USING OF ACCELEROMETER IN REHABILITATION OF BRAIN DAMAGE PATIENTS WITH UPPER ARM PARESIS

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Abstract

Rehabilitation of patients after brain damage is an interprofessional, complex, intensive, long-term process. Often, motor disorder post brain damage results in paresis and causes impairment of upper arm movement pattern. Movement ability of the upper arm is vital for self-sufficiency and activities of daily life.

Special rehabilitation therapeutic techniques must involve the training of new activities including the mechanism of motor learning which is responsible for functional reorganization of the motor cortex regions, and the activation of reserve neurons for reparation.

The aim of the study is to demonstrate that an accelerometer is a suitable instrument for objective monitoring of impairment of the upper arm movement pattern with biofeedback principles.

Another aim of the study is to demonstrate if the FIM test and Jebsen-Taylor (JT) test are appropriate instruments for detecting changes of the upper extremity movement pattern after intensive interprofessional rehabilitation brain damage patients. Clinical study was undertaken with selected patients after brain damage with paresis. The patients attended a rehabilitation day care center for 4 weeks.

The parameter of an all-day movement activity of the upper arm was detected by an accelerometer measurement. The FIM and JT tests were applied at the beginning and after 4 weeks during the final examination.

The results confirmed that an accelerometer is a suitable instrument for detecting of the changes of upper arm movement activity. Analysis of the results confirmed that functional tests, the FIM test and JT test, are sensitive to changes of functional abilities of patients after brain damage.

Keywords: Upper arm paresis, brain damage, accelerometer, interprofessional rehabilitation

Introduction:

Rehabilitation intervention of patients with brain damage is an interprofessional, complex, intensive, long-term and individual process. Motor disorder of the brain damage patients is often hemiparesis.

The aim of the study is to demonstrate that a sensor - accelerometer is a suitable instrument for objective monitoring of movement of upper arm with feedback principles.

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New technological developments have led to the production of miniature accelerometer sensors. These sensors are possible to use in clinical rehabilitation setting. The using of accelerometer is possibility for objective functional assessment in rehabilitation (1, 2).

Standardized functional instruments for the assessment of the degree of disability and functional abilities of patients are not usually used in rehabilitation in the Czech Republic.

In neurorehabilitation of the patients with hemiparesis is possible to use accelerometer for monitoring of functional changes of movement pattern (3).

The accelerometer can be used in gait analysis, balance evaluation, fall risk assessment and mobility monitoring (4).

The basic principle is measuring of static and dynamic acceleration. Sensors can be used objectively to quantify amount of movement paretic and healthy upper arm activity (5).

Picture 1, 2 Appearance of sensor – accelerometer

We used 3 different types of sensors: left blue sensor is on the left wrist, right red sensor is on the right wrist and green body sensor on the left hip.

Our clinical study was undertaken with selected patients after brain damage with paresis. 30 patients after brain damage with upper arm activity were measured by accelerometer.

Data from accelerometer monitoring were analysed in special program WMSAPP (Wrist Motion Sensor APPlication software) version 0.0.3. The following parameter was all-day percentage movement activity of paretic and healthy upper arm activity. The patients were detected at the first and the last week during 4 weeks in a rehabilitation day care center from 9 a.m. to 4 p.m.

The group A (30 patients with accelerometer), group B (25 patients without accelerometer).

The FIM test (Functional Independance Measures) and Jebsen-Taylor (JT) test were used in both group, experimental and control group, it means in 55 patients.

These tests can detect changes of the upper arm movement pattern after intensive interprofessional rehabilitation brain damage patients. The patients attended a rehabilitation day care center for 4 weeks. The day care center is specialized for individual and group therapy of brain damage patients. All patients in a study have daily 60 minutes of individual physiotherapy and also 60 minutes of individual occupational therapy.

Data analysis

Special SW - WMSAPP (Wrist Motion Sensor APPlication software)

Wilcoxon paired test

Mann-Whitney test

Methods

55 patients after brain damage with upper arm paresis were randomized to an experimental group (A, n=30) and a control group (B, n=25). Patients in both group attended a rehabilitation day care center for 4 weeks. Patients in group A were measured by sensor - accelerometer for 7 hours per day of first week after admission and the last week in the care center. The FIM and Jebsen-Taylor (JT) tests were applied on all patients at the beginning

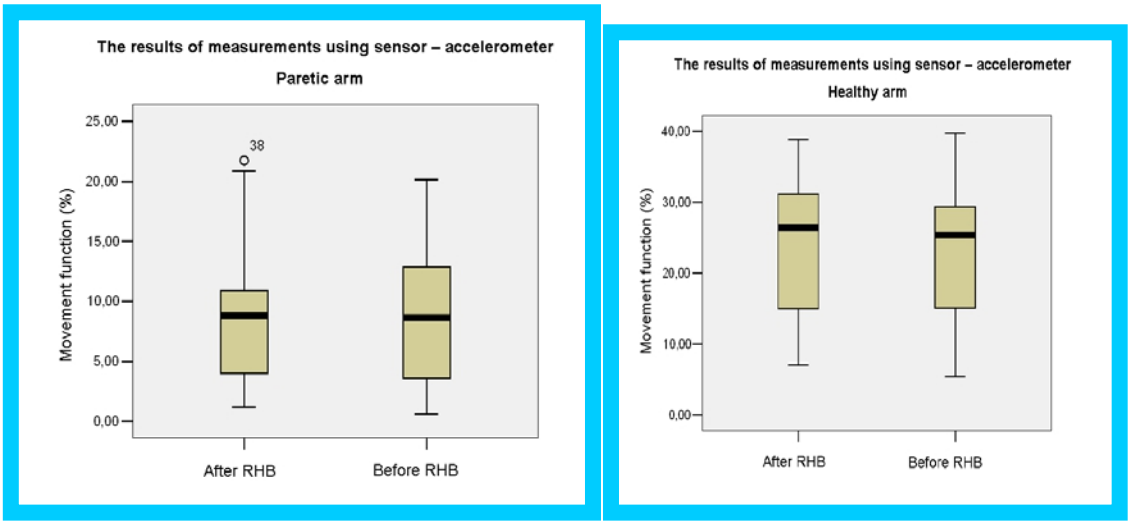
and after 4 weeks of rehabilitation intervention during the final examination. Both tests are used for measurement of quantitative and qualitative changes in activities of daily living during rehabilitation process.

Results

Using of sensor - accelerometer in the experimental group (group A) significantly improved upper arm movement activity, can objectively detected the positive changes in movement spastic pattern. The accelerometer has 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 rehabilitation process.

FIM test was used in all 55 patients. The results showed more significantly improvement of all items of activities of daily living in FIM test in group A than in group B.

Jebsen – Taylor test was used in all 55 patients. The results did not showed significant difference between measured time of activities of daily living between group A and group B.



Graph 1, 2 Results of measuring by accelerometer – paretic, healthy arm.

Conclusion:

Sensor – accelerometer can improve motivation (virtual therapists) of patients and also improve movement pattern and functioning of upper extremity. Activities of daily living of the patients with brain damage are also better.

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.

References:

Culhane, K. M., et al. Long-term mobility monitoring of older adults using accelerometers in a clinical environment. *Clinical Rehabilitation*. 2004, vol. 18, s. 335-343.

Gebruers, N., et al. Monitoring of physical activity after stroke: a systematic review of accecelerometry–based measures. *Physical Medicine and Rehabilitation*. February 2010, vol. 91, s. 288-297.

In, TS, et al. Virtual reality reflection therapy improves motor recovery and motor function in the upper extremities of people with chronic stroke. *Journal of Physical Therapy Science*. 2012, vol. 24, issue: 4, s. 339-343.

Evans, CC, et al. Evaluation of an interdisciplinary team intervention to improve therapeutic aliance in post-acute brain injury rehabilitation. *Journal of Head Trauma Rehabilitation*. 2008, vol. 23, issue: 5, s. 329-338.

Uswatte, G., et al. Objective measurement of functional upper – extremity movement using accelerometer recordings transformed with a treshold filter. Stroke. 2000, vol. 31, s. 662-667