CLINICAL EXPERIENCES ON SPASTICITY WITH A MODIFICATION OF THE MUMENTHALER PENDULUM TEST

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INTRODUCTION

Spasticity of the muscles in a patient with a transverse lesion is a troublesome symptom. In combating it, we have pharmaceutical, physiotherapeutic and surgical methods at our disposal.

To determine the degree of spasticity one can use the pendulum test described by Mumenthaler (1965). Studying the muscle-relaxant effect of Diazepam (Valium, Hoffmann—La Roche, Basel) in spastic patients Schlapfer and Mumenthaler (1964) used the pendulum test, the method of which is as follows:

Method. A light bulb is attached to the foot of the freely hanging and relaxed leg and the leg of the sitting patient is extended straight forwards and released. The lower leg, with the attached light bulb, follows a damped pendulum movement which is filmed from the side. Two points must be carefully observed:

(1) The camera must be pointed perpendicularly to the plane of the arc described by the light bulb and the transport of the film must be exactly vertical. If this is not so, it is possible that loops occur in the curves.
(2) The film transport must be continuous and exposure must be uninterrupted by a shutter. This implies that an expensive camera must be used.

To simplify this pendulum test for clinical application we suggested that:

(1) the test should be simple and able to be done quickly;
(2) a darkened room should not be necessary;
(3) the results of the test must be immediately available;
(4) the curves should not need further processing before filing with the patient's records;
(5) loops in the curve should not be present;
(6) the cost should be less than filmed curves.

We were able to meet these requirements with an apparatus now described (fig. 1). For recording, the Health-recorder type EUW-20A was used. EEG and ECG recorders may also be employed. The paper speed we used was 50 mm./min.

The motion of the swinging lower leg is transmitted to a motion transducer applied laterally to the knee-joint. This transducer consists of a wire-wound potentiometer of 5 k° and two metal strips of 25 × 2 cm. One of these strips is attached to the case of the potentiometer, the other is fixed to its spindle. Both strips are attached to the upper and lower leg with adhesive plaster or rubber bands (see fig.) in such a way that the spindle of the potentiometer corresponds with the axis of the knee-joint.

A two-wire shielded lead connects the transducer to the recorder via a battery of 1·5 V.

Each movement of the lower leg leads to a variation in resistance, which causes a proportional alteration in the current at the recorder input.

This apparatus permits a rapid pendulum test; darkening of the room is not necessary; the curve is immediately available; the paper strip can be filed; loops cannot form in the curves.

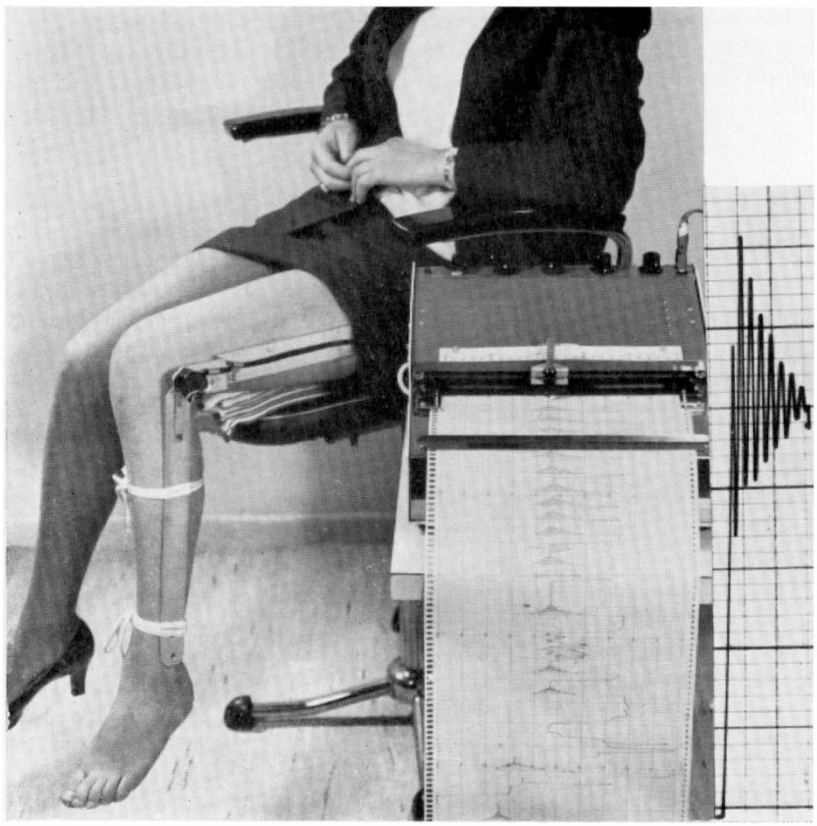

FIG. 1
Equipment for Pendulum Registration.

Costs for each test are less than for filming, even if a simple recorder has to be bought especially for this purpose.

This modification enables us to collect quantitatively reproducible values suitable for further mathematical analysis. The values are obtained in the course of the examination in the form of curves drawn on paper and they can be evaluated by the examiner direct. One can now also study the effects, if any, of drugs acting upon muscular spasm during the examination itself.

In our investigation the effect of diazepam on muscular spasticity was measured quantitatively, with the aid of the modified version of the pendulum test, in five normal persons and six patients with total or almost total paraplegia.

Procedure. The method consists of the quantitative assessment of the degree of impairment of movement that occurs when a lower leg, hanging freely, is allowed to swing like a pendulum at the knee-joint. On the basis of a previously adjusted

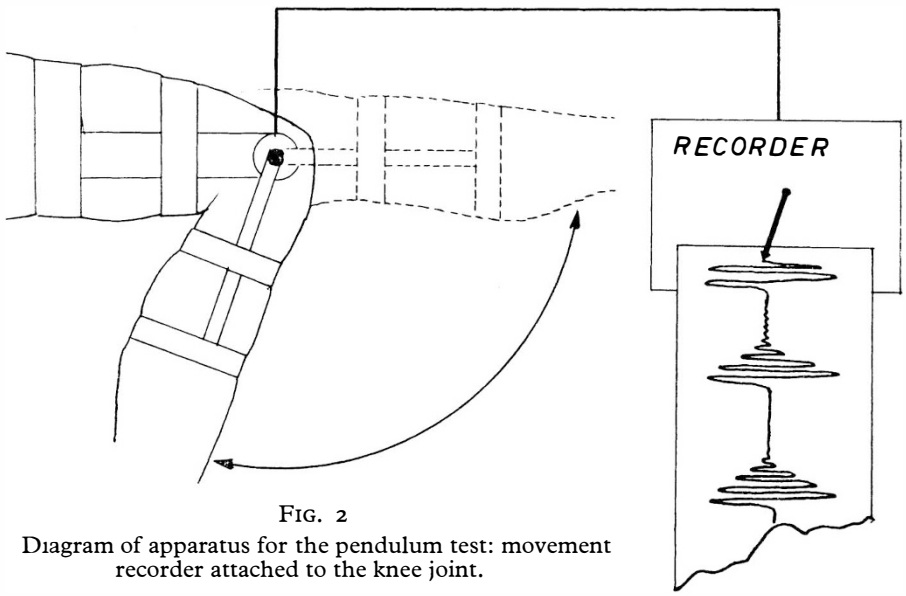

FIG. 2
Diagram of apparatus for the pendulum test: movement recorder attached to the knee joint.

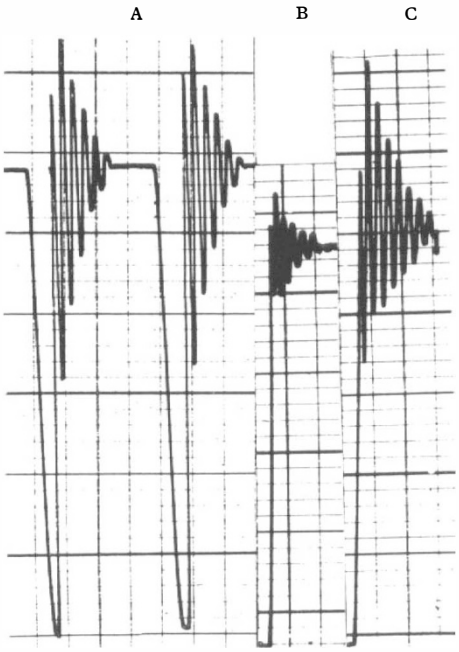

FIG. 3
A—Pendulum registration of a normal test subject.
B, C—Patient FvdB, before and after administration of diazepam.

initial amplitude of the writing pen of the recorder (we used a Health-recorder, type EUW-20A), registration and objective evaluations are possible. For this

examination, the test subject or the patient is placed in a relaxed, sitting position with both legs hanging free at the knee. The movement recorder is attached by rubber bands to the leg during examination (fig. 2). Calibration of the amplitude of the pen is accomplished by moving the leg from the free-hanging, vertical position into the extended, horizontal position. The rotation of the axis of the potentiometer attached to the knee-joint leads to a change of resistance and the pen assumes a different position. The extent of this change in position corresponds to the change in position of the leg in relation to the thigh. By altering the amplification of the signal we can ensure that this alteration in position is always of the same magnitude (figs. 3A-C).

RESULTS

This examination was carried out on six patients with spastic paraplegia and five normal controls.

The pendulum test was carried out prior to and at fixed intervals after the intravenous administration of 10 mg. diazepam. From the curves obtained three parameters could be deduced:

(*a*) the time in seconds from the moment of release of the extended leg to complete arrest after gradual subsidence of the pendulous swinging movement;
(*b*) the number of pendulous movements (= frequency) during the period defined above;
(*c*) the amplitude, which is found by adding the amplitudes of the pendulous movements in millimeters.

It was found that in five of the six patients the duration of the pendulous movement was increased after the administration of diazepam (fig. 4), but this increase was not observed in one patient (W.L.). The number of swings (= frequency) increased in all patients after the administration of diazepam (fig. 5). Tables I and II show total pendulum time, number of swings and amplitude in the normal controls and patients.

In Figure 6, the amplitude prior to the administration of diazepam was calculated from the curves obtained. The value found was corrected to 100. This gives us the correction factor which is multiplied, after administration of diazepam, by the amplitude measured at that time.

Example. The amplitude measured for one complete pendulum test, prior to the administration of diazepam, amounts to 75. Correction to 100 gives us the correction factor $\frac{100}{75}$. If we now assume that an amplitude of 90° is measured after the administration of diazepam, this value must be multiplied by $\frac{100}{75}$ to enable us to compare the value with the findings from other patients. This gives us $\frac{100 \times 90}{75} = 120$.

In four patients, diazepam brought about a marked increase in amplitude. In one patient the increase was only slight: 7 per cent. In one patient, the spasticity of the lower leg prior to the administration of diazepam rendered it impossible to obtain a valid curve, but after the administration of the drug a good recording was obtained (see Table II and fig. 5).

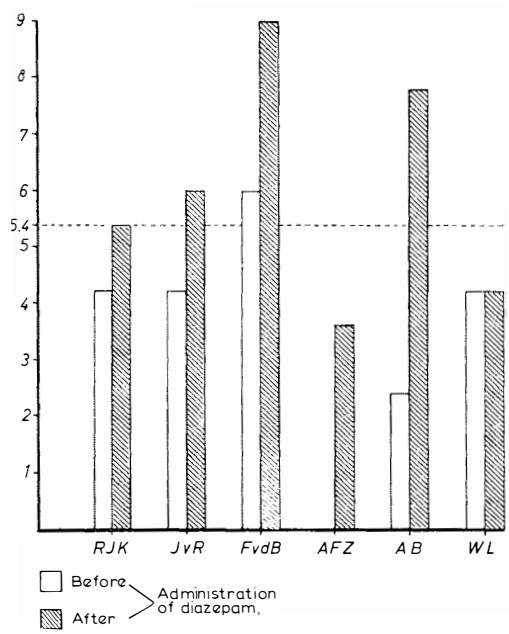

FIG. 4
Duration of swings.

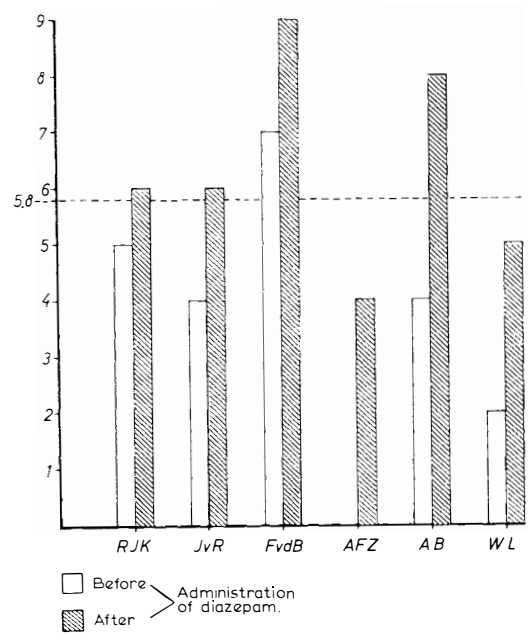

FIG. 5
Number of swings (= frequency) during one pendulum test.

TABLE I
Normal Persons

Test subject	Total pendulum time in sec.	Number of swings	Amplitude
1	5·4	6	126
2	5·4	5	100
3	4·8	6	112
4	5·4	6	124
5	6·0	6	118
Average	5·4	5·8	116

TABLE II
Patients

	Before administration of diazepam				After administration of diazepam			
Patient	Total pendulum time in sec.	Number of swings	Amplitude		Total pendulum time in sec.	Number of swings	Amplitude	
			Measured	Corrected			Measured	Corrected
(1) R. J. K.	4·2	5	21	100	5·4	6	65	309
(2) J. v R.	4·2	4	145	100	6·0	6	153	107
(3) F. v d B.	6·0	7	82	100	9·0	9	343	418
(4) A. F. Z.	0	0	0	—	3·6	4	84	—
(5) A. B.	2·4	4	14	100	7·8	8	65	455
(6) W. L.	4·2	2	2	100	4·2	5	27	1350

In three patients a mild degree of somnolence was observed. The pulse rate and the blood pressure were not appreciably influenced. Patients A. B. and W. L. were on one occasion given a solution of 0·9 per cent. NaCl instead of diaze-

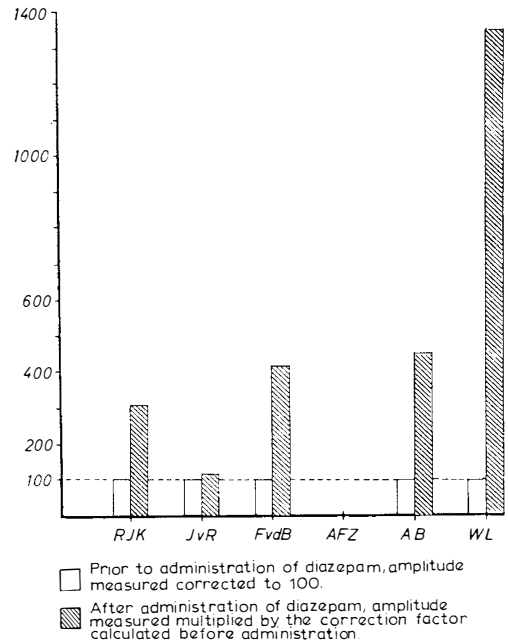

FIG. 6
Amplitude.

pam without their knowledge. The curves obtained in the course of the test showed no change of the pattern compared with the curve recorded prior to the injection, nor was any decrease in spasticity noticed subjectively.

CONCLUSION

The pendulum registration using a modification of the Mumenthaler Pendulum Test as described by the authors renders quantitative evaluation of muscular spasticity of the lower legs possible. This method was applied to five controls and six patients.

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