

Effect of L-dopa on speech in Parkinsonism¹

An EMG study of labial articulatory function

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SUMMARY The articulatory function of the labial musculature has been investigated electromyographically before and after treatment with L-dopa in patients with Parkinsonism who had dysarthria. Before medication the EMG traces generally showed a constant, abnormally increased, tonic activity, together with disturbed reciprocal innervation, which impaired the articulatory activity. After medication the tonic hyperactivity was reduced and the reciprocal innervation re-established. This normalization of the EMG articulatory pattern was paralleled by an improvement of the dysarthria.

After the initial clinical investigations (Barbeau, 1961; Birkmayer and Hornykiewicz, 1961) on the use of L-dopa in Parkinsonism, a large number of publications have described the positive effect of this substance on motor performance in patients with Parkinsonism (for example, Cotzias, Papavasiliou, and Gellene, 1969; Mawdsley, 1970; Andén, Carlsson, Kerstell, Magnusson, Olsson, Roos, Steen, Steg, Svanborg, Thieme, and Werdinius, 1970). Although dysarthria is a comparatively common and disabling symptom, there is in these reports no objective evaluation of the therapeutic effect of L-dopa on speech muscle function.

In earlier studies (Leanderson, Öhman, and Persson, 1967; Leanderson, Persson, and Öhman, 1970) it has been shown that electromyographic (EMG) recordings from the labial muscles during different vowel-consonant-vowel (VCV) combinations display a remarkably consistent and reproducible pattern with characteristics which differentiate normal and abnormal speech. Thus, EMG records obtained from patients with Parkinsonism who had dysarthria disclosed typical and abnormal articulatory features (see also Persson, Leanderson, and Öhman, 1969).

The present report deals with the effect of L-dopa in patients with Parkinson's disease on the EMG

pattern in lip musculature during articulation of labial speech sounds.

METHODS

The electromyographic activity was recorded with concentric needle electrodes from labial muscles simultaneously with the acoustic signal of different VCV utterances. The muscles chosen for study were: the lip-rounding/closing muscles orbicularis oris superior and inferior and the lip-opening/spreading muscles levator and depressor labii. These muscles normally constitute two functionally antagonistic muscle groups (for further details on the technique, see Leanderson, Persson, and Öhman, 1971). Seven Parkinsonism patients with dysarthria and displaying characteristic abnormal EMG patterns were examined. Two of the patients had previously undergone bilateral and three unilateral thalamotomy. Two patients had not been surgically treated. Those patients who had been operated unilaterally were examined on the side ipsilateral to the thalamotomy. EMG recordings were performed before and after treatment with L-dopa².

RESULTS

Six of the patients when treated with L-dopa experienced subjective improvement of their speech which was also apparent when comparing their speech recorded on tape before and after treatment. In two of the patients this improvement was paralleled by a normalization of the articulatory EMG pattern, whereas four patients showed similar,

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though less marked changes. The changes in the EMG pattern were essentially the same in the operated and non-operated patients. One patient developed perioral hyperkinesias, which rendered an evaluation of his records impossible.

The Figure shows the EMG traces from one of the non-operated patients before and after medication. Before medication there was during the entire recording period a constant, abnormally increased, tonic activity, especially in m. levator labii and m. depressor labii. As illustrated, this tonic activity is preserved during the whole utterance as a high intensity background activity in which the activity

associated with the articulatory movements can hardly be identified. The anticipation time (the latency between the onset of the muscular activity and of the corresponding acoustic segment) was generally longer than normal. This appears in the recording from m. orbicularis oris superioris, in which the activity for [y] starts about 300 msec in advance of the sound, as compared with a normal time of about 200 msec.

Furthermore, there is together with the implosion phase of [p] a simultaneous activity not only in the lip-closers, m. orbicularis oris superioris and inferioris but also in their antagonists, the lip-openers,

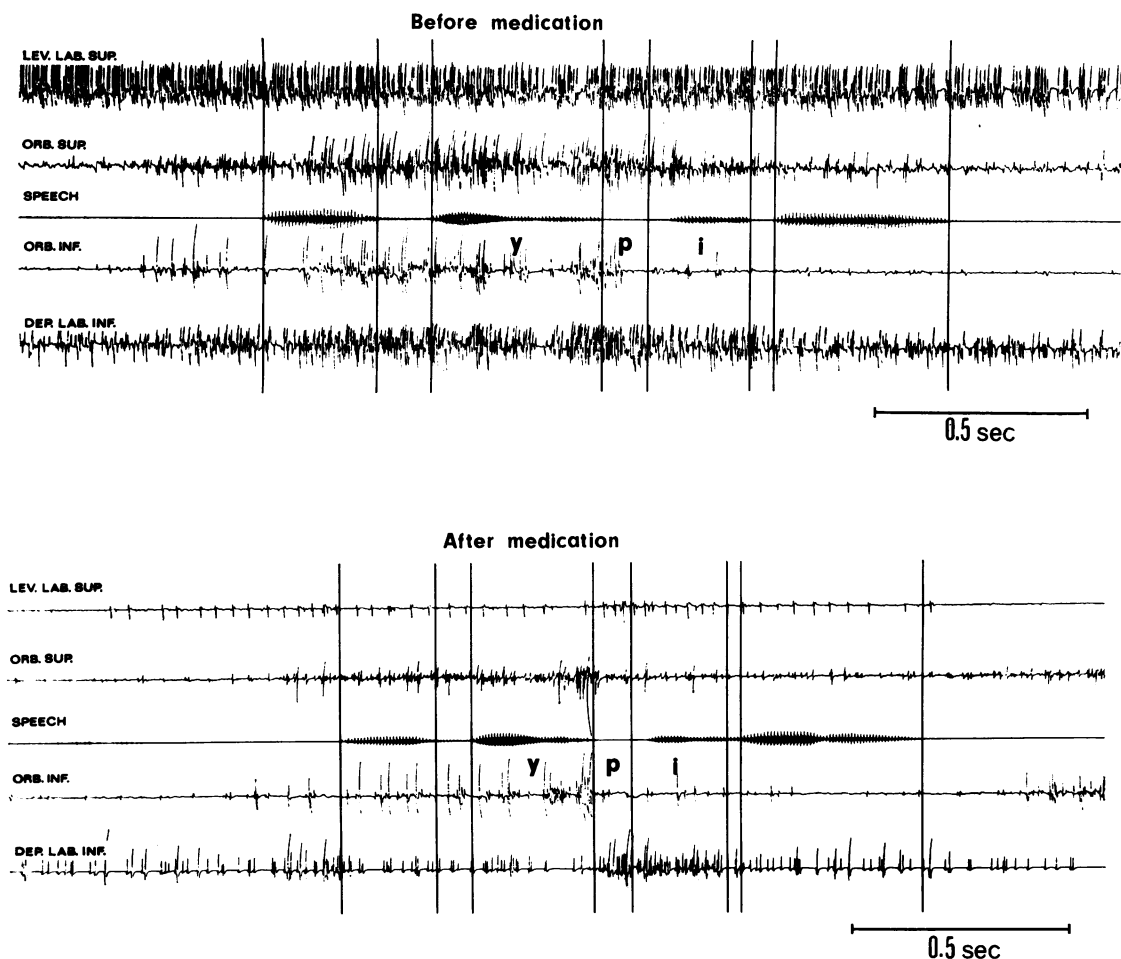


FIGURE. Polygraphic recordings of speech and EMG activity in four different labial muscles from a patient with Parkinsonism before and after L-dopa medication. The EMG and speech signals were recorded at 9.5 cm/sec, played back at 0.95 cm/sec and transcribed on an ink-writer at a paper speed of 25 Tm/sec. The acoustic segments of the utterance, a contextual frame surrounding the labial sounds [y], [p], and [i], were marked off across the whole display, permitting a comparison in time of the muscle activity in relation to speech.

m. levator and depressor labii. Thus, there was no reciprocal inhibition found in the premedication EMG patterns.

After medication (see Figure) the background muscular activity both between and during the utterances was considerably reduced, thus rendering the articulatory activity more easily discernible. The anticipation time was generally shorter than before medication. Furthermore, the duration of activity during the speech sound was clearly diminished (see, for example, the [y] segment in m. orbicularis oris superioris).

The most pertinent feature in tracings obtained from patients treated with L-dopa was the re-established reciprocal inhibition of antagonistic muscles. This can be seen in the Figure during [p] implosion when m. orbicularis oris superioris and m. orbicularis oris inferioris are activated with a corresponding decrease of activity in m. levator labii and m. depressor labii. For the following [p] release phase there is a reversed activation pattern.

DISCUSSION

In the present study it has been shown by means of EMG that dysarthria in Parkinsonism may be correlated with a constant muscular hyperactivity, seriously interfering with the articulatory activity. Furthermore, there is a disturbance in reciprocal muscular activation, manifested in a simultaneous contraction of opposing articulatory muscles. In a review of speech disturbances in Parkinsonism, Grewel (1957) concludes that the dysarthria can be attributed mainly to the rigidity and hypokinesia and to 'impairment of the subtle coordination of the speech muscles'. Thus, there is a correspondence between Grewel's general ideas and the abnormal features of the EMG pattern of the articulatory muscles.

It is a well-known fact that the neurological defect most likely to benefit from L-dopa is hypokinesia and several investigators have observed also substantial improvement of facial movement and speech (for references see Calne, 1970). In the present study it was observed that during L-dopa treatment the poor facial expression became lively and the slow and stiff articulatory lip movements faster and smoother. The slurred pronunciation, especially of the plosive consonants, improved. Electromyographically these changes corresponded to a considerable decrease in background activity upon which a normalized articulatory activity appeared more clearly. Finally, treatment with L-dopa resulted in the re-establishment of reciprocal muscular activation.

In Parkinsonism the EMG recordings from articulatory muscles obtained in the current study have many characteristics in common with those derived from large skeletal muscles (Hofer and Putnam, 1940; Schaltenbrand and Hufschmidt, 1957; Schneider, 1968). This indicates that there are similar disturbances of function of limb and articulatory muscles in this disease. Furthermore, it is known that thalamotomy may result in restitution of reciprocal innervation of skeletal muscles (Ohoye, Tsukahara, and Narabayashi, 1965). The fact that similar changes have been demonstrated after L-dopa treatment in lip muscles during articulation may be of relevance in the discussion of how this substance acts to promote normalization of motor control in general.

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