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The effect of stretching exercises as part of the rehabilitation program for patients with spinal cord injury

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Abstract

Introduction & objectives: Spinal cord injury is a neurological condition with a devastating impact on all aspects of patients' life. Spasticity, a symptom of the resulting pyramidal syndrome, can be both beneficial and non-beneficial, and requires treatment when it causes significant limitations and complications. The therapeutic approach comprises a wide variety of therapies ranging from non-invasive to invasive procedures. One of the non-invasive procedures is physiotherapy including stretching exercises. There are several studies investigating the effects of stretching on spasticity but with inconclusive results, slightly favoring a positive effect. The aim of this case-control study was to evaluate the effect of a stretching module added to the specific physiotherapy program for patients with SCI.

Material and method: An observational case-control study was conducted which included 20 patients with SCI attending a motor neurorehabilitation program for 10 consecutive days at the Rehabilitation Hospital Cluj-Napoca and "Dorina Palace" Center, Cluj-Napoca, during the years 2016-2017. The patients were divided into 2 groups of 10 patients each: the control group, which received specific physiotherapy and occupational therapy, and the study group, in which a stretching exercise module was added to the rehabilitation program (attended by the control group). The patients were assessed using the Modified Ashworth Scale, the Range of Motion (ROM) test for the lower limb joints, and the Ten Meter Walk Test, both at the beginning and at the end of the 10-days rehabilitation program.

Results & discussions: The patients in the study group had statistically significant improvements in all the assessed scores compared to the control group, in which improvements were also present, but at the limit of statistical significance.

Conclusion: The inclusion of stretching exercises in the specific physiotherapy program for patients with spastic paraparesis after spinal cord injury seems to have a short-term favorable impact, by reducing spasticity and improving ambulation.

Key words: *spinal cord injury, spasticity, stretching,*

Introduction

Spinal cord injury (SCI) is a neurological condition with a major impact on all aspects of patients' life (familial, professional, socio-economic), and also on the health care system. According to the National Spinal Cord Injury Statistical Center, there are 12,500 new cases of SCI every year in the United States of America, 90% being traumatic, caused by road traffic accidents, violence, sports or falls. About 78% of the new SCI cases are male (1-5).

As a neurological syndrome, SCI is followed by tetraplegia/tetraparesis or paraplegia/paraparesis, and clinical severity is evaluated using the ASIA score. Post-traumatic SCI paraparesis occurs when the traumatic injury involves the spinal cord below the T1 level. Spasticity occurs in 80% of patients with SCI and is a main characteristic of the upper motor neuron syndrome (along with motor deficit, increased tendon jerks, clonus, Babinski sign), and a major cause of disability. Spasticity is defined as a velocity-dependent increase in the tonic stretch reflex resulting in hypertonia of the deficient muscles. Spasticity develops progressively over the months following an injury, after a period of spinal shock, characterized by loss of tendon reflexes below the level of the lesion, motor deficit (paralysis) and hypotonia (2, 5-9).

Spasticity can be both beneficial and non-beneficial, and requires treatment when it causes significant impairments and complications. Although spasticity has a neural cause, there are also consecutive structural adaptations in the soft tissue. Spasticity increases motor deficit and induces pain and fatigue, tendon retraction and ankyloses (which can lead to joint deformation like in equinus contracture),

consequences that interfere with the efficacy of the rehabilitation program and increase the degree of disability (2, 10-12).

The pathogenesis of spasticity following SCI is not completely understood. Several mechanisms seem to be involved: enhancement of the excitability of motoneurons and interneurons, axonal sprouting, reduction of presynaptic inhibition, reciprocal Ia inhibition, post-activation depression, flexor withdrawal reflexes (6, 7).

The therapeutic approach comprises a wide variety of therapies ranging from non-invasive (antispastic drugs, physiotherapy) to invasive procedures (surgical rhizotomy). Antispastic drugs (baclofen, benzodiazepine, tizanidine, clonidine, botulinum toxin, dantrolene sodium) modulate the neuronal component of spasticity, and physiotherapy reduces its biomechanical side effects.

Electrotherapy comprises physiotherapy with exercises used to strengthen the deficient muscles, muscle stretching which helps in reducing muscle tone and in preserving joint mobility and range of motion, orthoses used to hold the limb in correct position, electrical stimulation which blocks the exaggerated motor activity (6, 8, 12-14).

Stretching, the process of elongation, is used by physiotherapists in the approach of spasticity. During stretching, tension is applied to soft tissue structures (muscles, tendons, connective, vascular, dermal, and neural tissues). There are several studies investigating the effects of stretching on spasticity, but with inconclusive results (11, 12, 15).

Starting from empirical findings in neurorehabilitation practice, the aim of this case-control study was to evaluate the effect of a stretching module added to the specific physiotherapy program in patients with SCI.

Material and method

An observational case-control study was conducted, which included 20 patients with SCI attending a motor neurorehabilitation program for 10 consecutive days at the Rehabilitation Hospital Cluj-Napoca and "Dorina Palace" Center Cluj Napoca, between 1.01.2016-31.12.2017. The patients were divided into 2 groups of 10 patients each: the **control group**, with traumatic and non-traumatic (disc herniation, spine vascular malformation, spinal demyelinating lesion, hereditary spastic paraparesis) SCI, which received specific physiotherapy and occupational therapy, and the **study group**, with traumatic SCI, in which a stretching exercise module was added to the rehabilitation program. Post-traumatic etiology of spastic paraparesis, ASIA score B, C and D, age over 18 years, imaging documentation, location of the lesion below T10, a length of time of maximum 1.5 years after SCI occurrence, the informed consent to participate in the study were the inclusion criteria.

The rehabilitation program attended by all patients was focused on specific physiotherapy which consisted of exercises aimed at an increase in joint mobility, particularly in the lower limbs, muscle relaxation and reduction of spasticity, an increase in muscle strength and resistance in both the lower and upper body (indispensable for transfers as well as other activities of daily living).

For the study group, passive stretching and neuroproprioceptive facilitation exercises were added, with emphasis on the most affected muscles by spastic paraparesis: coxofemoral flexors, knee flexors, plantar flexors. The principle of these exercises consists of placing the concerned muscles in the most elongated position tolerated by the patient. At this point, the contraction-relaxation technique is performed, after which elongation is continued, this succession being repeated until the patient's physiological limit or tolerance threshold is reached; at this point, this position is maintained for 10-15 seconds, followed by 15 seconds of relaxation while the initial position is regained. Three sets of 5 repetitions for each studied muscle were performed.

The patients of both groups were assessed at the beginning and at the end of the rehabilitation program in terms of spasticity and ambulation capacity. The evolution of spasticity was evaluated using the Modified Ashworth Scale (from 0 – normal tone to 4 – spastic limb on flexors and extensors) and the Range of Motion (ROM) test concerning flexion and extension of the coxofemoral joint, flexion and extension of the knee joint and foot dorsiflexion. The Ten Meter Walk Test evaluates the walking speed over 10 meters on a flat surface, at the patient's comfortable pace, being a method to classify patients from the point of view of ambulation.

Statistical analysis was performed using Microsoft Excel, categorical data being presented as diagrams, absolute and relative frequencies, and continuous variables being summarized using synthetic centrality or frequency histograms. The paired t test was also used. A p value lower than 0.05 allows rejection of the null hypothesis (absence of any effect of stretching exercises associated with physiotherapy in patients with spastic paraparesis

post-SCI) and acceptance of the alternative hypothesis.

Results

The distribution by gender and age is presented in Table 1 and Figure 1.

Table 1: Distribution by gender

Gender	Study group	Control group
Female	30%	40%
Male	70%	60%

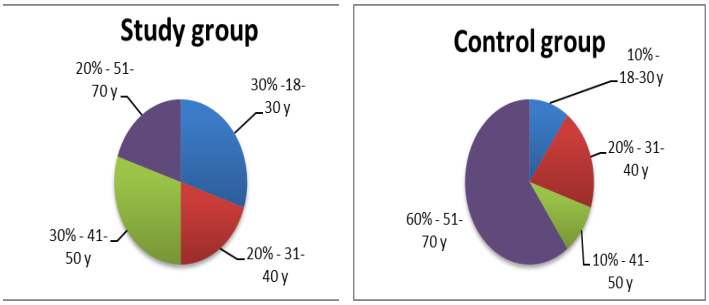


Fig. 1: Distribution by age in the study and the control group.

Patients in the control group were assigned based on ASIA scores to classes C and D. The study group also included 2 patients with a more severe clinical picture (class B) (Fig. 2).

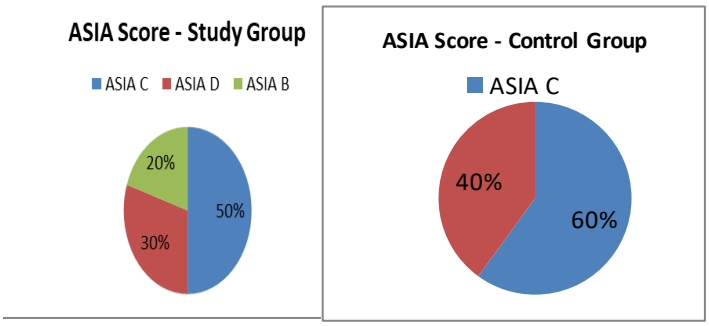
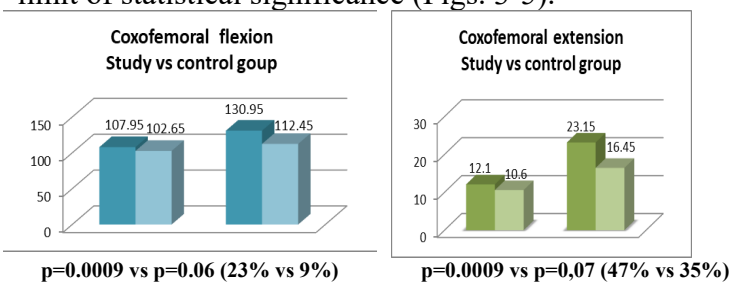


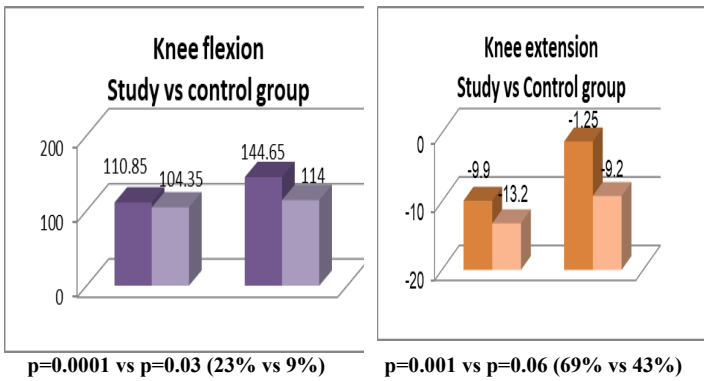
Fig. 2: Distribution by ASIA score in the study and the control group

Concerning the coxofemoral and knee range of flexion and extension and also the foot dorsiflexion range, a statistically significant improvement was found in the study group (with stretching exercises added to the rehabilitation program) compared to the control group, in which the improvement was at the limit of statistical significance (Figs. 3-5).



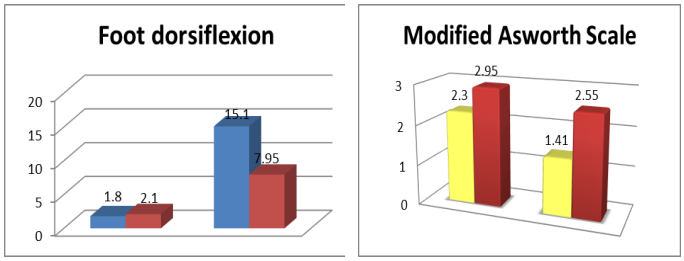
p=0.0009 vs p=0.06 (23% vs 9%) p=0.0009 vs p=0,07 (47% vs 35%)

Fig. 3: Evolution of coxofemoral flexion and extension during 10 days (study vs control group)



p=0.0001 vs p=0.03 (23% vs 9%) p=0.001 vs p=0.06 (69% vs 43%)

Fig. 4: Evolution of knee flexion and extension during 10 days (study vs control group)

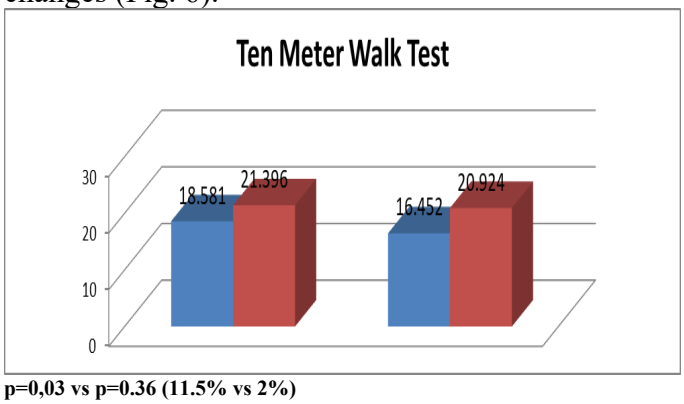


p=0.001 vs p=0.06 (88% vs 73%) p=0,008 vs p=0,03 (38% vs 15%)

Fig. 5: Evolution of foot dorsiflexion and modified Ashworth scale during 10 days (study vs control group)

Spasticity reflected by the values of the modified Ashworth scale also improved statistically significantly in patients with stretching exercises added to the rehabilitation program, while the improvement was at the limit of statistical significance in the control group (Fig. 5).

The time measured by the Ten Meter Walk Test decreased statistically significantly in the study group, while the control group showed no notable changes (Fig. 6).



p=0,03 vs p=0.36 (11.5% vs 2%)

Fig. 6: Evolution of the Ten Meter Walk Test during 10 days (study vs control group)

Discussions

Although the study group included patients with a more severe neurological picture after SCI than those in the control group (ASIA score), these had

highly statistically significant improvements in spasticity reflected by the modified Ashworth scale and ROM in the coxofemoral, knee and ankle joints, as well as in the walking speed on the Ten Meter Walk Test, suggesting an improvement of ambulation.

The study has some limitations. The groups were not homogeneous, the patients in the control group also had other etiologies of SCI with a less severe neurological picture compared to the study group, in which all patients had traumatic SCI. Also, in the control group, the majority of the patients were aged over 50 years (reflecting in fact SCI etiology in this group), while patients in the study group were considerably younger. The patients came from two rehabilitation centers. Only the short-term effects were assessed, which were beneficial, but the long-term effects, which require a long time period during which stretching exercises added to physiotherapy should be performed constantly and their effects should be monitored, are not yet known. Also, consensus regarding a stretching protocol applied to patients with paraparesis after traumatic SCI, as well as consensus regarding the assessment methods would be necessary.

Conclusion

The inclusion of stretching exercises in the specific physiotherapy program for patients with spastic paraparesis after spinal cord injury seems to have a positive short-term impact on motor deficit, reflected by an improvement in walking, most probably by a reduction of spasticity. The study should be extended to larger groups of patients, and stretching deserves increased attention as part of physiotherapy programs intended for this category of patients.

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