The conscious control of reciprocal innervation and motor irradiation of voluntary activity in the hemiplegic arm.

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Summary

The voluntary control on reciprocal innervation in the upper arm and motor irradiation in thenar and hypothenar was studied during isometric flexion and extension of the elbow in patients with spastic hemiparesis. The method of EMG feedback provided a basis for an index of voluntary control in spastic muscles. The effectiveness of EMG feedback in therapy will be discussed.

Introduction

It is wellknown that in normal subjects there 's a perfect execution of excitation and inhibition of agonists and antagonists. Activity in antagonists can occur, depending on the nature of the voluntary movement. Reciprocal activity for instance increases in antagonists at the end of flexion or extension of a hinge joint to prevent damage to the joint (Bierman and Ralston 1965). Cocontraction in antagonists takes place by an increasing load and fatique(Patten and Mortensen 1970, Visser and de Rijke 1974). In normal conditions muscle contraction is always accompanied by simultaneous activation of synergistic muscles and also of distant groups (Gregg 1957, Hopf 1974, Jelassic 1969). This phenomenon is more prominent in children than in adults (Ajuriaguerra 1963). Associated muscle activity or synkinesis is finely adapted to strength, and relevant postural adjustments (Livingstone 1951).

In hemiplegic subjects there is an intense activation of antagonists on the affected side (Yusevich 1971). Associated muscle activity or motor irradiation is also considerably increased, developping associated movements, or synergy patterns. (Garcia Mullin 1971). In rehabilitation several methods are used to diminish the increased reciprocal innervation and motor irradiation with the purpose to obtain a better motor function. In facilitation-exercise therapy, the influence of inhibition of abnormal patterns and reflex inhibiting postures are emphasized, but results are still in discussion. Some reports do not indicate improvement by exercise therapy (Stern 1970). Recently EMG feedback therapy seems to be a more effective approach. Basmajian and associates (1977) reported an increase in strength and range of motion which was approximately twice as great as in conventional physical therapy. Brudny (1976) observed return of upper extremity function in hemiplegic subjects. The mechanism of improvement after EMG feedback are not well understood. These reports suggest some residual voluntary control on spastic muscles. Anyhow the EMG feedback method provides a basis for an index of voluntary control in muscle activity (Harrison and Connolly 1971, Simard and Basmajian 1967). This study was designed to measure in detail the remaining conscious control on reciprocal innervation and motor irradiation in the affected arm in hemiplegic patients during isometric flexion of the elbow.

Method

Eighteen hemiplegic patients with a lesion in the left or right hemisphere were selected. Clinical localisation in all of them was a hemisphere lesion in the area of the middle cerebral artery. Hemiparesis existed for at least one year. Nine patients received audio -visual EMG feedback therapy of reciprocal activity of flexor

muscles in the upper arm and of motor irradiation in thenar and hypothenar muscles, both during maximal isometric flexion of the elbow. Surface electrodes were used. During treatment the arm was in a position of adduction, flexion and pronation. They were trained three times a week lasting one hour. The EMG and the integrated EMG were recorded (Siemens Mingograf 34). The attention of the patient was only focused on the scope and the speaker. The patient wasn't aware of these recordings. The recording speed of the writer was 10 mm/sec. Therapy on reciprocal innervation and motor irradiation were of the same duration. After approximately 400 attemps to reduce the increased reciprocal innervation of flexors of the elbow and the increased motor irradiation in thenar and hypothenar muscles the experiment was stopped. The median of 25 attemps at the beginning and at the end was determined. Nine normal subjects underwent exactly the same EMG feedback therapy in order to find out the normal values under the same circumstances. The other nine patients had standard exercise therapy comparable in duration and frequency.

Parameters

- Before and after treatment the mean integrated amplitude of the biceps and triceps muscle was determined simultaneously during half maximal isometric flexion and extension of the elbow during 60 seconds. In addition the mean integrated amplitude of motor irradiation in thenar and hypothenar muscles was analysed also during half maximal isometric flexion and extension of the elbow during 60 seconds.

  The EMG was recorded with surface electrodes, and converted into a digital processing system by computer.
- Motor function was evaluated by a method which reflected the development and dissolution of pathological synergy patterns (Fugl Meyer 1975).
- The independant movements in the shoulder, elbow, hand and fingers were scored.

- "Method time measurement" was executed for function like picking up large, light and heavy objects (Jebsen 1969). The activities of daily living were evaluated.

Results

All subjects treated by EMG feedback had significant improvement on reciprocal innervation and motor irradiation; at least in the muscles which were exclusively trained on these pathological features. (fig. 1). The results were achieved gradually. After treatment the integrated amplitude demonstrated still the effect of EMG myofeedback therapy. (fig. 2). The mean reciprocal coëfficient

$$\left(\begin{matrix}\text{reciprocal}\\ \text{coëfficient}\end{matrix} = 100 \times \frac{\text{mean integrated amplitude in antagonist}}{\text{mean integrated amplitude in agonist}}\right)$$

was changed from 72% before treatment to 34% after treatment. Motor irradiation was decreased: the mean integrated amplitude in thenar muscles was changed from 49.0 uV before treatment to 22.5 uV after treatment. However when flexion of the elbow was turned into extension reciprocal activity and irradiation activity was unchanged in the experimental group. (fig. 3). Patients which received standard exercise therapy showed no decrease in reciprocal innervation and motor irradiation. (fig. 4). In both groups no changes were observed in motor synergy patterns, independant movements, function of the hand and activities of daily living.

Conclusion

Hemiplegic subjects are able to recognise, and to reduce their increased reciprocal innervation and motor irradiation. The method of EMG feedback is more favourable than standard exercise therapy to demonstrate this phenomenon. It seems that the effectiveness of EMG feedback therapy is rather restricted; the gradually achieved results were limited to the muscles which were exclusively trained.

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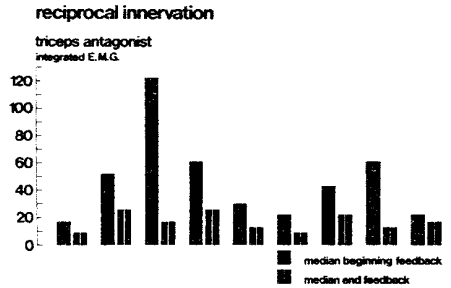
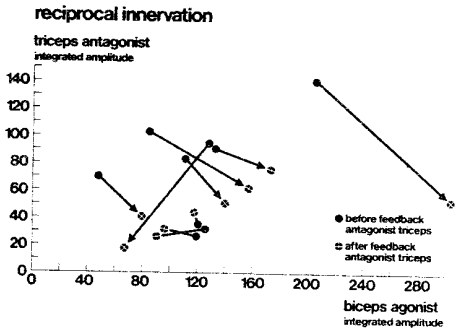


figure 1.



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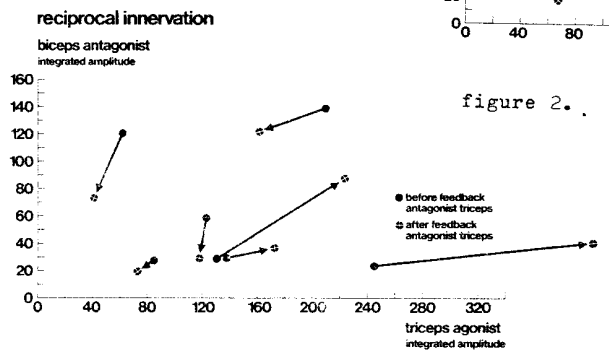

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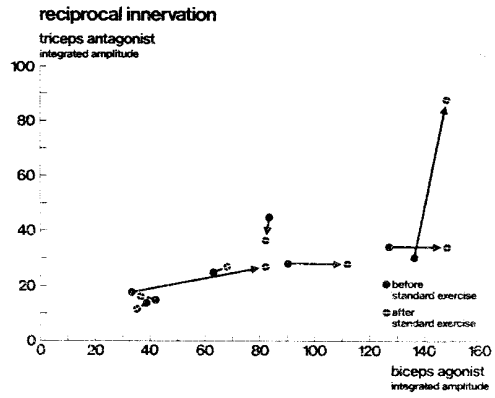

figure 4.