing through the nose, on an oscilloscope screen.

The method of computer processing was essentially the same as reported elsewhere (Benguerel et al., 1975), with some modificaion in sampling rate [3] and display program. [4]

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2) The clinic for voice and speech disorders, part of ENT clinic, Tokyo University Hospital.

3) The EMG signals were A-D converted in 9 bit numbers at a sampling frequency of 10 kHz.

4) Summed data were displayed by a simple moving average method.

TABLE 1

List 1: nonsense syllable sequence

repetition of /teN/ at a

1) slow, constant rate
2) intermediate, constant rate
3) rapid, constant rate
4) gradually accelerated rate

List 2: meaningful disyllabic words

1) /tee'ee/	郵影	8) /'ee'ee/	営営
2) /teetee/	亭亭	9) /'ee'eN/	永遠
3) /tee'eN/	庭園	10) /teenee/	丁寧
4) /teN'ee/	点影	11) /teeneN/	定年
5) /teNtee/	天帝	12) /neNneN/	年年
6) /teNteN/	点点	13) /'eN'ee/	遠泳
7) /teN'eN/	展延	14) /'eN'eN/	延延

3. Results and Remarks

Figure 1 shows the results for List 1-3). In this figure three parts within one successive sequence are illustrated: 1) beginning, 2) middle, and 3) end of the utterance. No averaging was done in this particular series, i. e., the data were simply rectified, integrated, and smoothed for a single token. The vertical lines are arbitrary. Although the EMG curves show a kind of oscillatory pattern of activity with peaks for non-nasal consonant /t/'s and dips for syllable-final nasal /N/'s, two abnormal findings must be mentioned:

1) Height of peak for each /t/ gradually decreases and disappears near the very end of the utterance.

2) Suppression for /N/ likewise gradually becomes unremarkable toward the end of the utterance

Particularly, finding 1) above can be interpreted as an indication of easy fatigability of the velum during the repetitive up-and-down movements. These two findings would suggest that the rhythmical pattern of alternating excitation and suppression movements of the velum tends to decay gradually in this pathological condition.

Other characteristic findings for Myasthenia Gravis are seen in the averaged EMG curves in Figure 2. This figure includes three types of utterance, /teetee/, /teNtee/, and /tee'eN/, followed by a carrier sentence /---#desu/ (It is ---.), where # indicates a word boundary. Each type of utterance was averaged for the first three and for the last three readings out of ten in order to compare the activity near the beginning with that near the end of the experimental session. The timing of voice onset

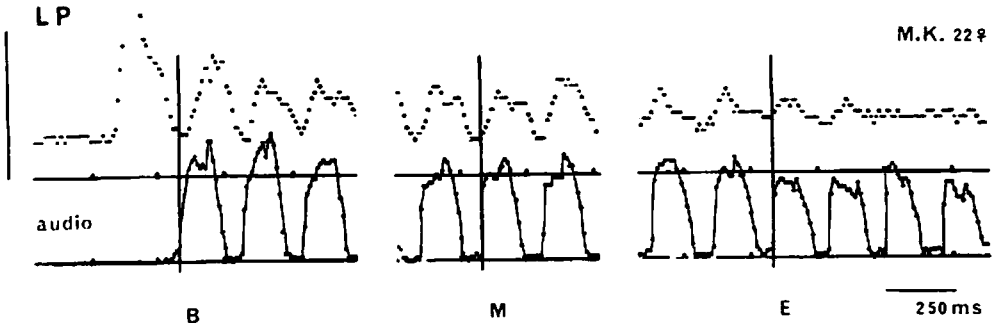

Fig. 1: Processed EMG curves for repetitions of /teN/.
B: beginning, M: middle, E: end of the utterance.
Cal: 50 μv, 440 Hz.

after the initial consonant was used as a lineup point for averaging. The same type of averaged EMG curves are presented in Figure 3[5] as a control; these were obtained from normal Japanese subjects (Ushijima and Hirose, 1975). Because of the similarity of the speech materials and of the processing system (Kewley-Port, 1973), Figures 2 and 3 must be comparable.

In the /teetee/ sample in Figure 2, there is no increased activity for the intervocalic /t/. On the other hand, there is a clear peak for the similar intervocalic high-velum consonant in normal subjects in Figure 3. If we assume that the change in EMG activity is proportional to that in displacement (Bell-Berti and Hirose, 1972), the velum does not seem to elevate higher for the intervocalic /t/, but rather stays as high as for the interconsonantal /ee/ in this pathological case.

Even for the /t/ following /N/, the curve does not show a greater peak than for the initial /t/ in /teNtee/, as shown in the middle of Figure 2. In the normal subjects, the peak value for the second /s/ in /seNsee/ is far greater than the initial, because the velar displacement is greatest in the context where the velum must elevate from the rest position to the highest position for complete velopharyngeal closure.

Figure 2 also indicates that the velum seems as a whole to become lower in the last three readings than in the first three.

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5) This figure is based on EMG data taken at Haskins Laboratories, New Haven, Connecticut, USA with the support of Grant No. DE-01774 NIDR, NIH.

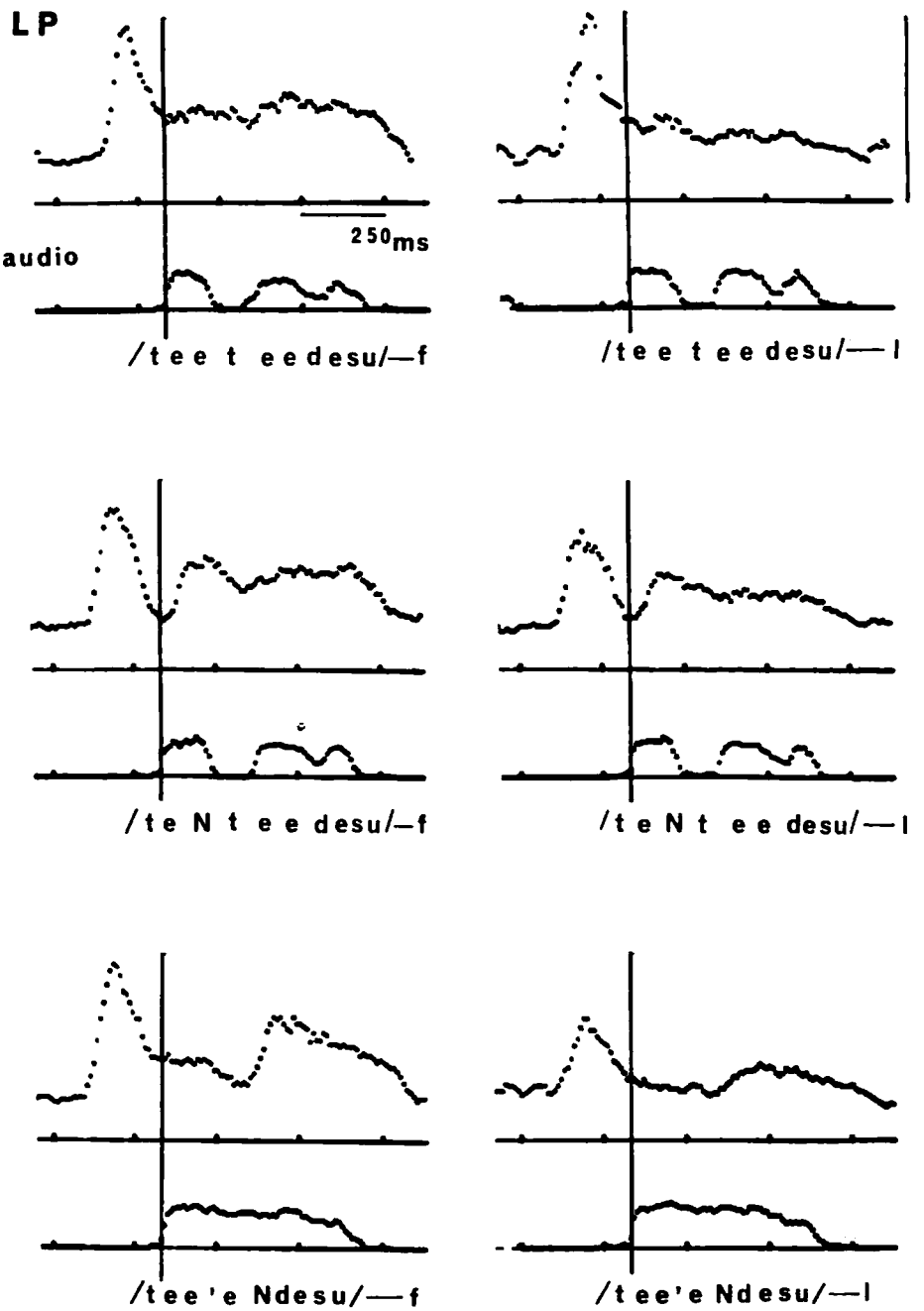

Fig. 2: Averaged EMG curves of LP from M. K. for /teeteedesu/ /teNteedesu/, and /tee'eNdesu/. f: first three readings, l: last three readings. Cal: 50 μv, 440 Hz.

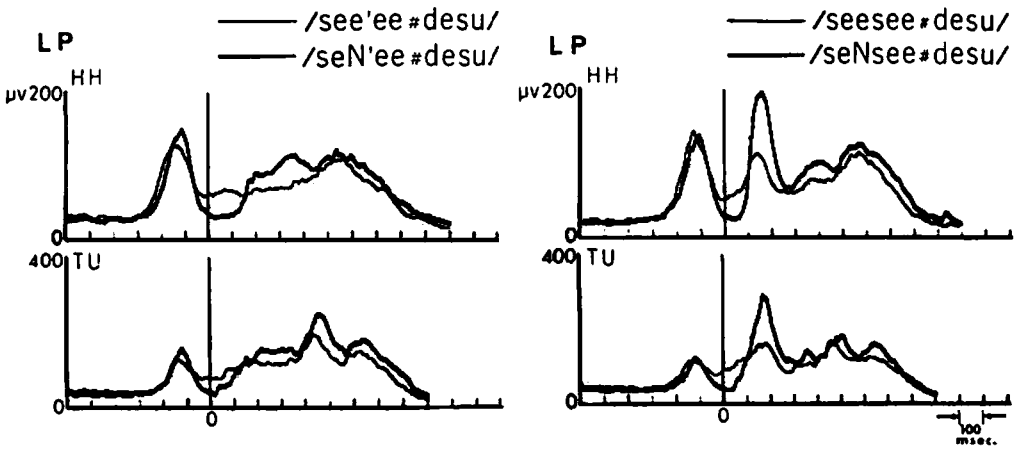

Fig. 3: Averaged EMG curves of LP from normal subjects for /see'ee desu/, /seN'eedesu/, /seeseedesu/, and /seNseedesu/.

A comparison of the averaged levator activity between two conditions, viz., the first three and the last three readings, is given in Figure 4. This figure illustrates the value of the averaged EMG activity for each consonant or vowel classified according to its context. The peak values for /t/, /d/, and /e/ as well as the dip values for /n/, /N/, and /Nn/ are plotted and connected with solid lines for the samples belonging to the same utterance type. The left end of the line corresponds to the value for the first three readings, the right, to the value for the last three.

It is revealed in Figure 4 that:

1) There is no appreciable difference in the degree of suppression of velar activity for nasal sounds.

2) For /t/, /d/, and /e/, there is a tendency of suppression of levator activity for the last three readings compared with the first three.

In the present study, easy fatigability of the velum due to Myasthenia Gravis appeared to be proven in terms of gradually decreasing EMG values for non-nasal sounds and the vowel /e/. However, it was also noted that suppression of levator activity for nasal sounds appeared to be manifested in specific tasks, such as rapid repetition of a monosyllabic word. The nature of the incomplete suppression cannot simply be related to easy fatigability; alternative explanations are still unclear, however.

It should also be remembered that the present study deals with only one speech organ, the velum, in Myasthenia Gravis. With regard to the distortion of consonantal articulation, involvement of the tongue must be taken into consideration, and, therefore, velar control cannot always be independent of the pathological condition of the other speech organs. Rather, the patterns of velar movement must be taken as a part of reorganization of

entire speech activity in this pathological condition. Further study is needed for better understanding of pathological kinesiology of neuromuscular disorders.

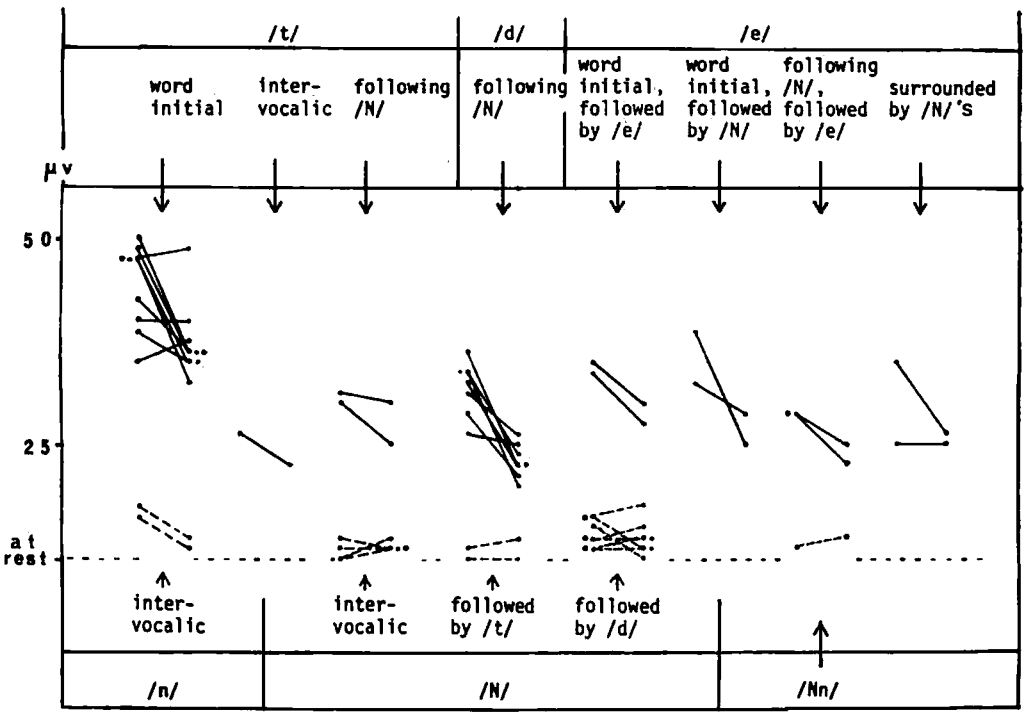

Fig. 4: Comparison of the averaged EMG values of LP from M. K. for the first three and for the last three readings.

4. Conclusion

1) Easy fatigability of the velum in Myasthenia Gravis was tested electromyographically.

2) EMG data were collected from the levator palatini muscle and computer processed. Evidences of easy fatigability were shown in terms of decreasing activity of the muscle.

3) Further investigation should be extended to other speech organs, with simultaneous recording of EMG and organ movements, for better understanding of the mechanism of pathological speech.

References

Bell-Berti, F. and H. Hirose (1972), "Velar Activity in Voicing Distinctions: A Simultaneous Fiberoptic and Electromyographic Study," Status Report on Speech Research (Haskins Laboratories) SR-31/32 (pp. 223-229).

Benguerel, A-P., H. Hirose, M. Sawashima and T. Ushijima (1975), "Electromyographic Study of the Velum in French," Ann. Bull. RILP No. 9 (pp. 79-89).

Hirose, H. (1971), "Electromyography of the Articulatory Muscles; Current Instrumentation and Technique," Status Report on Speech Research (Haskins Laboratories) SR-25/26 (pp. 77-86).

Kewley-Port, D. (1973), "Computer Processing of EMG Signals at Haskins Laboratories," Status Report on Speech Research (Haskins Laboratories) SR-33 (pp. 173-184).

Sawashima, M. and T. Ushijima (1971), "Use of the Fiberscope in Speech Research," Ann. Bull. RILP, No. 5 (pp. 25-34).

Ushijima, T. and H. Hirose (1974), "Electromyographic Study of the Velum during Speech," Journal of Phonetics 2 (pp. 315-326).

Ushijima, T. and H. Hirose (1975), "Activity of the Levator Palatini Muscle during Speech," Japan J. Logopedics and Phoniatrics, Vol. 16, No. 3 (pp. 137-138).

Ushijima, T. and M. Sawashima (1972), "Fiberscopic Observation of Velar Movements during Speech," Ann. Bull. RILP, No. 6 (pp. 25-38).