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EFFECTS OF ELECTROSTIMILATION ON STRETCH REFLEX AND IRRADIATION OF HEMIPARETIC PATIENTS.

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ABSTRACT. - Electrical stimulation is fit to reduce both abnormal stretch reflex and irradiation, but with different modalities. The reduction of stretch reflex is immediate but short-lived and a great number of electro-stimulation sessions are needed to stabilize it; the abnormal irradiation reduces very gradually, but tends to stabilize at a lower level in a shorter time. A possible rationale of the two different behaviour is discussed.

Introduction

As it is known, the most selective and adjustable external control of spasticity is the electrical stimulation.

With the term "selective" it is meant the possibility to act selectively on different nervous structures, by means of positioning, configuration and dimensions of electrodes and with different parameters of impulses.

For what regards amplitude of electrical impulses, using threshold impulses we obtain the excitation of the afferent Ia fibres coming from the primary endings of neuromuscular spindles. If electrical impulses are applied on hypotonic paretic muscles, alpha-motoneurones of antagonistic muscles are inhibited because of the reciprocal inhibition, thus provoking a fall of spasticity in the last-ones (1-5-7-8).

Nevertheless the simple excitation of Ia afferent fibres could have only a transient effect, because, as this kind of inhibition has essentially a segmental integration, the stimulation cannot influence the causes of the functional silence of reciprocal inhibition depending on higher levels affection.

On the contrary, experience demonstrates that, after a more or less great number of electrostimulation sessions, the antispastic effect tends to become permanent (2-3-4-6). This is due to the fact that generally we don't use threshold impulses, but impulses of an intensity that may evoke a visible contraction of the stimulated muscle. The use of sufficiently high intensities implies also the excitation of higher threshold fibres, with more complex consequences. In this way not only the stretch reflex, but also the abnormal irradiation of the spastic limbs is modified.

Method and results

Material, method and results have been reported in 2, 3 and 4. Clinical comparative evalutations, Ashworth scale, EMG and kinesiologic assessment were the criteria to check up the results. A set of slides is shown during this presentation. Fig. 1 is an example. But in those works, so as in any other work we can find in bibliography, the only parameter to assess spa sticity is the stretch reflex; the other main component of spasticity, i. e. irradiation, is never mentioned. In reality, stretch reflex is a reliable and sufficient parameter to assess spasticity. Anyway the two phenomena seem to behave in different ways. Abnormal stretch reflex drops just during the first electrostimulation session, but raises again soon after; 20-50 or more sessions are needed to reach a lasting relaxation (3). Irradiation, abnormal both in entity and distribution, doesn't reduce during or immediately after the single session, but tends to decrease gradually and to stabilize at a lower level in a shorter time.

We tried to verify this observation with the following procedure.

Five spastic hemiparetic patients, with spasticity of upper limb between 2 and 3 level of the Ashworth scale, were treated with 20 sessions of electrostimulation on extensor muscles of wrist and fingers. We used trains of modulated impulses of 0.5 ms at 50 Hz. We did not stimulate triceps muscle, in order not to inhibite directly the biceps muscle. The measurements were very simple: for stretch reflex we used Ashworth scale; as for irradiation, we measured at the end of each session, the angle reached by the synkinetic flexion movement of the affected elbow after the effort caused by ten steps.

Fig. 2 shows a typical graphic aspect of the results. In the other four patients we observed similar reactions.

Discussion

The rationale of the mentioned effects could be the following.

Electrical stimulation excites, among the other-ones, also the II group afferent fibres originating from the spindle secondary endings. Such a fibres take part of complex polisynaptic circuits involved in co-ordinate movements of the four limbs and in activities of co-contraction; they give uninterrupted information on the length and state of contraction of the pertaining muscle and thus on the position, at the very moment, of the body segments among them and in the space; but -above all, in regard of this speculation- they form, according to Wiesendanger (9), the afferent limb of that transcortical long loop, which starts from the spindle, integrating in a complex way between 3 and 4 cortical areas and whose efferent limb goes along the pyramidal tract. The circuit is the ground of a long loop transcortical reflex mechanism regulating movement with flexible, selective, gain-provided modalities.

The reason of the different effects of electrostimulation on stretch reflex and irradiation seems therefore to be searched in their different levels of integration.

The first depends on a monosynaptic reflex mechanism, at segmental integration, able to give stereotyped and scarcely modifiable answers; consequently, the inhibition of stretch reflex by excitation of Ia group fibres of the antagonistic muscle is immediate but fleeting. The stabilizing effect on reciprocal inhibition after prolonged electrostimulation could be ascribed to the excitation, through the II group fibres, of the cortical neurons cells of 4 area corresponding to the stimulated muscles. This excitation seems to be sufficient to evoke alpha-gamma co-activation, which causes a further excitation of the fusimotor system of the stimulated muscle, yet directly stimulated by electrical impulses; the consequence should be an additional supply

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of inhibitory impulses of central origine to the spastic antagonistic muscles.

The second (irradiation) is essentially a cortical phenomenon and can be influenced by the long loop transcortical reflex mechanism led by II group fibres coming from secondary endings. This transcortical reflex mechanism of motion control can probably not give immediate effect on irradiation because of the many and complicated connections especially between cortical 3 and 4 areas and with other parts of the cortex. But it should be suitable to stir up a sort of automatic learning process.

References

1. Alfieri V.: La stimolazione elettrica nell'emiplegia. La Riab, 10: 73-87, 1977.

2. Alfieri V. and Vitale A.: EMG and kinesiologic control study on electrical therapy of the hemiplegic hypotonic shoulder. Proceed. 5th I. S. E. K. Congr, Ljubljana, June 21-25, 1982; Zdrav Vestn, 51, Supl. I: 191-192, 1982.

3. Alfieri V. and Vitale A.: Denervazione periferica ed elettroterapia in spalla emiplegica ipotonica. La Riab, 15:211-222, 1982.

4. Alfieri V.: Electrical Treatment of Spasticity. Reflex tonic activity in hemiplegic patients and Selected Specific Electrostimulation. Scand J Rehab Med, 14: 177-182, 1982.

5. Carnstam B. and Larsson L. E.: Electrical stimulation in patients with spasticity. EEG and Clin. Neurophys., Society Proceedings, 38: 214, 1975.

6. Gračanin F.: Possibili meccanismi neurofisiologici implicati durante la stimolazione elettrica funzionale. La Riab, 3: 101, 1973.

7. Levine M. G., Knott M. & Kabat H.: Relaxation of spasticity by electrical stimulation of antagonistic muscles. Arch Phys Med Rehab 11: 668, 1952.

8. Visser S. L. & Zilvold G.: EMG analysis in hemiplegic patients treated by means of FES of the peroneal nerve. 3rd Int. Congr. I. S. E. K., Pavia, Italy, Aug 30-Sept 4, 1976.

9. Wiesendanger M., Ruegg D. G. & Lucier G. E.: Why transcortical reflexes? J Canad Sc Neurol, Aug: 295, 1975.

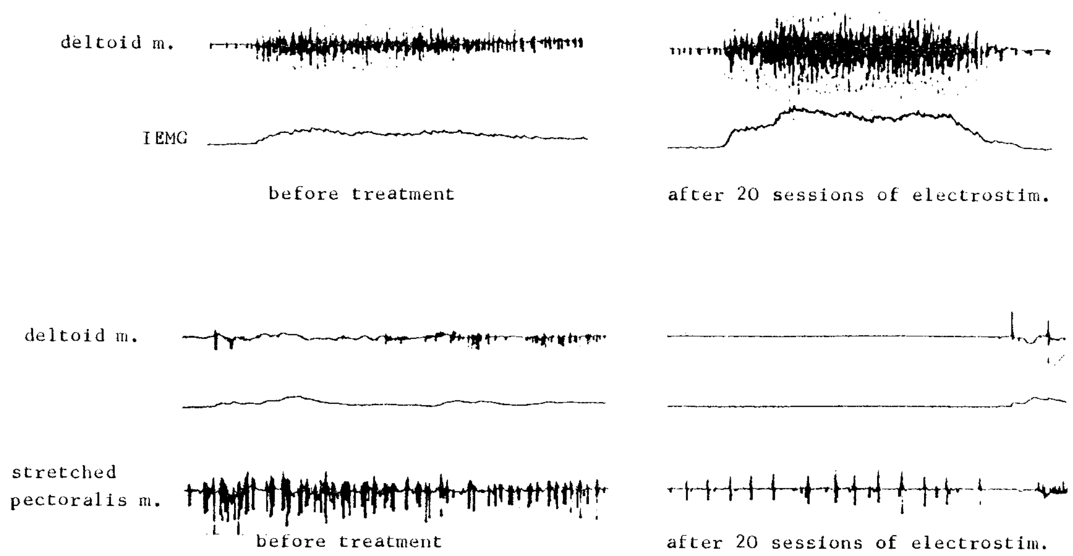

FIG. 1.- Effect of electrostimulation on voluntary activity of stimulated deltoid muscle and on stretch reflex of its spastic antagonist, pectoralis major.

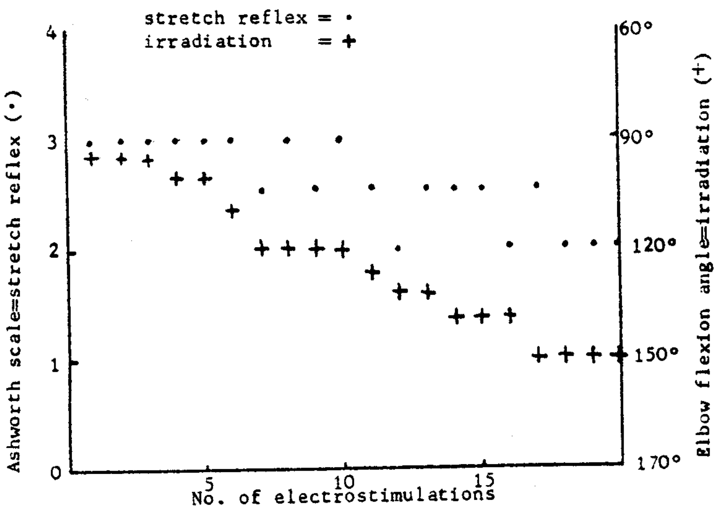

Fig.2 - Typical course of stretch reflex and ir= radiation during electrotherapy (case 4)