

## ELECTRICAL FACILITATION OF VOLUNTARY FINGER MOVEMENTS IN HEMIPLEGICS

by: W. T. Liberson, M.D., Ph.D.  
 Brooklyn-Cumberland Medical Center, Brooklyn, NY  
 and Greynolds Park Rehabilitation Center, North  
 Miami Beach, Florida

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During my early research<sup>^</sup> on functional electro-therapy in hemiplegics (1961), leading to the evolution of the electrophysiological brace with the peroneal nerve stimulator, I made an observation which was confirmed by all other investigators. I was demonstrating early in the course of my investigation the effectiveness of the peroneal nerve stimulator, correcting the foot drop in hemiplegics, and was trying to show to my audience that as soon as the current <sup>was</sup> / turned off, the patient's foot drop will immediately re-appear. To my embarrassment the patient continued to dorsi-flex his foot for the remaining time of this demonstration.

As I tried to explain this unexpected carry-over of the effect of the peroneal nerve stimulation I involved inhibition of the gastrocnemius which was expected from the stimulation of the peroneal nerve. Although the inhibition should be expected to cease with the cessation of the current, Beritoff showed that the effect of wide spread inhibition may last for a relatively prolonged period of time. (2)

In other investigations on the subject, I showed that in normal individuals (3) reciprocal inhibition does occur following stimulation of motor points of a muscle, and that wide spread inhibition can indeed be found in man. <sup>(4,5)</sup> There was no reason to doubt that both of these forms of inhibition would be operational in hemiplegics.

I therefore treated many of the hemiplegics by electrical stimulation especially that of the extensors of the wrist and fingers. Such stimulation carried out for many hours a day would decrease substantially spasticity of flexor muscles to the satisfaction of my patients. In some of them, I went a step forward. Instead of suppressing spasticity of the flexors, I took advantage of it. If the patient could hold an object by his or her spastic flexors of the fingers he or she could open the fist by electrical stimulation of the extensors using a shoulder switch. (6) I am pleased to see during this conference that Ljubljana investigators improved this brace (see this volume).

As my investigation progressed interrupted as they were by other concerns, I found another unexpected phenomenon. In hemiplegics in whom no voluntary finger movements were observed, I could elicit such movements while the extensors of the wrist and fingers were stimulated. In other instances, I stimulated the flexors instead. In all these cases the movements were of relatively low amplitude and quite slow. At first they were surprising to the patient himself who was prompted to induce them voluntarily. However as their amplitude would progressively increase their voluntary nature was recognized by the patients themselves. So far in no patients these movements acquired a functional significance, although we are optimistic on this score provided that therapists overcome their natural skepticism. Thus in some patients the finger movements could be initiated without application of the electrical stimulation even though at the beginning they were induced during such stimulation. In others they would be present only during stimulation despite repeated trials.

This phenomenon could not be explained by reciprocal inhibition as both flexion and extension could be elicited during the stimulation of extensors. One is brought to

the notion of an electrical facilitation of some processes which are suspended in a hemiplegic patient. Facilitation of voluntary movements were of course reported in the past by physical therapists and physiatrists using stimulation of the skin overlying the activated muscles. In our case both extensors and flexors were facilitated by a strong electrical stimulation of the extensors.

Although practical significance of the reported phenomenon has not yet been sufficiently explored with a continuous stimulation, its theoretical significance seems to be indisputable. The general concept of a paralysis of muscles in patients with organic hemiplegia always implied an interruption of pathways without which the connection between the voluntary centers and anterior horn cells is impossible. The presently reported observation challenges this classical concept, suggesting that other pathways remain open around the organic lesion; yet they are functionally discontinued because of a lack of an appropriate facilitation.

It seems to me that this observation reduces the gap between the organic and functional disturbances and suggest the possibility in the future to reverse organic deficits by electrical facilitation of the central processes <sup>in addition to</sup> / of using functional stimulation of peripheral nerves.

This observation, together with the discovery of a "functional neuropathy" due to reduced protoplasmic flow from the anterior horn cells along the peripheral nerve fibres contribute to a new and more optimistic approach to the management of stroke patients.

## S U M M A R Y

A persistent electrical stimulation of the flexors and extensors of the fingers in hemiplegics associated with continuous prompting of patients to voluntarily "help the current" results in a n improvement of the voluntary finger and wrist movements. In the majority of patients treated in this way in whom voluntary finger movements had not been present prior to therapy, these movements did appear after a prolonged therapy (several weeks). In those patients in whom such movements were weak, their amplitude became larger. Once movements appeared, a painstaking occupational therapy becomes more effective.

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