Karl Landsteiner Institute for Neurorehabilitation and Space Neurology

The Proprioceptive System, basis for motor activities, changes in weightlessness - Introduction

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WS08 New Methods in Neurorehabilitation developed in space neurology
21th March, 2010

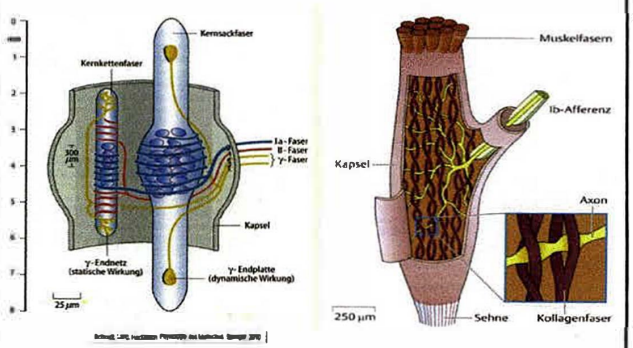
Definition of proprioception

- Proprius [lat.] = meaning „one's own"
- Perception = the sense of the relative position of neighboring parts of the body

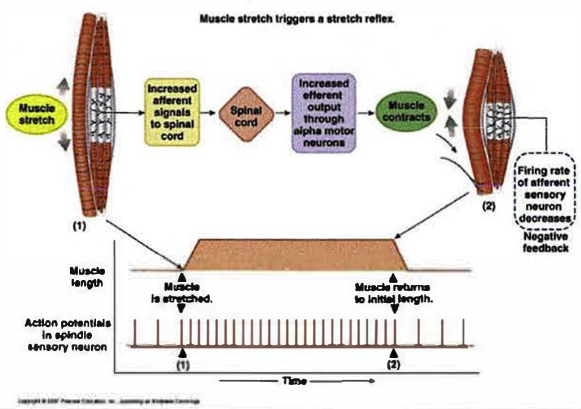
Different senses

- First modality:
  Exteroceptive senses perceiving the outside world
  - see, taste, smell, touch, hear, balance
- Second modality:
  Interceptive senses perceiving pain, movement of internal organs
- Third modality provides feedback solely on the status body internally, moving of the body, location of the various parts of the body in relation to each other

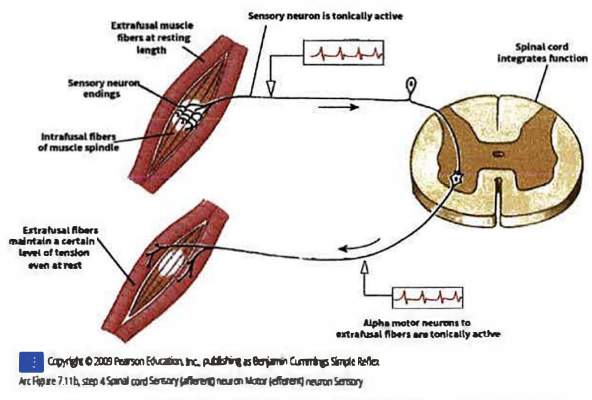
Scheme of muscle spindle



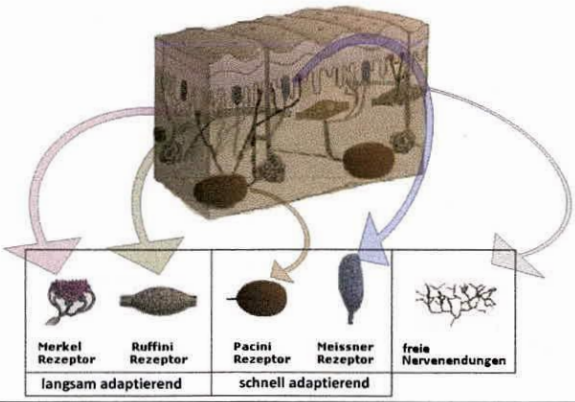
Muscle spindle function



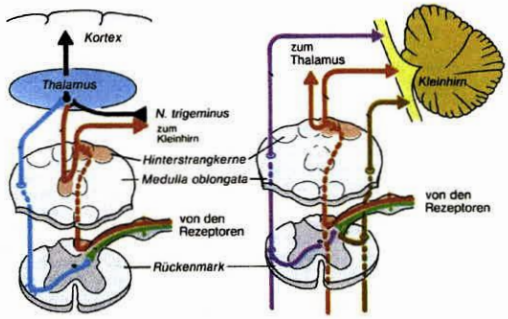
Muscle spindle function



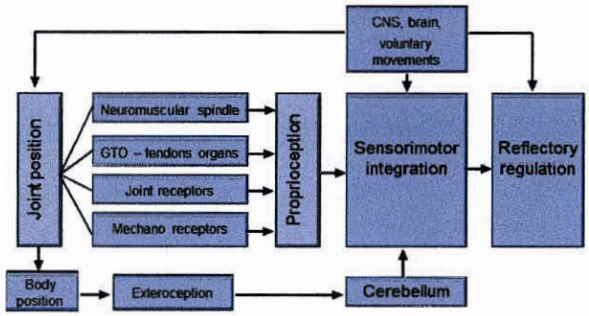
Scheme of Mechano-Receptors



Connection of the proprioceptive system to the cortex and to the cerebellum



Scheme of the function of proprioception



Function of Mechano-Receptors in normal gravity, G_1

- Every movement of the whole body and its details is changing the geometry of the body, displaces the body's balance point
- Every muscle activity is accompanied of restoring force per unit area reacting of the body segments and are threating to move them
- In weightlessness new body scheme has to be created, postural corrections are introduced

Space Neurology

- Research content: influence of microgravity to human being and animals
  - Real microgravity
    - Influence on the proprioceptive system
    - Influence on the vestibular system (otolit system)
  - Simulated microgravity, ground based laboratory
    - Influence on the proprioceptive system
- Research results: use in neurology
  - Diagnosis in acute neurology
  - Neurorehabilitation
- Development of new methods and new devices for use in
  - Acute neurology
  - Neurorehabilitation

Research in Microgravity

- Parable flight
- Real microgravity
- Simulated microgravity
  - Ground based laboratory

Symptoms of the Cosmonaut Syndrome

- Muscle atrophy with morphological changes
- Polyneuropathy symptoms
- Proprioceptive disturbances
- Spinal ataxia
- Cerebellar ataxia
- Reduced vigility
- Disturbances of higher cortical functions
- Vegetative disorders
  - Diminished bone density (osteoporosis)

Counter Measures in Real Microgravity

- Treadmill exercises
  - Daily fixed program
- Special exercises legs and arms
- Adaptation of fine motor skills
  - Target training
- Adaptation training of cognitive functions
- Electrode trousers
- Penguin suit

Counter Measures in Real Microgravity

Cosmonauts at MIR in training

Research in Microgravity

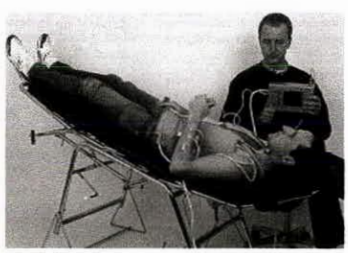
- Parable flight
- Real microgravity
- Simulated microgravity
  - Ground based laboratory

Simulated microgravity

Ground based laboratory
Special equipment necessary

- Methods
  - Bedrest system
    - Head down tilt-system – HDT
  - Body weight discharge
  - Dry water immersion model – DWI-method

Simulated microgravity



Head down tilt position (HDT), bedrest method

Unilateral body weight discharge

Simulated microgravity
Dry water immersion model – DWI-method

DWI institution, Innsbruck, Neurospace Institute, 2 healthy volunteers, 48 hours experiment

DWI experiment, healthy volunteer lift out for showering

Symptoms of the Bedrest Syndrome

- Primary muscle atrophy with muscular changes and structural lesions
- Changing in muscle enzymes
- Polyneuropathy
- Disturbances of the proprioceptive system (spinal ataxia, posterior tract disturbances)
- Thalamic symptoms
- Decrease in vigilance
- Cognitive disturbances
- Body scheme disturbances
- Osteoporosis

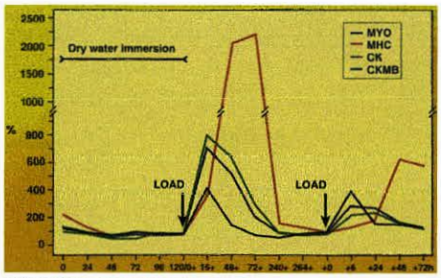
Bedrest Syndrome – Etiology

- Pathogenous origin
  - Long-lasting coma-states, apallic syndrome, etc.
  - Cardio-vascular disturbances, long bed stay
  - Post-traumatic states (severe bone fractures, etc.)
  - Parkinson Syndrome
  - Spasticity
  - Dementia
- Psychiatric patients (reduced motion - drug induced)
- Elderly people (reduced motion)

Pathophysiology of Cosmonaut and Bedrest Syndrome

- Microgravity miss-influence of gravity receptors, disturbances of the proprioceptive system
  - Disturbances of motoric system (body movement)
  - Disturbance of the upright position (postural reflexes)
  - Disturbances of the sensoric system, reafference
  - Disturbances of the thalamic function
  - Disturbances of frontal lobe functions (cognitive abilities, psycho-motoric coordination, associativity, critism, emotional control)
  - Disturbances of vigilance (ascending reticular system)
  - Disturbances of higher and highest brain functions

Pattern of Skeletal Muscle Proteins after DWI for 5 days followed by isometric muscle load



- Myoglobin: Myo
- Myosin heavy chain fragments: MHC
- Creatine kinase enzyme activity: CK
- Creatine kinase MB isoenzyme enzyme mass: CK-MB

Source: Artner Dworzak et al, 1993

Pattern of skeletal muscle proteins which were measured in the plasma of a healthy male volunteer. The concentrations are shown as percent increase from baseline value. Total immobilization (DWI) lasted for 5 days followed by a standardized isometric muscle load. After a regeneration period of 14 days the same procedure of muscle load was performed but with a 2-fold increased isometric load.

Research Results
Real and Simulated Microgravity
Acute Neurology

- In simulated microgravity examinations using bedrest methods (DWI, HDT)
  - discovering of minimal brain lesions (spasticity, extra-pyramidal symptoms, frontal lobe symptoms
  - multiplication effect of minimal neurological symptoms (rigidity, spastic signs, frontal lobe symptoms, etc.)
- In real microgravity: danger in multiplication of minimal neurological symptoms
  - Pre-flight examination of cosmonauts/astronauts

Development of new medical methods in neuro-diagnosis

- Bedrest method in early stages
  - Parkinson's disease, spasticity, cerebellar disturbances, frontal lobe syndrome, etc.
- Monitoring of the neurological conditions using bedrest methods (clinical monitoring and additional methods)

Research Results Real and Simulated Microgravity Neurorehabilitation

- Development of new methods in
  - Motoric disturbances
    - Parkinson symptoms, spasticity, cerebellar disturbances
    - Disturbances of the peripheral nerve system
  - Bedrest syndrome
  - Dementia

Research Results Real and Simulated Microgravity Further fields of application

- Development and application of new methods
  - Geriatrics
  - Psychiatric disorders
  - Special methods in wellness institutions

Different Devices for Neurorehabilitation, Spin-Off Effects of Space Neurology

- Pressure shoe – Austrian model
- Pressure shoe – Russian model
- Korvit System – Foot loading imitator
- Regent – treatment suit
- Penguin System

New Neurorehabilitation Methods

Pressure shoe
Austrian model

Used in:

long-lasting coma states (intensive care units), Prevention of bedrest syndrome

Apallic syndrome
Locked-in syndrome

Severe stroke defects

Severe states after traumatic brain injury

Planned: Dementia, Geriatric institutions

Neurology, Neurorehabilitation and Space Neurology in Future

- Neurological examinations, focused on simulated microgravity methods
  - Additional knowledge of the proprioceptive system (motoric system, thalamic system, higher and highest brain functions)
  - New methods in neuro-diagnosis (multiplication effect of minimal brain lesions)
  - Development of new methods in neuro-rehabilitation
- Neurological examination in real microgravity (orbit flights in ISS, moon missions, planned manned Mars mission)
- Examination in partial microgravity of underwater conditions

Time	Room	
09:00 – 11:00	**Forum**	**WS01 Modular motor therapy upper extremity** *H. Krause/O. Dahncke, Germany*
	Souterrain	**WS02 Gait restoration in cerebral palsy: The interplay of surgeon and neuropaediatrician** Gait development and gait training in children with cerebral palsy; *K. Müller, Germany* Gait improvement surgery – state of the art; *B. Westhoff, Germany*
	Gartensaal	**WS03 Critical illness neuropathy** The view of intensive care physician from risk factors to prevention; *E. Schmutzhard, Austria* Neurophysiological aspects of critical illness myopathy and neuropathy; *C.F. Bolton, Canada* Clinical aspects of critical illness myopathy and neuropathy; *N. Latronico, Italy* The view of the neuro-rehab physicians; *P. Tonin, Italy*
	Geheime Ratstube	**WS04 Vocational rehabilitation** *M. Leonardi, Italy* Social/vocational reintegration following traumatic injury: the french experience; *J.L. Truelle, Fr.* Vocational rehabilitation: the UK experience; *A. Frank, UK*
	Rittersaal	**WS05 Neuropsychological evaluation** Interdisciplinary assessment of neglect; *S. Clarke, Switzerland* Assessment of executive deficits; *J. Evans, UK* Ecological assessment – predicting problems in everyday life; *B. Wilson, UK*
11:00		Coffee Break
11:30 – 13:30	**Forum**	**WS06 Robots International** Using Upper and Lower Limb Robots in Clinical Practice, Live hands-on experience *H.I. Krebs, USA, G. Colombo, Switzerland, S. Hesse, Germany*
	Souterrain	**WS07 Treatment of spasticity** *M. Barnes, UK & M. Zampolini, Italy*
	Gartensaal	**WS08 New methods in neurorehabilitation developed in space neurology** *Chair: F. Gerstenbrand, Austria, I.B. Kozlovskaya, Russia* The proprioceptive system, Basis for motoric activities, Changement in the weightlessness, Introduction; *F. Gerstenbrand, Austria* Real and simulated micro gravity, Influence to the motoric system; *I.B. Kozlovskaya, Russia* Foot sole vibro stimulation, verification of activitation in sensory motor area using Fmri; *S. Golaszewski* New methods in neurorehabilitation due to results in space neurology; *A. Guekht, Russia* First results with the stimulation shoe in apallic syndrome, Vegetative state and locked-in Syndrome; *G. Pichler, Austria*
	Geheime Ratstube	**WS09 Neurological music therapy** *M. Thaut, USA*
	Rittersaal	**WS10 Non organicity assessment in claimed TBI** *N. Zasler, USA*
13:30		Lunch Break
14:30 – 16:30	**Forum**	**WS11 Modular motor therapy lower extremity** Rehabilitation pathway for stroke patients; *B. Briem/H. Wittenberg, Germany*
	Souterrain	**WS12 SCI assessment and education** Standards in neurological diagnosis and scoring, respectively in education; *G. Onose, Romania* Standards in functional assessment; *H. van Hedel, Switzerland* Pattern and thresholds of clinical recovery in in/complete SCI; *A. Curt, Switzerland* Long term survey/assessment of persons with post SCI sequels – pattern of an electronic proposed related database with dynamic clustering mechanism; *A. Mirea, Romania*
	Gartensaal	**WS13 Pain Topics in Neurorehabilitation** *Chair: N. Namerow, USA* The pain and neurorehabilitation interface; *C. Argoff, USA* Central pain syndromes following stroke and spinal cord injury; *D. Bouhassira, France* The diagnosis and management of chronic low back pain; *M. Grabois, USA*
	Geheime Ratstube	**WS14 Brain Storming** Future of Neuro-Rehab-Education Structures *H. Binder, Austria, V. Hömberg, Germany, B. Dobkin, USA*
	Rittersaal	**WS15 Early Home Supported Discharge (EHSD) – a new model of post-stroke rehabilitation** Early supported discharge after stroke; *J. Opara, Poland;* Evidence on the Efficacy of Integrated Care; *T. Larsen, Denmark;* Home rehabilitation of stroke patients – results of multicenter study; *P. Mogensen, Denmark;*
16:30		Coffee Break
17:00	**Festssaal**	**Michael P. Barnes Lecture:** Axonal regeneration in the central nervous system - A Retrospective, *A. Aguayo, Canada* **Opening** followed by a **Welcome Drink**

WFNR

World Federation for NeuroRehabilitation

6th World Congress for NeuroRehabilitation 2010

Hofburg Congress Center
Vienna, Austria

Sunday, March 21 – Thursday, March 25

Final Programme

www.wcnr2010.org

6th WORLD CONGRESS FOR NEUROREHABILITATION
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