

SPACE NEUROLOGY AND THE USE OF ITS SCIENTIFIC RESULTS IN NEUROREHABILITATION

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The research goal of space neurology is to get new information about the influence of the microgravity on the nervous system and the application of the results in routine neurology. A spin-off effect is the development of new methods for neuro-diagnostics and neuro-rehabilitation.

Only a minimal part of the research programme in space medicine takes place under the condition of the real microgravity during space flights or in the orbit station (ISS). Most experiments are performed in ground based laboratories by using the methods of simulated microgravity, like the head down tilt system (HDT) and the dry water immersion model (DWI).

In the real as well as in the simulated microgravity typical functional disorders of the nervous system occur, caused by the different stimulation of the receptors in the foot sole, vertebral spine joints etc. and a changed information through the afferent system to the brain, the proprioceptive system. The proprioception is responsible for the control of the position and the movements of the human body in the gravity field. Over millions of years, the human organism was adapted to the gravity, the human motoric, especially for the control of the upright position and the bipod-gait of man have been developed accordingly.

Without the normal influence of gravity the central interpretation of the modified afferent signals, mainly from the proprioception and the otolithic system is different. The consequence is a dysfunction in the orientation to the own body and a disorientation to the surroundings. By the undisturbed signals from the visual system and the afferences of the skin- and joint-receptors an "up-dating" of the internal representation of the head, trunk and the extremities, the body scheme, has to be restored, developing an "adapted dynamic body scheme" (Parker et al, 1985).

During long-term stay in real microgravity, in the weightlessness like in the situation of the crew in the ISS complex musculo-skeletal failures as well a disturbance in postural control occur (Berger et al, 1997). Without appropriate countermeasures during the training of astronauts/cosmonauts, the symptoms of the so called "cosmonaut-syndrome" are developing (Gerstenbrand, Muigg, 1993), with the main symptoms of polyneuropathic disturbances, primary muscle atrophies, posterior column disturbances, thalamic sensations and a reduction of cognitive functions and the vigilance. All this symptoms show a rapid restauration after return to the Earth's atmosphere.

A similar state to compare with the cosmonaut-syndrome is developing in patients being in a situation like a simulated microgravity during long-term bedfastness, called "bed-rest-syndrome". The bed rest syndrome frequently can be observed in patients in a long lasting coma state, Apallic syndrome, as well in other long-term bed stay (cardio-vascular disease, post traumatic states, severe bone fractures etc.). A bed rest syndrome can be find also in elderly people with a motion deficit. The symptoms of the bed rest syndrome are similar to cosmonaut syndrome, as polyneuropathy, primary muscle atrophy, posterior column disturbances, cognitive failures, declining in vigilance and a vegetative dysbalance. The patho-physiological explanation of the bed rest syndrome is the longer horizontal position with a deficit to the impact of the normal gravity.

For neurodiagnostic and neurorehabilitation the results in experiments and the real and simulated micro gravity can be used for new methods in the development of new medical equipment.

For the neurodiagnostics the effect of intensifying of minimal neurological failures observed in experimental microgravity (Gerstenbrand, Marosi, 1997) can be used in the early diagnosis of neurological diseases like in Parkinson Syndrome, Spasticity etc.

In neurorehabilitation different methods to stimulate the proprioceptive system are in development like the foot sole pressure therapy using the vibro stimulation method for the foot sole. The development of the bed rest syndrome can be influenced, then the Parkinson symptoms and spasticity ameliorated. A new devise called "pressure shoe" is developed especially for the treatment of Apallic patients. The Russian space medicine adapted cosmonaut-

trousers for use in rehabilitation of spastic paresis.

A remarkable experiment for the development of methods and devices in neurorehabilitation is the examination of the foot sole vibro stimulation using the functional MRI in an increase of the blood flow, the BOLD-effect can be demonstrated immediately in the sensorimotoric areas, contra lateral and homo lateral, the thalamus, in the frontal brain and the temporal lobe region.

A new method coming from the special situation of a partial micro gravity which is existing under water with influence to the proprioceptive system can be seen during scuba diving in 4-5 meters depth. Therapeutic use of scuba diving is in the neurorehabilitation of spasticity and vertebral spine disturbances.

Space neurology is not only a fascinating new and pioneering research field with a special fascination, but supplies a wide range of new possibilities in diagnosis and therapy in day-to-day medicine.



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