

ELECTROSTIMULATION OF THE SPINAL CORD IN THE EXPERIMENT AND CLINIC.

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A very important biological, clinical and social problem is the problem of regeneration of the injured spinal cord. It is well established that applied electric fields affect development and regeneration of neurites in vivo and not only the facilitated regeneration of adult mammalian central axons, but also their guidance, by an imposed electric field. (Borgens, 1999).

In our experiments on dogs with damaged spinal cord various parameters of electric current, modes of its conduction and responses of the spinal to its application were explored. As the result of these experiments, a radiofrequency-powered spinal cord stimulator was designed and procedure for its application worked out. It was found that the threshold of current was 200mcA.

The experimental design was based on implantation of either active or sham oscillating field stimulator stimulators, combined with standard veterinary care, including laminectomy and hemisection of the spinal cord. The animals were divided into two treatment categories: those implanted with active stimulators (15 dogs) and those with sham stimulator units and electrodes (15 dogs). After T-10

hemisectioning of the spinal cord, two electrodes were placed under the dura longitudinally above and below the injury area, respectively, over the posterior cord aspect, with the contact surfaces facing the cord. These were placed together with the receiver in the subcutaneous pocket. Stimulation was started 5-5 days after the operation and was carried out for 30-40 sec/session 5 or 6 times/day using the following stimulus parameters: intensity 100-150 mcA, frequency 20Hz, pulse width 0,5msec. The extent of recovery was measured with standardized neurological electrodiagnostic and general medical examinations every month during 12 months.

We used open-field walking to measure the animals' gross locomotor ability (M.Breattie, J.Bresnahan, 1989).

After 12 months animals were killed and the spinal cords were removed. A hemotoxylin-eosin (Avtsyn's stain) was used on several sections to assess cord histology.

In both groups of animals, spinal cord morphological assessment showed a rigid glial tissue on the side of the spinal cord hemisection formation of the intramedullary cysts above the injury zone.

In the undamaged part of the cord in the control group we observed no evidence of neuronal activation or sprouting phenomenon. In 13 dogs (86,7%) from the "stimulation " group, regular electrostimulation of the undamaged portion of the spinal cord led to hypertrophy of nuclei of neurons. In these animals clear evidence

of neuroactivation and of intensification of sprouting phenomenon were observed, since the presence of these processes was not observed in “control” animals. The difference between both groups was significant { $p < 0.01$ analysis of variance}.

After positive results of an experimental study, the method was used in the clinic (A.Livshits, 1977, 1991) in the 6 patients who underwent operation for the implantation of a radio-frequency stimulating device for the spinal cord. Level of the spinal cord injury: T-3 (one patient); T-6-7 (2 patients); T-8 (one patient); T-9-10 (one patient); T-12 (one patient).

ASIA impairment scale showed total paralysis=0, dysfunction of the pelvic organs. We performed operation 5-7 hours after trauma. In three patients lateral corticospinal tract; in one patient-lateral corticospinal and spino-cerebellar tracts were found partly damaged; in two patients-extra-intramedular hematoma and edema of the spinal cord were found and result of electrostimulation of the spinal cord of this two patients were unsatisfactory. In four patients electrostimulation of the spinal cord was started 3 days after operation and carried out one year. Approximately 27-35 days after the operation the involuntary function of micturition was received. After 80 days voluntary motor activity has reached 1 by the ASIA scale, after 120-140 days - 2, after 150-160 days - 3 by the scale. After 6 months, voluntary motor activity in 3 patients has reached scale 4. High reflex activity of the spinal cord was found, with increases recorded both H-reflex and M-responses. Suspension of stimulation [for one month] resulted in reduced reflex activity.

Three years follow-up studies of this patients onward have shown that regular electrostimulation has induced the formation of new efferent pathways, as it was indicated by the reappearance of audiospinal and H-reflexes in a patients with completely lost efferent conduction.

Radiofrequency electric stimulation in acute period of spinal cord trauma promotes the activation of the reflex and conduction functions of the intact spinal structures. The mechanisms of the effect caused by electric stimulation on the functional state of the injured spinal structures require a further study.

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