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Neurorehabilitation with using of 3 special inertial sensors (innovative software and hardware)

Petra Sladkova, Olga Svestkova and Marie Ticha

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Petra Sladkova, M.D., Ph.D., Marie Ticha, MD, prof. Olga Svestkova, M.D., Ph.D., e-mail: petra@sladkova.eu, petra.sladkova@vfn.cz
Department of Rehabilitation Medicine, General University Hospital in Prague and 1st Medical Faculty of Charles University in Prague

***Abstract*—The neurorehabilitation of patients with brain damage is an interprofessional, complex, intensive, long-lasting and individually oriented process.**
One frequent consequence of brain damage is hemiparesis, which also causes a disorder of the upper extremity movement pattern.

One of the aims of this work was to demonstrate, using objective function methods, the possibility of influencing the movement patterns of a paretic upper extremity by means of intensive interprofessional neurorehabilitation even several years after the brain damage.

The second aim was to demonstrate that the monitoring of motor functions in patients after brain damage leads to improved motivation, thereby improving motor functions.

A study was conducted among 60 selected patients after brain damage with central hemiparesis who participated in the 4-week stay in a neurorehabilitation day care center.

Two groups of patients were studied, one group with a sensor (30 patients - Group A) and one group without a sensor (30 patients - Group B). The parameter studied with the sensor was daylong physical activity of the upper limbs, paretic limb and non-paretic limb.

The results obtained confirmed that brain plasticity can be activated by intensive interprofessional neurorehabilitation even several years after brain damage, rather than just one or two years after the injury or disease.

The results confirmed that an inertial sensor is a suitable instrument for detecting of the changes of upper limb movement activity.

I. INTRODUCTION

The movement ability of the upper limb is essential for an individual's self-sufficiency, the performance of common daily activities, and thus for an independent life in a family setting.

New technological developments have led to the production of miniature inertial sensors.

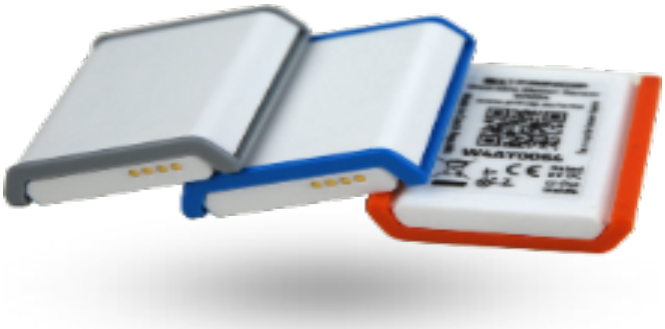
The using of inertial sensor is possibility for objective functional assessment in neurorehabilitation.

Special therapeutic neurorehabilitation approaches should involve the training of new activities, including the motor learning mechanism that activates brain plasticity.

A functional reorganization of the motor cortex occurs along with the activation of reserve neurons and the replacement of damaged synapses.

II. METHODS AND DESIGN

In neurorehabilitation of the patients with hemiparesis is possible to use inertial sensors for monitoring of functional changes of movement pattern (1).
These sensors are possible to use in clinical rehabilitation setting. The using of accelerometer is possibility for objective functional assessment in rehabilitation (2).
The basic principle is measuring of static and dynamic acceleration.
Sensors can be used objectively to quantify amount of movement paretic and non-paretic upper limb activity (3).
The parameter studied with the inertial sensor was daylong physical activity of the upper limbs, paretic limb and non-paretic limb (4, 5).
The new innovative software and hardware was used in special miniature sensors (6, 7).
We used 3 different types of sensors: left blue sensor is on the left wrist, orange sensor is on the right wrist and black body sensor on the left hip.



Picture 1, 2: Appearance of sensor – inertial sensor

Our clinical study was undertaken with selected patients after brain damage with paresis.

Data from sensors monitoring were analysed in special program WMSAPP (Wrist Motion Sensor APPlication software) version 0.0.5.
The following parameter was all-day percentage movement activity of paretic and non-paretic upper limb activity.
The patients were detected at the first and the last week during 4 weeks in a neurorehabilitation day care center from 9 a.m. to 4 p.m.
One of the aims of this work was to demonstrate, using objective function methods, the possibility of influencing the movement patterns of a paretic upper limb by means of intensive interprofessional neurorehabilitation even several years after the acquired brain injury.
The second aim was to demonstrate that the monitoring of motor functions in patients after acquired brain injury leads to improved motivation, thereby improving motor functions.
A study was conducted among 60 selected patients after brain damage with central hemiparesis who participated in the 4-week stay in a neurorehabilitation day care center.
Two groups of patients were studied, one group with an inertial sensor (30 patients - Group A) and one group without an inertial sensor (30 patients - Group B).

Patients in group A were measured by sensor for 7 hours per day of first week after admission and the last week in the care center. The day care center is specialized for individual and group therapy of brain damage patients.

All patients in a study have daily 120 minutes of individual physiotherapy and also120 minutes of individual occupational therapy.

For data analysis were used **s**pecial new SW - WMSAPP (Wrist Motion Sensor APPlication software), Wilcoxon paired test, Mann-Whitney test.

III. Results and conclusion

The sensor had the role of virtual therapist for the idea of permanent monitoring by the therapist. The patients were more motivated for active cooperation during the whole neurorehabilitation process.

Using of sensor – inertial sensor in the experimental group (group A) improved upper limb movement activity, can objectively detected the positive changes in movement spastic pattern.
The results confirmed that inertial sensor is a suitable instrument for detecting of the changes of upper limb movement activity.
The most important positive parameters of the monitoring are the increased motivation of patients for physical therapy and the use of the principles of a feedback inertial sensors.
Sensor can improve motivation (virtual therapists) of patients and also improve movement pattern and functioning of upper extremity and activities of daily living of the patients with brain damage were also improved.
It is possible to use the mechanism of neuroplasticity in intensive interprofessional rehabilitation intervention of patients after brain damage also long time after their illness or injury.

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