Balance and gait Neurorehabilitation in multiple sclerosis with significant fatigue and spasticity

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Abstract

Multiple sclerosis (MS) is a socially important disease, with a high level of acquired disability in a relatively young population. Motor weakness, spasticity, balance and coordination dysfunctions provoke severe difficulty in everyday activities of MS patients.

Neurorehabilitation (NR) is an interdisciplinary thematic field between Neurology, Neurosurgery, Physical and rehabilitation medicine (PRM). According the White Book of PRM, Rehabilitation (including NR) is a functional therapy, based on a detailed functional assessment. Balance and Gait recovery are important goal in NR-clinical practice, essential for the independence of patients in activities in daily living.

We present the case of a 33-years old female, with definitive MS, cerebro-spinal form, relapsing-remitting evolution with secondary progression; admitted to our PRM-Department for NR 15 days after a relapse. Ad the entry, the patient had spastic inferior paraplegia, cerebellar ataxia; significant spasticity, and important fatigue. EDSS-score = 6,5.

We applied a complex NR-programme, combination of traditional and modern methods, oriented to diagnosis (functional tests and scales, stabilometry and gait assessment; International Classification of Functioning) and therapy (proprioceptive neuromuscular facilitation - PNF; electrical stimulations; cryotherapy; balance and gait training; transcranial and transmedullar magnetic field, ergotherapy, LOCOMAT (Hocoma).

Because of the significant spasticity, appearance of clonus and important fatigue, we divided the physiotherapy and robotic procedures in periods of 30 minutes. Complex NR-programme is effective for stimulation of activity-dependent neuroplasticity. We emphasize the impact of NR for functional recovery, amelioration of autonomy and quality of life of MS-patients. In case of fatigue and spasticity, we recommend fractionation of the NR-procedures.

Keywords: Neurorehabilitation, Multiple sclerosis, fatigue, spasticity, robotic rehabilitation, Locomat, Expanded Disability Status scale, algorithm, functional assessment, physical medicine, rehabilitation

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Introduction

Multiple sclerosis (MS) is an autoimmune demyelinating disease of the central nervous system, usually beginning between 20 and 40 years (predominantly in females) [1].

Motor weakness, spasticity, balance and coordination dysfunctions provoke severe difficulty in everyday activities of MS patients [2]. MS is a socially important disease, with a high level of acquired disability in a relatively young population [3]. Traditionally, the rehabilitation in MS includes physiotherapy [4] and cryotherapy [5]. Our goal is to apply the complex Neurorehabilitation principles in case of MS.

Neurorehabilitation (NR) is an interdisciplinary thematic field between Neurology, Neurosurgery, Physical and rehabilitation medicine (PRM).

According the White Book of PRM [6, 7], Rehabilitation (including NR) is a functional therapy, based on a detailed functional assessment.

For functional evaluation in NR we apply neurological scales, the International Classification of Diseases (ICD) [8] and the International Classification of Functioning (ICF) [9]. For treatment, we use the SMART approach (specific, measurable, achievable, realistic and time-bound). We apply the "rehabilitation puzzle"- a synergic combination of different physical modalities (electric currents, magnetic field, movement, activities, temperature, etc.).

Balance and Gait recovery are important goal in NR-clinical practice [10], essential for the independence of patients in activities in daily living.

Case Presentation

2.1. General presentation of the patient

We present the case of a 33-years old female, with definitive MS, cerebro-spinal form, relapsing-remitting evolution with secondary progression; admitted to our PRM-Department for NR 15 days after a relapse. The diagnosis was clinically and radiologically proved (fig.1) by the staff of University Clinic of Neurology. At the entry, the patient had spastic inferior paraplegia, cerebellar ataxia, significant spasticity, and important fatigue. EDSS-score = 6,5.

We applied a complex NR-programme, combination of traditional and modern methods, oriented to diagnosis (functional tests and scales, stabilometry and gait assessment; International Classification of Functioning) and therapy (proprioceptive neuromuscular facilitation - PNF; electrical stimulations; cryotherapy; balance and gait training; transcranial and transmedullar magnetic field, ergotherapy, LOCOMAT (Hocoma).

2.2. Functional evaluation

At the admission, she presented a quadriparetic syndrome with inferior spastic paraplegia; cerebellar ataxia (static ataxia in sitting position, dynamic dyscoordination); urinary incontinence (urinary catheter). Spasticity – 3+. Pathologic reflexes of the Babinski and Rossolimo groups in feet. Defensive reflexes in lower extremities. Clonus of the right foot. Wheeled mobility (using an electric wheelchair).

During clinical assessment, we accentuate on some analyses:

- pain (localization, type, intensity – verbal or visual analogue scale);
- joint stability (including joint position sense) and range of motion (active and passive);
- presence of muscle or joint contractures;
- evaluation of the muscle force / muscle insufficiency, motor deficit;
- analysis of the grasp and gait; mobility (necessity of technical aids: canes, walking sticks, crutches, walkers, wheelchairs or other devices); fatigue (physical endurance, necessity of rest during the examination or the functional activity);
- autonomy in everyday activities (bathing, dressing, eating, putting shoes on, personal hygiene, need of help in activities of daily life - ADL).

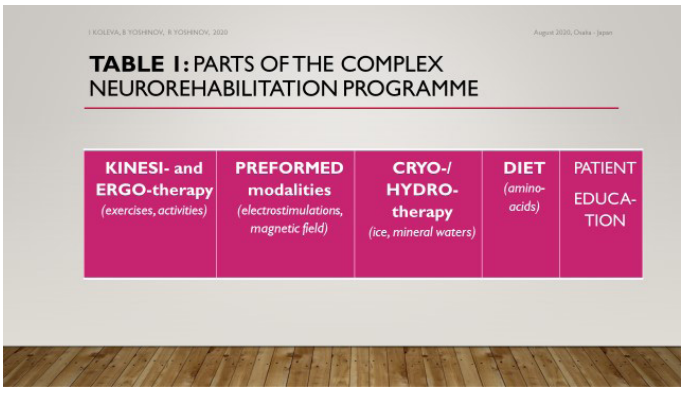
Evaluation of problems must be qualitative and quantitative, including: fatigue, motor deficiency, coordination problems (body position, gait, grasp); irritative sensory signs and pain; conscience for the necessity of technical aids and assistive technologies; difficulties in ADL; limitations of functional mobility.

In MS cases, we consider very important the investigation of the vibration sense (vibro-esthesiometry -Ryedel-Seyfert fork) and of joint position sense (analysis of proprioception).

2.3. Complex NR programme

In clinical NR-practice, many traditional and contemporaneous physical modalities and methods are applied:

- From the field of physiotherapy: proprioceptive neuro-muscular facilitation (PNF) techniques; aerobic exercises; strengthening exercises, analytic exercises; stretching and range-of-motion exercises; bimanual and bipedal training (if possible); Regular physical activity (repetition of exercises with mild to moderate intensity); grasp training and Mirror therapy; balance and gait training; device-assisted mechanotherapy (passive, active or combined);
- From the domain of ergotherapy (occupational therapy): Education of the person with disability trough task oriented (task-specific) activities; Art therapy, music-therapy; relaxation techniques (including sleeping); technical aids (wheelchair, canes, or walking sticks); home adaptations;
- From the field of balneotherapy: cryotherapy; underwater exercises; etc.
- From the field of preformed physical modalities: electrical stimulations (with low and middle frequency electric currents); transcranial and transmedullar magnetic stimulation; deep oscillation;
- Robotic NR: Exoskeleton, Locomat, Virtual reality, etc.



In this case, we applied a complex NR-programme, combination of traditional and modern methods, oriented to diagnosis (functional tests and scales, stabilometry and gait assessment; International Classification of Functioning) and therapy (proprioceptive neuromuscular facilitation - PNF; electrical

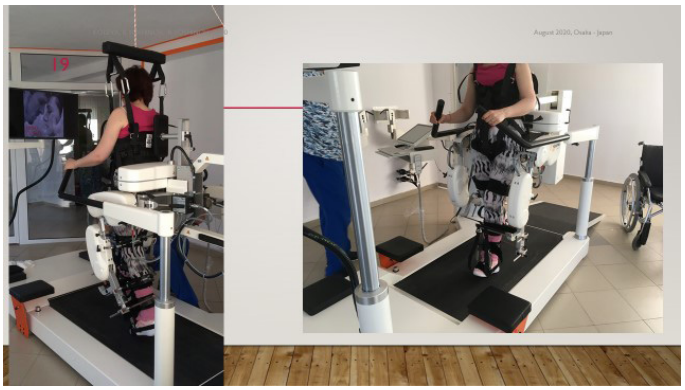
stimulations; cryotherapy; balance and gait training; transcranial and transmedullar magnetic field, ergotherapy, LOCOMAT (fig.2).

The complex NR-programme of our patient included everyday séances of many procedures, as follows:

- Cryotherapy (ice-packages) for the spastic muscles (m.triceps surae, m. tibialis anterior) and for ankle contractures; séances of 10 minutes, 3-5 sessions daily;
- Antagonists' electrostimulations - for feet extensors (m.tibialis anterior, m.peroneus longus, m.extensor digitorum longus, m.extensor halluces) – galvanic current, tetanic pulses, 10-15 minutes, 20 procedures;
- Low frequency pulsed magnetic field – 16 000 A / m, 10-20 min. – paravertebral localization of inductors; 8 000 A / m, 10-20 min. – trans cerebral application;
- Proprioceptive neuromuscular facilitation (PNF) techniques;
- Aerobic exercises and general strengthening for arms and legs;
- Analytic exercises – especially for ankle flexors and extensors; for muscles - digital flexors, for m. abductor pollicis, m. flexor pollicis, m. opponens pollicis;
- Bimanual coordination exercises;
- Stretching of ankle ligaments and exercises for ankle ROM;
- Relaxation techniques and Yoga elements
- Grasp training and Goal-oriented activities (for ADL);
- Training of the Posture, Balance & Trunk control (in sitting position),
- Gradual verticalization, balance and gait training with two crutches and two physiotherapists.
- Coordination, transfers and ambulation (gait) training;
- Balance and gait training with LOCOMAT (20 procedures of 60 minutes, or 40 séances of 30 minutes, twice daily).

Nota Bene!

- During the NR-course (PT – 2 x 60 min, Locomat – 60 min.), we observed an important increase of fatigue, spasticity and appearance of clonus (fig.3) and we were obliged to divide the physical load.
- The physiotherapeutic procedures were fractioned into 4 times per day (4 x 30 min), the Locomat séances were distributed twice daily (2 x 30 min).



Results and Discussion

After one month, we observed amelioration in trunk control, increase of the range-of-motion of ankle joints and decrease of motor weakness of lower limbs, reduction of spasticity, amelioration of the balance; improvement of functional capacity and autonomy in ADL.

3.1. Neuroplasticity

Complex NR-programme is effective for stimulation of activity-dependent neuroplasticity.

Neuroplasticity is considered as: the adult brain's ability to adapt. According the medical dictionaries: "neuroplasticity is the brain's capacity to reorganize itself by forming new neural connections throughout life". The "aim" of neuroplasticity is to optimize neural networks during phylogenesis, ontogenesis and physiological

learning, and in case of a brain disease [11]. Neuroplasticity allows the neurons to compensate for injury and disease and to adjust their activities in response to new situations or to changes in their environment. Principal mechanisms of brain repair are based on brain plasticity (spontaneous recovery, input of "axonal sprouting" and "mirror-neurons", use-dependent plasticity, synaptic or grey matter plasticity, white matter plasticity).

The goal of NR is the patient's adaptation to the "new" situation (of neuronal alteration). For this, we use two types of modulation techniques: stimulation of some functions (e.g. motor and sensory functions) and inhibition of other (e.g. pain reduction).

For stimulation, we apply training of the altered motor function (through movements and activities - use-dependent plasticity) and some compensatory mechanisms (bypass strategies, replacement of functions by aiding devices, adaptation of the environment to patient's needs).

For inhibition, we apply pain management mechanisms: blocking the nociception and the neurotransmission, peripheral sympaticolysis, input the gate-control, peripheral and central desensitization, influence on the descending systems for pain control and activation of the encephalic blocking system of the central nervous system, activation of reflectory connections.

Neuroplasticity is the pathophysiological basis for treatment of the cerebral lesions through physical training and rehabilitation, including goal-directed activities. Rehabilitation is a functional therapy, based on a detailed functional assessment. Practically, every rehabilitation process is founded on neuroplasticity (training or use-dependent plasticity).

Based on our modest clinical practice (of 30 years) in the NR-field and our own results [12], we emphasize on the capacity of physical modalities for stimulation of neuroplasticity (especially on activity-induced plasticity), on the potential for functional recovery and amelioration of independence in everyday life of MS-patients.

3.2. Neurorehabilitation team in MS

For effective gait rehabilitation the inclusion of a multi-professional Neurorehabilitation team is obligatory.

In Bulgarian rehabilitation practice traditionally a lot of specialists are included: medical doctors – specialists in Neurology and in Physical and Rehabilitation Medicine (PRM); bachelors and masters in Physical Therapy and in Occupational therapy (Kinesio-therapy and Ergo-therapy – according the nomenclature of our country). In some cases, we include psychologist, neuropsychologist, social worker, and medical doctors, specialists in Neurosurgery; Rheumatology; Orthopedics and Traumatology. The coordinated teamwork is the crucial circumstance of the successful Neurorehabilitation.

Conclusion

- Complex NR-Programme is effective for stimulation of activity-dependent neuroplasticity. NR is effective on functional recovery of MS-patients, especially after a relapse.
- Systematic NR ameliorates autonomy and quality of life of MS-patients. In case of fatigue and spasticity, we recommend fractionation of the NR-procedures.

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