A damping factor in human voluntary contraction¹

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SYNOPSIS Experiments on patients with Parkinsonism showed that the damping factor was lowered, so that, a tension stimulus being without supraspinal effect, oscillation occurred.

In previous work (Hufschmidt, 1959a, 1960, 1968) and in a further publication in preparation we have demonstrated that the nature of the silent period in human muscles is an autogenetic inhibition (Granit, 1950) and is neither the effect of a spindle pause (Merton, 1951) nor an antidromic inhibition involving the Renshaw feed-back mechanism (Renshaw, 1941).

The character of this true inhibition is best seen in the masseter muscles. During voluntary contraction a direct stimulus of one masseter is followed by a silent period of 50-60 ms in both muscles (Hufschmidt and Spuler, 1962). The opposite muscle is not shortened by the stimulus but clearly gives the same inhibition. We assumed that the interneurons mediating the impulses from Golgi receptors of one muscle are centrally linked to the motoneurons of both muscles. This system is therefore very useful for double stimulation, because the second stimulus can be applied to the opposite muscle whereas the central effect of inhibition can be shown on both sites again. Applying the second stimulus to the opposite muscle has the advantage of not interfering mechanically with the contraction following the first stimulus in latencies between 10 and 100 ms.

Figure 1 shows the results in eight normal subjects. It is quite obvious that after 25 ms the silent period following the second stimulus is somewhat reduced. Between 30 and 150 ms the second silent period is shortened to half of

its original value. After 300 ms the normal value is reached again. Figure 2 demonstrates an example of an EMG record.

It seems clear that after 25 ms the first stimulus applied over a long loop, probably supraspinal, was able to damp the common interneurone pool for the second stimulus. The damping of the second silent period would prohibit further oscillation.

It was therefore of great interest to do the same experiment in patients with Parkinsonism. In previous experiments we found that the silent period in these patients was longer than in normal patients (Hufschmidt, 1959b, 1963). We assumed that the δ interneurons would be in a high state of excitation. We are now able to demonstrate that the damping factor is remarkably diminished to a value of 25 and 70 ms and is absent after 100 ms in patients with Parkinsonism (Fig. 1).

FIG. 1 Time difference between two stimuli. ★ Normal subjects. ● Parkinsonism patients.

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FIG. 2 Example of EMG record. A. Double stimuli, 70 ms separated. The silent period following the second stimulus is shortened to half of its original value. B. Silent period after the second stimulus without a previous stimulus.

We conclude that in these cases tension stimulus has no supraspinal effect, so that the δ interneurons are fully excitable for the second stimulus. In this way oscillation will occur in Parkinsonism.

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