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M. R. DIMITRIJEVIĆ, J. FAGANEL AND M. JANKO

OBSERVATIONS ON VARIABILITY OF TENDON REFLEXES IN PARKINSONIAN PATIENTS

The tendon jerks have been used in human neurophysiology as a tool in the studies of a variety of abnormal conditions for over 70 years. Their use has particulary expanded in the last decade, which has brought advanced technical facilities for their accurate eliciting, recording and analysis, and significant improvements in the background physiological knowledge.

More than 15 years ago, Struppler and Fleischhauer published a study on tendon jerks in patients with hemiparkinsonism (5). They were able to demonstrate a decrease in tendon jerks on the affected side, while there was no difference between the two sides in the H-reflex, which is the electrically induced counterpart of the tendon jerk, by-passing the gamma loop.

This interesting observation was later confirmed by Meltzer, Hunt and Landau (3). Arthur Ward took these findings as experimental support to his model of Parkinsonian syndrome based on partial interruption of gamma excitatory circuits (6).

However, more recently there appeared an elaborate microneurographic study by Hagbarth and associates who demonstrated exaggerated discharging of I a fibres in Parkinsonian patients, hence hyper- rahter than hypoactivity of the gamma system (2).

It is the teaching of clinical neurology that the tendon jerks in Parkinsonism tend to be normal, though rigidity may render them difficult to elicit and reduced in amplitude. It is also said that in the early stages they may actually be increased (1, 4).

The premise of our own study on which we wish to report here was that, for the stretch reflex to be elicited, one has to have an active gamma loop biased to spindle primaries, although the experimentally proved alpha-to-gamma linkage might well compensate for the partial interruption of the gamma system.

On the other hand, the size of the tendon jerk should depend on the spinal interneuronal system, which is known to influence motoneurone excitability, in addition to the supraspinal descending excitatory and inhibitory pathways. Our previous studies on normals and hemiple-

gic and paraplegic patients have shown that some insight into the function of these structures can be obtained by testing the fluctuation of spinal motoneurone excitability by repetitively elicited tendon jerks.

Indeed the comparison of these conditions with Parkinsonism revealed interesting differences.

MATERIAL AND METHOD

The results to be presented were obtained in five patients suffering from Parkinsonism for 4 years or longer. Their ages are between 50 and 60 years and none of them had any clinical or neurophysiological evidence of other neurological disorders. In all of them hypokinesia and rigidity were the most prominent symptoms.

The taps to the patellar tendon were delivered by a specially designed electrodynamic hammer with controllable force and repetition rate. An in-built pressure sensitive element reported the effective force of the head for each blow.

The EMG reflex responses were picked up by surface electrodes from the quadriceps muscle, amplified, recified and integrated with an originally constructed hybrid unit and fed into an HP 2114 B computer. The output of the pressure-sensitive element of the hammer was subjected to the same procedure. Means, standard deviations and histograms, as well as cross-corelation between the two functions were computed on-line (the technical part of the experimental design and the original constructions have been accomplished by our engineer Mr. Janez Trontelj).

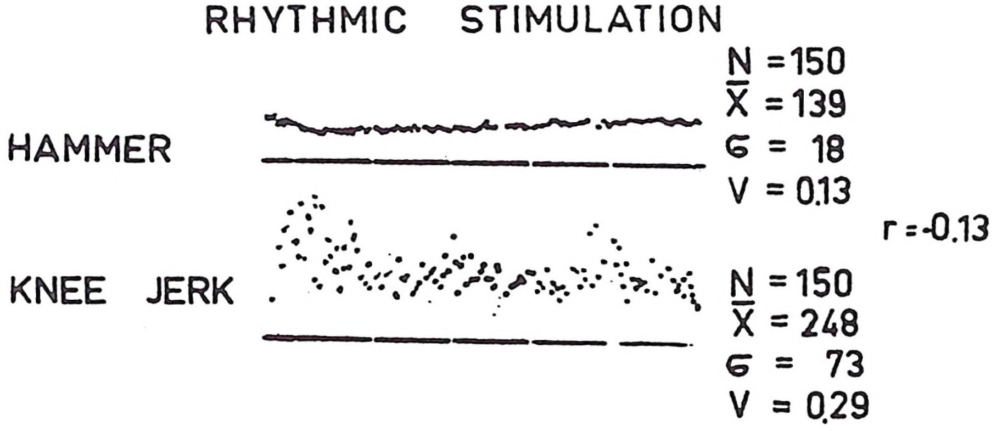

Fig. 1

Repetitively induced knee jerks in a normal subject. Upper trace: hammer force; lower trace: mean EMG of individual jerks.

RESULTS

Figure 1 shows the results of this procedure in a normal person. One hundred successive jerks elicited at a regular frequency of 1 per second show typical degree of scattering of the size. As you can see this is considerable, although all controllable experimental conditions were kept as constant as possible. Particular attention was paid to achieve as complete relaxation of the subjects as possible and a uniform level of wakefullness. (From our previous studies we were well aware of extensive changes in the size of the tendon jerks during drowsiness and sleep) (fig. 2).

Before presenting the results in the Parkinsonian patients, it will be of interest to see what happens in complete paraplegia (fig. 3) and in hemiplegia — the patient had a stroke 2 years before (fig. 4).

In sharp contrast to these conditions is what we found in the Parkinsonian patients (fig. 5). As you can notice, the variation of the size of repetitive jerks here is much wider. That this was not due to the inconstancy of the taps is shown on figure 6 and there was no correlation between the strength of the tap and the size of the jerk.

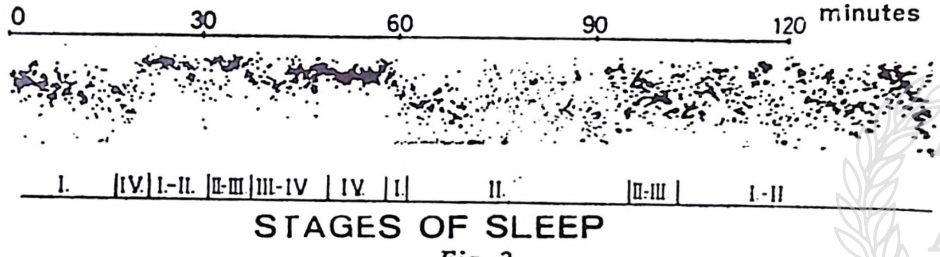

Fig. 2

Repetitively induced (0,2 Hz) Achilles jerks in a normal subject during different stages of sleep.

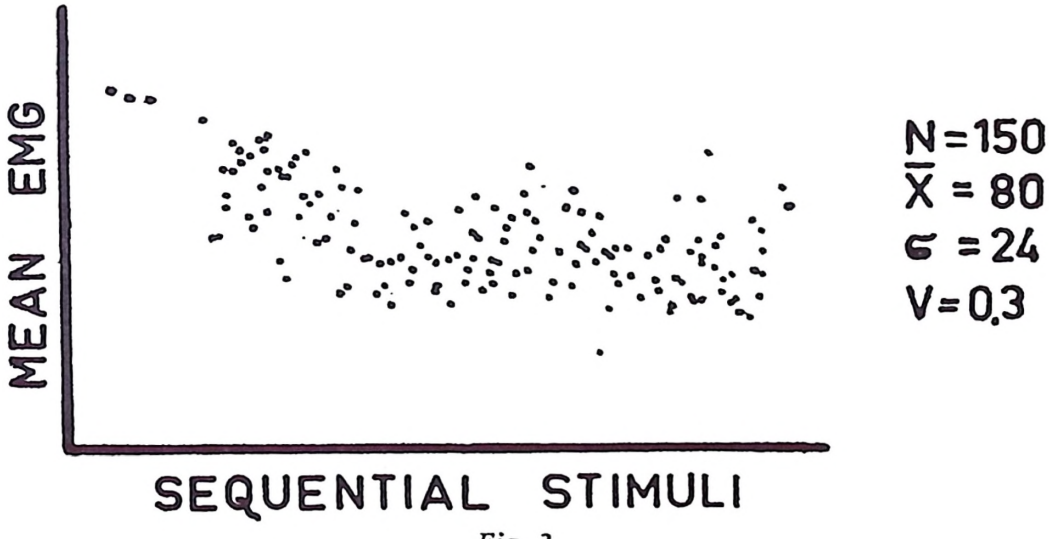

Fig. 3

Repetitively induced knee jerks in a patient with complete paraplegia.

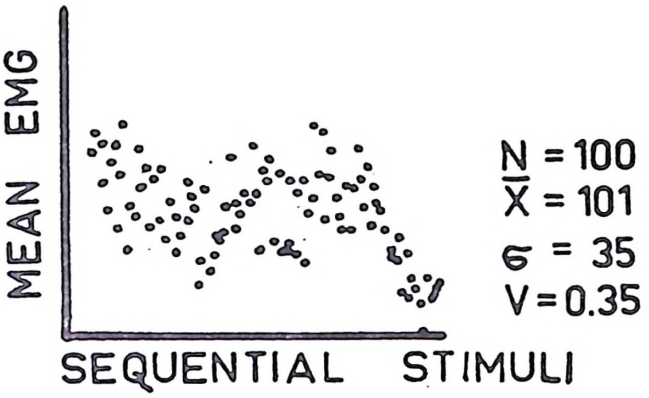

Fig. 4
Repetitively induced knee jerks (the affected side) in a hemiplegic patient.

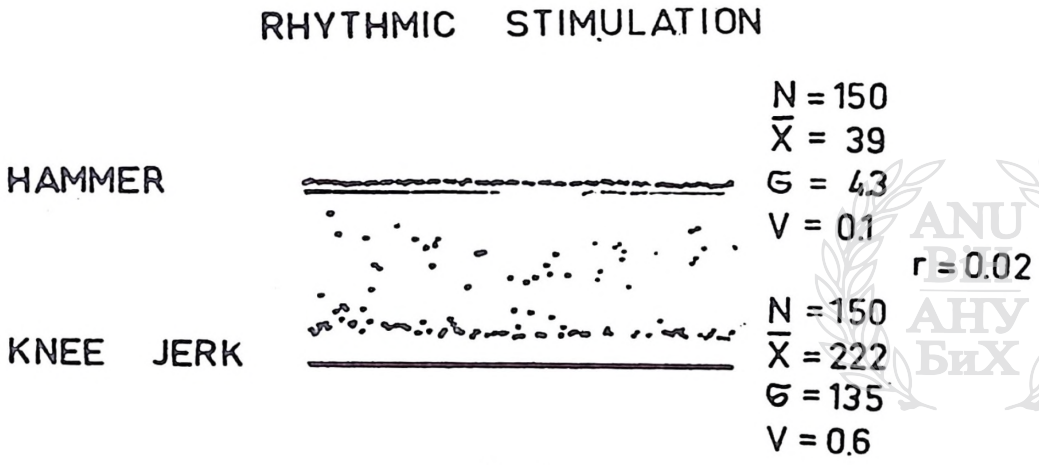

Fig. 5
Repetitively induced knee jerks in a Parkinsonian patient. Upper trace: hammer force; lower trace: mean EMG of individual jerks.

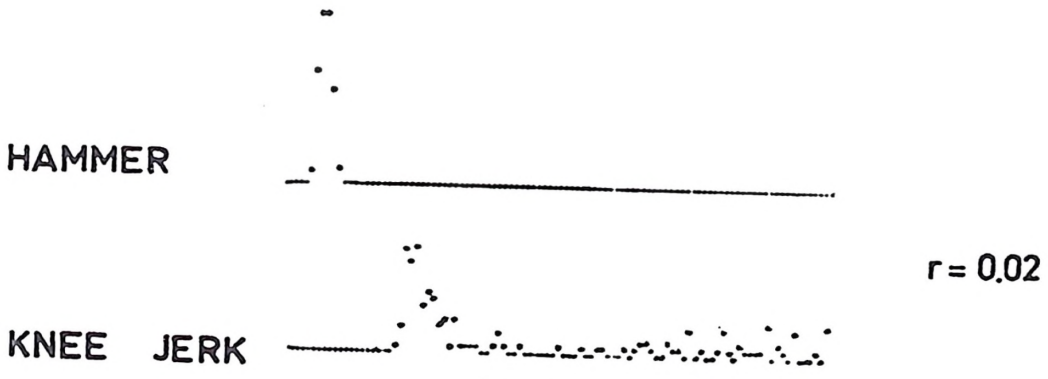

Fig. 6
Distribution of hammer forces (upper trace) and EMG responses (lower trace). r = coefficient of correlation.

There was striking consistency of the results in all of the 5 patients, as you can see from table 1.

Table 1.

MEAN EMG RESPONSE TO RHYTHMIC STIMULATION

PATIENT	NUMBER OF STIMULI	MEAN EMG RESPONSE	STANDARD DEVIATION	COEFFICIENT OF VARIABILITY
SPP 1	100	363	85	0.23
	100	342	88	0.26
	150	273	100	0.36
SPP 4	100	262	76	0.29
	250	217	70	0.32
	150	291	105	0.36
SPP 5	100	325	109	0.33
	250	272	99	0.36
	150	190	40	0.21
SPP 6	100	176	22	0.12
	250	160	94	0.58
	150	222	135	0.60
SPP 7	100	214	123	0.57
	250	239	133	0.55

It must be admitted that this type of findings is somewhat surprising: it indicates a very rich fluctuation of the excitability of spinal motoneurons, which would seem to stand in a sharp contrast to the cardinal clinical symptoms of these patients: poverty and slowness of voluntary movement, and rigidity.

In an attempt to elucidate this contradiction, we made another type of experiments in which the intervals between the successive tendon taps were randomly changed. The range of these changes was between 0.25 and 2 seconds. This procedure greatly increased variation of the size of the jerks in normals, hemiplegics and paraplegics. Figure 7 shows what happens in a normal subject; according to our interpretation, the increased variation in this case is primarily due to the changes induced by random stimulation in the spinal interneuronal system.

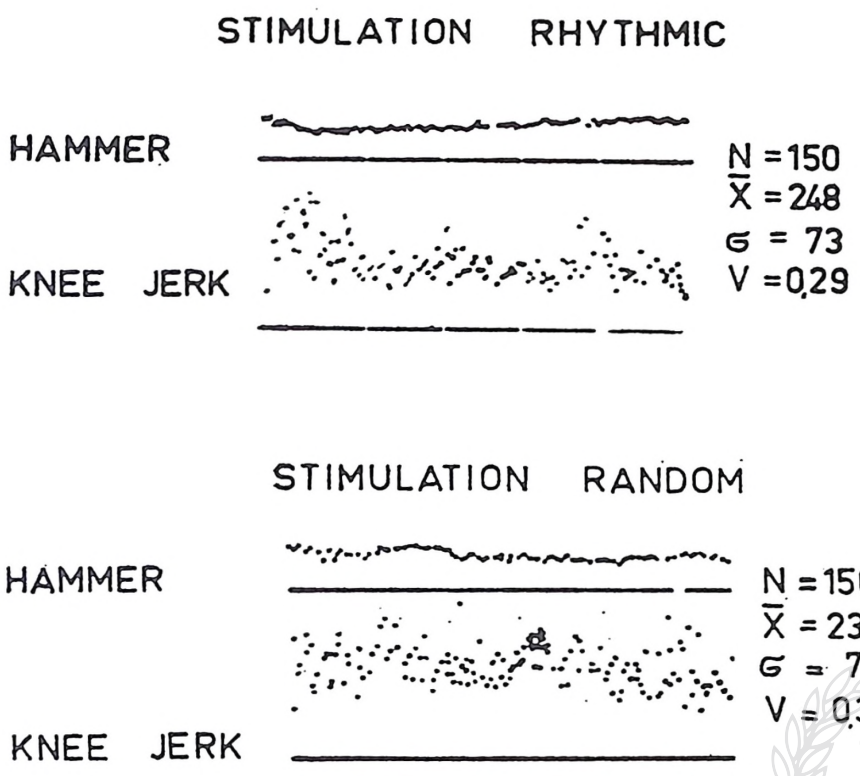

Fig. 7

Responses to tapping at regular and random intervals in a normal subject.

Table 2.

MEAN EMG RESPONSE TO STIMULATION AT RANDOM INTERVALS

PATIENT	NUMBER OF STIMULI	MEAN EMG RESPONSE	STANDARD DEVIATION	COEFFICIENT OF VARIABILITY
SPP 1	100	188	81	0.43
	100	345	79	0.23
SPP 4	250	323	98	0.30
	250	278	109	0.39
SPP 5	250	354	95	0.26
	250	354	96	0.27
SPP 6	250	189	93	0.49
	250	122	24	0.19
SPP 7	250	236	123	0.55
	250	258	135	0.52

Again, the Parkinsonian patients behaved quite differently (fig. 8). Table 2 shows no obvious differences between the effects of rhythmical and random stimulation.

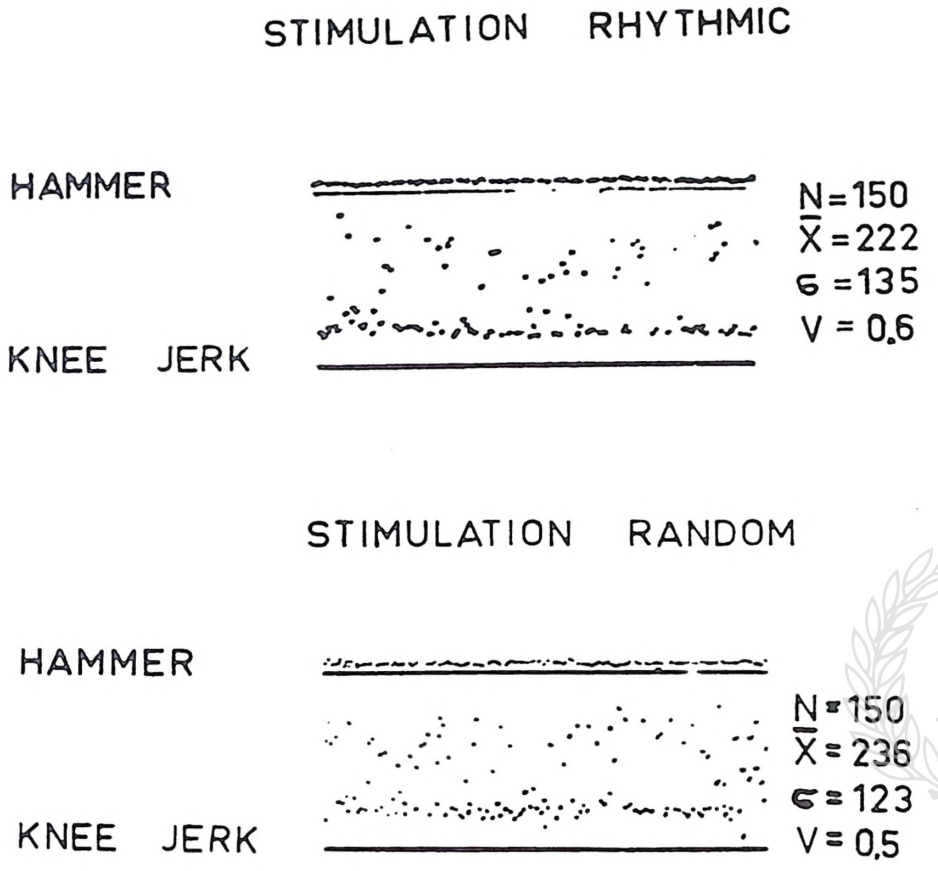

Fig. 8

Responses to tapping at regular and random intervals in a Parkinsonian patient.

CONCLUSIONS

Presented results indicate a very rich fluctuation of spinal motoneurone excitability in the Parkinsonian patients studied; this is in sharp contrast to the clinicaly observed hypokinesia and rigidity; and it is little influenced by the changes in the afferent information code. It seems as if the spinal motor cells and their primary and interneurone afferents were subordinated to abnormally strong supraspinal control, which however does not preclude rich fluctuation of spinal motoneurone excitability, the latter again being of some supraspinal origin.

M. R. DIMITRIJEVIĆ, J. FAGANEL I M. JANKO

O VARIJABILITETU TETIVNOG REFLEKSA KOD PACIJENATA SA PARKINSONOVOM BOLEŠĆU

KRATAK SADRŽAJ

Kod ritmičnog izazivanja tetivnog refleksa veličina elektromiografskih odgovora pokazuje varijacije koje među ostalim odražavaju promjene u ekscitabilnosti donjeg motornog neurona. U ovom radu uspoređivan je varijabilitet tetivnog refleksa kod normalnog čovjeka, paraplegičara, hemiplegičara i pacijenata sa Parkinsonovom bolešću. Kod poslednjih su nađene neočekivano bogate fluktuacije ekscitabilnosti donjeg motornog neurona, što je u oštrom kontrastu sa kliničkom hipokinezijom i rigidnošću. Promjene u kodi aferentne informacije sa slučajno promjenljivim intervalima između stimulusa kod parkinsoničara nisu imale značajnog utjecaja. Izgleda kao da su spinalne motorne ćelije i njihovi primarni i interneuronski aferentni putevi podvgrnuti pretjerano jakoj supraspinalnoj kontroli, koja ipak ne sprečava bogate, vjerojatno supraspinalno determinirane fluktuacije ekscitabilnosti spinalnih motoneurona.

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DISCUSSION

Struppler: May I ask, what time intervals you used between the single mechanically evoked responses? As you know, repetetive responses are remarkably influenced by a long lasting depression you certainly were aware of.

Dimitrijević: We were aware of the phenomenon described as low frequency depression. For this reason we used two different patterns of stimulation: one with regular intervals between the stimuli and the other one with random intervals ranging between 0.25 and 2 sec. We have observed

that stimulation of this latter type prevents or delays the development of low frequency depression. We did observe some gradual decline in the size of responses on regular stimulation in normals (cf. Fig. 1), but we could not see any decline in the Parkinsonian patients even when the stimulation was regular.

Struppler: I would like to ask you, if you have recorded in your interesting investigations the amount of rigidity simultaneously with T-reflex. As you know the T-reflex response depends not only upon the excitability of the α-motoneurons, but also on the amount of stretch, which depends on the length of the muscle. Therefore I am wondering whether changes in stretch might contribute to the variation of the reflex responses.

Dimitrijević: The pressure-sensitive element built in the hammer head reported the pressure developed at the tendon by the individual blows; there was no correlation between the pressures and the mean EMG's. Therefore we believe that the state of the tendon did not contribute to the large fluctuation we observed in the Parkinsonian patients.