FROM CEREBELLAR DYSARTHRIA TO NORMAL SPEECH PRODUCTION

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The purpose of this paper is to consider what cerebellar dysarthria tells us about the physiological mechanisms involved in speech, from EMG patterns of 13 cerebellar patients. Results are discussed in terms of cerebellar system characteristics regulating speech activity.

1. INTRODUCTION

Careful observations of humans with lesions of the cerebellum or cerebellar pathways have demonstrated a variety of motor deficits including disorders of voluntary movements. Lesions affecting the cerebellar system result in dysarthric speech. Acoustic and X-ray analyses of ataxic dysarthria have shown that the movements of speech lack precision in direction, velocity and extent [1, 3, 4]. A few studies have described the pathological kinesiology of the articulatory organs of the cerebellar patients in EMG terms [2, 5]. We assessed the effects of cerebellar lesions on oro-motor system for a better understanding of the control mechanisms involved in speech. We studied EMG patterns associated with lip and jaw movements during speech production for 13 patients with Friedreich ataxia.

2. METHOD

9 females and 4 males with a diagnosis of Friedreich ataxia and 2 normal subjects (1 female and 1 male) participated in this study. The mean age of patients was 37.6 with a standard deviation (SD) of 12.3. Normal subjects were 25 years old.

Electromyographic signals were recorded simultaneously from 5 muscles using hooked wire electrodes. They were orbicularis oris superior (OOS), orbicularis oris inferior (OOI), mentalis (MENT), depressor labii inferior (DLI) and anterior belly of the digastric (ABD). All electrodes were placed on one side of the subject, usually the left.

The subjects were required to :
- Produce the syllable /ba/ in response to an auditory signal (10 times)
- Repeat similar monosyllabic or four-syllable nonsense utterances /ba/, /epapap ə/. Each utterance was repeated 7 times at 2 speaking rates, conversational and fast.

The amplified data signals were simultaneously recorded on magnetic tape using an 8-channel instrumentation recorder (Euromag model 5423 MP) and on paper using an 8-channel recorder (Gould model ES 1000). The audio signal from a microphone LEM was also recorded on an edge track of the tape, and on paper.

The data were processed using a laboratory computer system including a Digital Equipment Corporation PDP 11 / 34 control processor. All of the data were subjected to ensemble averaging.

3. RESULTS

3.1 Initiation of muscle activities

A delay in the initiation of muscle activities was observed. The patients always showed a much longer interval between an auditory signal and the onset of any muscular activity for the production of the /b/ in the syllable /ba/, than normals. Table 1 summarizes results for 11 patients and 2 normal subjects. Among other things, cerebellar lesions result in hypotonia [3] This appears us a probable explanation for the delay in the initiation of muscular activities.

3.2 Mean durations of muscular activities

The mean durations of muscular activities for patients with Friedreich disease always exceeded those for normals. The lengthening of muscular activities for 11 patients in comparison with normals is shown in tables 2 (for /b/) and 3 (for /a/) in the syllable /ba/ produced at a conversational speaking rate. These results suggest that the cerebellar system is involved in the control of duration parameters of vocalization.

3.3 Muscular synergia

Muscular synergia can be gauged from the performance of alternating movements. At a conversational speaking rate, muscular synergia was better preserved than at a fast speaking rate. In fact, at a conversational speaking rate, 5 of 13 patients showed a normal EMG pattern similar to that of the control subject. Fig 1 illustrates this normal EMG pattern for patient MD. It is observed the synchronization of the MENT, OOI, OOS activities associated with the closing movement of lips on the one hand, and that of the ABD, DLI activities associated with the opening movement of jaw and inferior lip on the other hand. Moreover, this pattern reveals reciprocity between activity of agonists and antagonists. The other 8

patient productions at a conversational speaking rate were abnormal (fig. 2).
Of 13 patients, only 8 could produce the 4-syllable nonsense utterance /epapapə / 7 times at a relatively fast speaking rate, the rapid alternating movements of articulatory organs presented too many difficulties for the other 5. At a fast speaking rate, no patient produced a normal EMG pattern. In other words, the cerebellar system is concerned with control of speech movements requiring coordination of synergistic muscle groups.

4.CONCLUSION

It is known that the cerebellum is responsible for the delicate and precise control of posture and locomotion [6] but our knowledge of its real role in the regulation of speech movements is still limited. Extensive studies are needed to throw light on control of the vocal tract exerted by the cerebellum at multiple levels, including coordination of orofacial, velopharyngal, laryngeal and respiratory activities in speech production.

5.REFERENCES

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Table 1 - Summary of mean reaction times : Intervals between an auditory signal and the onset of the muscular activities for eleven patients and two normal subjects. All values are in msec.

		PATIENTS										NORMALS	
SUBJECTS	MUSCLES	AM	SC	MD	XF	JM	ED	DD	NR	HB	AG	LM	MA	MP
MEAN REACTION TIMES	MENT	255	172	181	284	180	112	252	144	179	144		58	10
	OOI	550			473	212	141	307	144	327		109		29
	OOS	351	211	196	370	141		212		320		160	58	

Table 2 - Mean durations of the muscular activities for the production /b/ in the syllable /ba/. All values are in msec.

SUBJECTS	PATIENTS										NORMALS
	AM	SC	MD	CB	XF	JM	ED	DD	NR	AG	LM
MENT	334	423	484	510	554	394	280		488	363	495	240
OOS	269	533	408	550	§	353	304	360	500	§	472	152

§ Data were not available.

Table 3 - Mean durations of the muscular activities for the production /a/ in the syllable /ba/. All values are in msec.

SUBJECTS	PATIENTS										NORMALS
	AM	SC	MD	CB	XF	JM	ED	DD	NR	AG	LM
ABD		364		§		315	388	390	457	266	427	168
DLI	246	372	291	276	495	285	348	300		116	412	174

§ This muscular activity was not recorded.

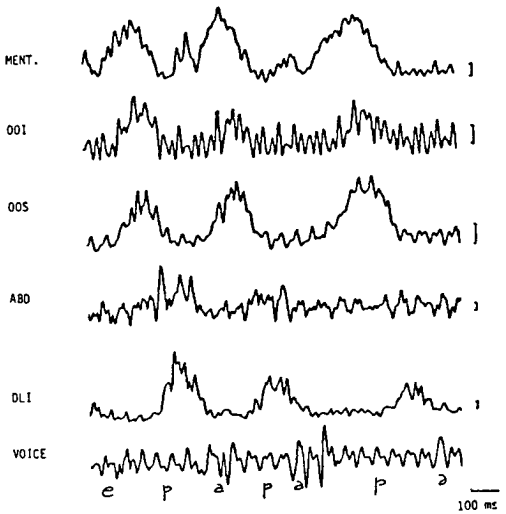

Figure **1** *Averaged integrated EMG; patient M.D. shows a normal pattern during the production /epapapa/ at a conversational speaking rate. Brackets indicate 100 μV.*

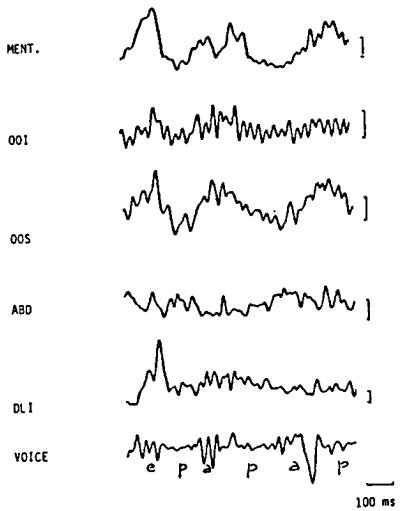

Figure **2** *Averaged integrated EMG; patient A.M. shows an abnormal pattern during the production /epapapa/ at a conversational speaking rate. Brackets indicate 100 μV.*