Ann.Bull.RILP(1984)No.18, 161-167

LARYNGEAL DYNAMICS IN DYSARTHRIC SPEECH*

Hajime Hirose, Kiyoshi Honda, Masayuki Sawashima

and Hirohide Yoshioka**

Dysarthric speech is often a cardinal symptom of diseases of the central nervous system. The pattern of dysarthrias differs depending on the type of disease[1] and on the severity of the pathology, but, in most cases, both articulation and prosody aspects are affected to varying degrees.

As for the abnormality of prosody, a breakdown in the temporal pattern of speech is dominant in general, but disturbances in phonatory function related to the control of pitch and intensity of voice are also noted in certain types of dysarthrias. Further, an abnormal voice quality is often another important feature of dysarthric speech. For example, it has been documented that abnormal voice is often an initial sign of parkinsonism.[2] In the case of amyotrophic lateral sclerosis or pseudobulbar palsy, a monotonous, choked or strained voice is frequently observed. Thus, the analysis of laryngeal dynamics related to the articulatory and phonatory functions of dysarthric subjects is an important approach for the clinical evaluation of dysarthrias.

The present paper will present the preliminary results of an analysis of laryngeal maneuvers during speech production in selected cases of different types of dysarthria. For analyzing this laryngeal articulatory behavior, the technique of photoglottography was used.

Procedures

In the photoglottographic recordings, a fiberscope was inserted through a nostril of each subject. The fiberscope was attached to a video-camera and, while the glottal maneuvers were displayed on a monitor screen, the illuminating light modulated by the glottal gestures was sensed by a phototransister attached to the anterior neck on the trachea. The signals were recorded on a PCM data-recorder (Fig. 1).

Recordings were made in 2 cases of parkinsonism and 3 cases of amyotrophic lateral sclerosis (ALS). As a control, a normal

---

*Paper presented at the Annual Meeting of the Japan Broncho-esophagological Society, Osaka, November 1983. This study was supported in part by a Grant-in-Aid for Scientific Research from the Japanese Ministry of Education. (Grant No.58570708)

**Department of Otorhinolaryngology

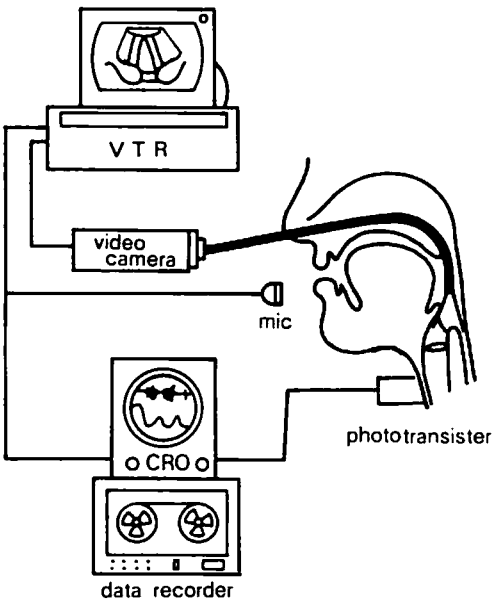


Fig. 1 Block diagram of the photoglottography procedure with video-image monitoring.

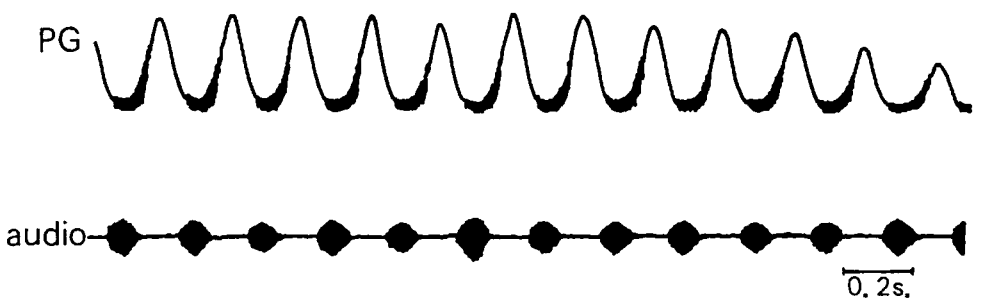


Fig. 2 Photoglottogram obtained from a normal subject for repetitions of the monosyllable /se/ displayed as timefunctions.

speaker also served as a subject. The subjects were required to repeat the Japanese monosyllables /se/ and /he/ as quickly and as regularly as possible. In addition, different types of Japanese meaningful words embedded in a carrier phrase were also recorded.

Separate from the glottographic recordings, electromyographic signals were recorded from the thyroarytenoid muscleduring sustained phonation and respiration.

Results and Comments

Fig. 2 shows a photoglottogram obtained from the normal subject during repetition of the monosyllable /se/. The upward shift of the curve indicates the glottal opening gesture. It is apparent that the glottis opens and closes regularly for the rhythmical repetition of the monosyllable which consisted of a voiceless consonant and a vowel. The degree of glottal opening represented by the height of the upward shift appears to be consistent.

Fig. 3 shows another photoglottogram obtained from the same normal subject repetitively producing the monosyllable /he/. A regular rhythm of glottal opening and closing is also maintained here, although the degree of glottal opening gradually decreases towards the end of the series of repetitions.

A glottogram obtained from one of the cases with amyotrophic lateral sclerosis during repetition of the monosyllable /he/ is shown in Fig. 4. As compared to the pattern obtained from the normal subject presented above, the pattern of the repetitive gestures of the glottis quickly becomes irregular. The glottal opening also becomes smaller, and the voiceless /h/ appears to be replaced by a voiced /h/. The fifth repetition is preceded by an interval of glottal opening associated with an abrupt air intake and followed by a choking gesture associated with an outbreak of coughing (arrow).

The glottal gesture of choking followed by an outbreak of coughing is also seen in Fig. 5a which shows the ALS subject's utterance of the Japanese sentence "soreo kisee to yuu". The choking occurs at the end of the carrier portion of "soreo (that is___)" and the subsequent outbreak of coughing is indicated by an arrow. In contrast to the pattern of the normal subject (Fig. 5b), the subject did not produce a devoicing of /i/ between /k/ and /s/ in the test word.

The choking gesture seems to be the result of a tight reflex closure of the glottis, which is often seen in the case of ALS or pseudobulbar palsy as evidence of increasing spasticity.

It has often been noted that parkinsonian subjects tend to automatically repeat the same articulatory gesture, or to "stutter", during speech. Fig. 6 shows the glottogram of a parkinsonian subject during the production of the test word "kisee"

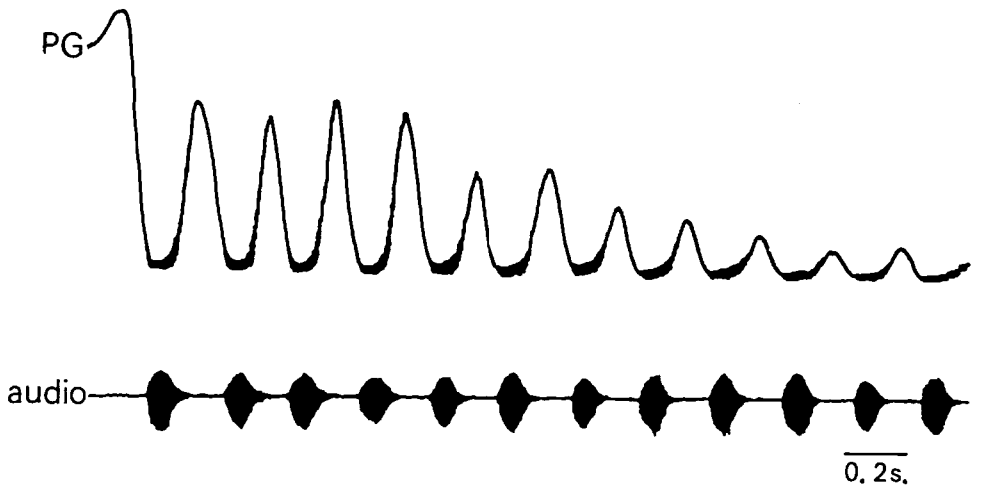


Fig. 3 Photoglottogram obtained from a normal subject for repetitions of the monosyllable /he/.

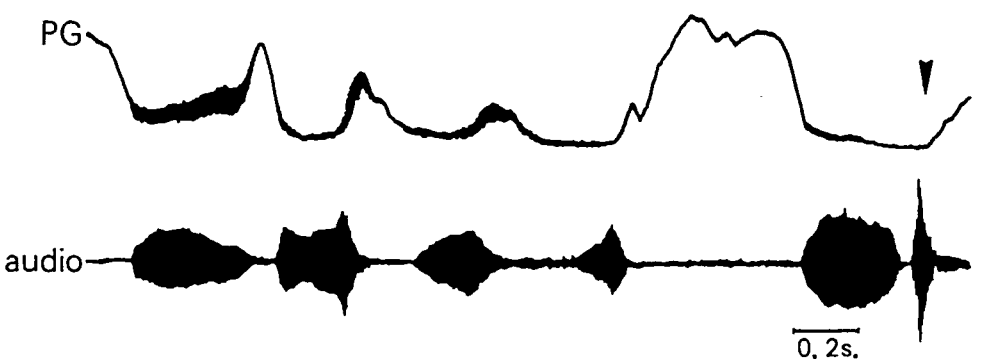
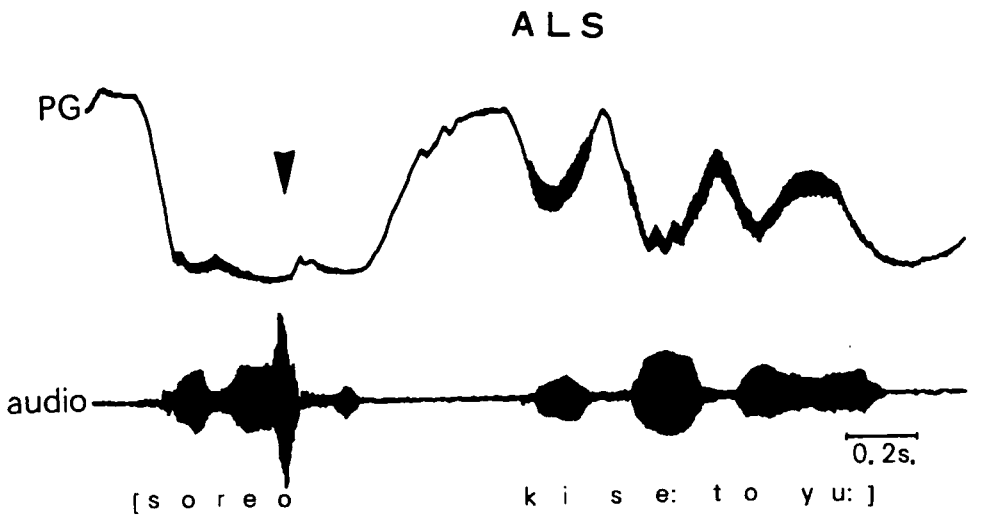
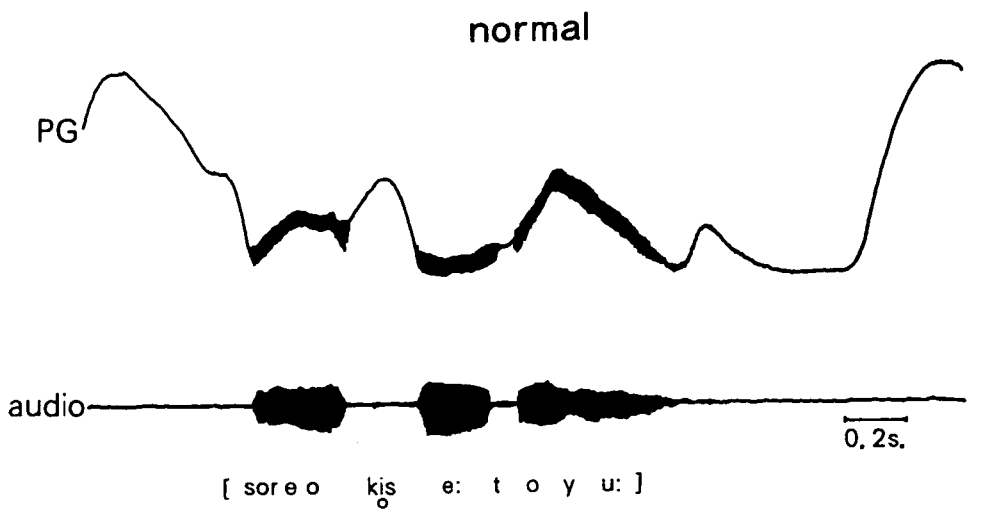


Fig. 4 Photoglottogram obtained from a subject with amyotrophic lateral sclerosis (ALS) for repetitions of the monosyllable /he/.



(a)



(b)

Fig. 5 Photoglottogram obtained from a subject with ALS (a) and a normal subject (b) for the production of the Japanese test sentence "soreo kisee to yuu"

embedded in the carrier "soreo____to yuu". The subject appears to repeat the articulatory gesture for the production of /k/, but the laryngeal gesture for the consonantal opening is not obtained. The glottis appears to be nearly closed. This pattern is quite similar to that observed in the case of stuttering.[3)]

It has been reported in the literature that parkinsonian subjects may develop laryngeal paralysis in the course of the disease.[4)] In this report, however, the diagnosis of laryngeal paralysis was simply made by observation under conventional laryngoscopy. Although it is often the case that parkinsonian subjects present very weak, breathy voice associated with apparently limited movements of the vocal folds, a definite diagnosis of paralysis can only be made electromyographically.

Fig. 7 illustrates EMG patterns for the thyroarytenoid obtained from a case of parkinsonism who showed very limited vocal fold movements under indirect laryngoscopy. The EMG was recorded during a series of alternating inspiration and phonation. It appears that the number of NMU discharges for phonation, or for the concomittant vocal fold adduction, is not reduced, and there are no pathological discharge patterns such as polyphasic or high-amplitude voltages. On the other hand, persistent firing is seen even during the period of inspiration in which thyroarytenoid activity is suppressed in normal cases. These findings would seem to indicate that there is no evidence of neurogenic paralysis in this case, but that there is a loss of the reciprocal suppression of the thyroarytenoid during inspiration.

Hypokinetic patterns in parkinsonism in terms of a reduction in the range of movements can be related to a deterioration in the reciprocal adjustment of the antagonistic muscles. the limitation of the vocal fold movement in the above case must be one example of this type of pathology. The EMG pattern of persistent discharges in the antagonistic pair of muscles must be taken as the physiological basis of parkinsonian rigidity as described by Leanderson and his colleagues[5)] who found persistent EMG discharges in functionally antagonistic pairs of facial muscles of parkinsonian subjects.

Although EMG signals were not recorded from the functionally antagonistic muscle, the posterior cricoarytenoid in this case, it seems probable that the apparent limitation in vocal fold mobility is due to a rigidity of the laryngeal muscles in parkinsonism. In the case of the muscles in the extremities, however, parkinsonian rigidity is considered to be due to an increase in the stretch reflex secondary to the hypofunction of the gamma system. Since the significance of the gamma system in the control of the muscle systems innervated by the cranial nerves is still unclear, the definitive interpretation of the EMG results obtained in the present study remains open to debate. Even so, it must be re-emphasized that the apparent limitation of vocal fold movements in parkinsonian patients should not simply be taken as a paralysis of the vocal folds.

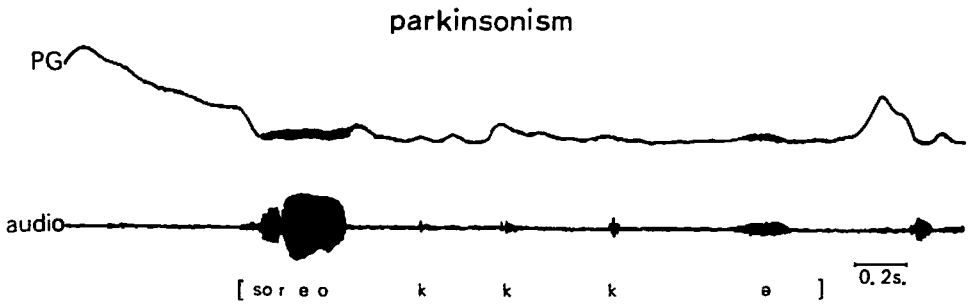


Fig. 6 Photoglottogram obtained from a subject with parkinsonism for the production of the test sentence "soreokisee to yuu".

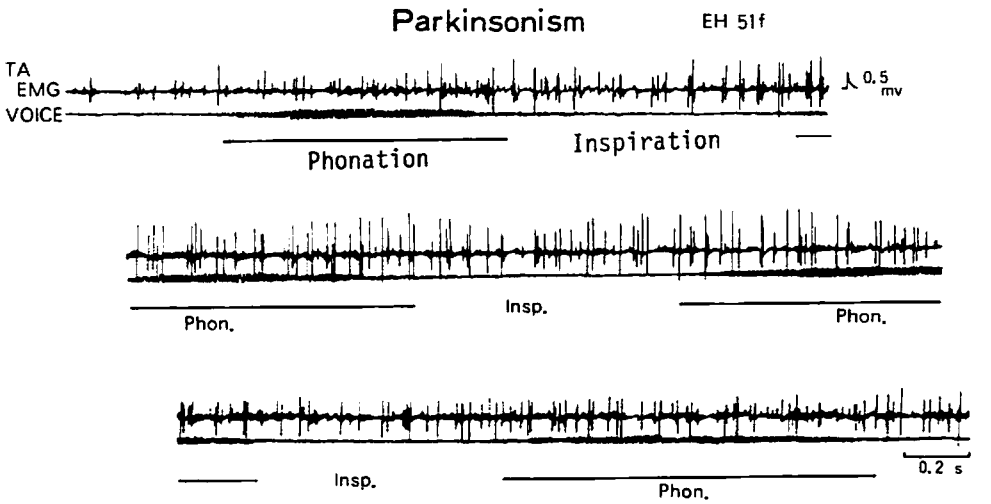


Fig. 7 EMG patterns for the thyroarytenoid obtained from a subject with parkinsonism for a series of alternating inspiration and phonation.

References

1. Darley, F.L., Aronson, A.E. and Brown, J.R. (1975); Motor Speech Disorders, Saunders, Philadelphia.
2. Logemann, J., Boshes, B and Fisher, H. (1973); The steps in the degeneration of speech and voice in parkinson's disease. In "Parkinson's Diseases", Vol. 2 (J. Siegfried, Ed.), Hans Huber, Bern, pp.101-112.
3. Yoshioka, H. and Löfqvist, A. (1981); Laryngeal involvement in stuttering - A glottographic observation using a reaction time paradigm. Folia phoniat., 33, 348-357.
4. Plasse, H,M, and Lieberman, A.N. (1981); Bilateral vocal cord paralysis in parkinson's disease. Arch. Otolaryngol., 107, 252-253.
5. Leanderson, R., Meyerson B.A. and Persson, A. (1972); Lip muscle function in Parkisonian dysarthria. Acta otolaryngol., 74, 354-357.