CAROL DAVILA UNIVERSITY OF MEDICINE AND PHARMACY

DOCTORAL SCHOOL

PARTICULARITIES OF MEDICAL REHABILITATION IN POST STROKE GENU RECURVATUM PATIENTS

- SUMMARY -

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I. CURRENT STATE OF KNOWLEDGE

1. Stroke

1.1 Definition

Stroke is a sudden onset of a permanent brain injury due to a blood vessel obstruction or bleeding at this level. Pathologies not included in this definition, such as craniocerebral trauma, demyelinating lesions, brain tumors, brain abscesses and many others produce clinical manifestations similar to those of stroke [1].

1.2 Epidemiology of stroke

It is well known that stroke continues to have a significant mortality, morbidity and disability rate in people over the age of 65. Stroke is mainly a pathology of elderly patients, but 28% of them also occur in people under the age of 65 [2].

1.3 Risk factors for stroke

Prevention is critical in reducing stroke morbidity and mortality. Risk factors for ischemic stroke were classified into two categories, unchangeable (age, race, ethnicity, family history) and modifiable (hypertension, smoking, atrial fibrillation, diabetes, obesity, diet, sedentary lifestyle, and hyperlipidemia). [1].

1.4 Stroke classification

1.4.1 Ischemic stroke

Transient ischemic attack (TIA) is a short episode of neurological dysfunction due to focal or retinal cerebral ischemia, the duration of clinical symptoms being less than one hour, without highlighting the acute infarction by brain imaging [3].

1.4.2 Hemorrhagic stroke

Unlike lacunar strokes, intracerebral hemorrhage does not respect the vascular anatomical distribution, but dissects through the tissue planes. Such an injury can be significant, resulting in increased intracranial pressure, disruption of multiple neural tracts, ventricular compression, and cerebral herniation [1].

1.5 Clinical stroke syndromes

1.5.1 Middle Cerebral Artery Syndromes (CMA)

The clinical manifestations of stroke at the ACM level will be consistent with its 3 divisions, namely, the main trunk, the upper and lower divisions. Stroke in the main trunk of the ACM causes complete hemiplegia, affecting both the upper and lower limbs and the lower half of the face to the same extent [2].

1.5.2 Anterior and posterior cerebral artery syndromes

The anterior cerebral artery (ACA) vascularizes the cortical interhemispheric surface of the frontal and parietal lobes. Secondary stroke hemiplegia in the ACA is characterized by decreased muscle strength in the shoulder and lower limb, sparing the forearm, hand and face.

1.5.3 Brainstem syndromes

Thus, unilateral stroke in the brainstem affects the function of the nerves of the skull on the same side and contralateral sensory-motor dysfunction [4].

2. Assessment of gait disorder in patients with post-stroke hemiparesis

2.1 Physiology of gait

In the case of normal gait, the stance phase represents the first 60% of the gait cycle. The stance phase is also divided into the following periods: initial contact (heel attack), middle stance, terminal stance and pre-swing. The swing phase is defined as the period of time in which the ipsilateral lower limb advances anteriorly being suspended in the air (does not support the weight of the body). The swing phase represents the last 40% of the running cycle, being divided into the following periods: the initial swing, the middle swing and the terminal swing. [5]

2.2 Pathophysiology of gait in patients with post-stroke hemiparesis

About 80% of people with stroke experience gait disorders within 3 months of onset. The results of a prospective study of 800 stroke patients described a mortality rate of 21%, 18% of the total could not walk, and 11% moved with the help of an assistive device. [6].

2.2.1 Neural control of post-stroke gait

Decreased muscle strength and loss of voluntary motor control are predominant signs that appear shortly after stroke. The primary gait disorders are due to the impairment of the descending tracts while the secondary ones represent the processes of neural adaptation. Adaptation processes can be cognitive and / or automatic, including in both cases the cerebellum, which is usually not affected by stroke located strictly in the brain. [7]

2.2.2 Spatial-temporal characteristics of post-stroke gait

Spatial-temporal parameters of gait refer to gait speed, single step length, double step length and cadence; all these parameters are modified in the case of the course of the patient with post-stroke hemiparesis. [8].

2.2.3 Walking speed

Low walking speed is a hallmark of post-stroke walking. The mean walking speed reported in 17 studies in post-stroke patients compared to healthy subjects ranged from 0.23 m / s (SD = 0.11 m / s) to 0.73 m / s (SD = 0.38 m / s). [8]

2.2.4 Temporal and spatial asymmetries of gait

Patterns of temporal asymmetry of the affected limb are often characterized by a short period of stance and an increased period of swing phase, while spatial asymmetry of the unaffected limb is often characterized by a short distance of simple step, however opposite patterns may occur. also. [9]

2.2.5 Impaired balance in orthostatism

Impaired balance control and orthostatism have been linked to spatial-temporal asymmetry while walking in post-stroke patients. However, the load distribution of the lower limbs during the stance phase in orthostatism was negatively correlated with the asymmetry time of the support phase only while walking at maximum speed [10]

2.3 Methods of analysis of gait

2.3.1 Motion capture video cameras

The 3D gait analysis requires the reconstruction of the patient's points of interest throughout the evaluation, so the points must be visible to at least 2 video cameras for each moment. [11]

2.3.2 Inertial systems

It incorporates accelerometers and gyroscopes, operating on the principle of intermittent measurements. The accelerometer and gyroscope provide data related to the acceleration and orientation of the point attached to the segment, through which the acceleration, orientation and position of the segment joint provide data related to the analysis of gait [11]

2.3.3 Electro-goniometer

It is an electro-mechanical instrument that measures joint angles during mobilization, this type of instrument is not comfortable being difficult to use in the case of joints with more than one degree of freedom. [12]

2.3.4 Walking mat

It is a special carpet in which sensors arranged in a certain shape are incorporated. The geometry of the carpet is predetermined and the sensors incorporated in it have the possibility to record the contact of the plant as well as the vector of the reaction force of the ground during walking. Approaches to gait rehabilitation in patients with post-stroke hemiparesis [12]

2.3.5 Electromyography

Given that each patient has their own gait pattern, EMG assessments can help determine the individualized treatment according to the gait pattern. Thanks to new EMG techniques, we can identify specific gait patterns and establish the organization of movements at the medullary or central level. [13]

2.4 Pathophysiology of the genu recurvatum

Genu recurvatum affects between 40 and 68% of patients with residual stroke hemiparesis. From the point of view of the spatial-temporal parameters of gait, genu recurvatum is present during the stance phase. The causes of post-stroke recurvatum are numerous, such as decreased muscle strength of the quadriceps and hamstrings, spasticity of the extensor muscles of the knee and ankle plantar flexors and limitation of plantar dorsiflexion. [14]

3. Gait rehabilitation approaches in patients with post-stroke hemiparesis

3.1 Neurodevelopmental techniques

Traditional post-stroke rehabilitation approaches rely on neurodevelopmental or neurofacilitation techniques to inhibit increased muscle tone, stimulate muscle activity in the presence of hypotonia, and facilitate normal movement patterns. The findings of an analysis of six studies (3 of which were controlled) using neurodevelopmental techniques / Bobath concept on post-stroke restraining, neurophysiology programs were equal to or less than other approaches to improving gait [15]

3.2 Muscle strength training

In the case of impaired muscle strength (including endurance) post-stroke, muscle strength training has gained a lot of attention among potential rehabilitation strategies. There is a strong relationship between muscle strength and function, so research has focused on optimal models of muscle strength training in post-stroke rehabilitation [16]

3.3 Intensive mobilization training

A number of programs have been developed that incorporate repetitive training of mobilization tasks.

3.4 Training on the treadmill

Body weight training with the support of the body weight gives the patient the opportunity to train the coordination of steps in the following ways: allows postural control while increasing his requirements, allows control of walking speed, has a potential to stimulate the normal gait. [15]

3.5 Orthosis training

Ankle and foot orthoses (AFO) are used in post-stroke rehabilitation as spasticity control strategies, in reducing excessive plantar flexion and improving gait and swing phase. [17]

3.6 Functional electrical stimulation

Functional electrical stimulation (FES) is a useful method in post-stroke rehabilitation in chronic post-stroke patients. FES is the provision of an electrical stimulus by means of electrodes to the muscles. [18]

3.7 Gait training with the help of robotic devices

Regarding the current strategies used in robotic devices, the concept of task control-assistance has emerged to encourage the active movement of the patient. In this concept, the purpose of the device is either to assist or to correct the patient's movements. [19]

3.8 Effects of botulinum toxin on lower limb spasticity

Botulinic toxin type A (TxB-A) is recommended as a first-line treatment for focal spasticity in the upper and lower limbs. To date, there are data supporting the safety and efficacy of the use of TxB-A in reducing post-stroke spasticity, and studies and meta-analyzes have shown that injection using TxB-A is the first-line treatment for focal spasticity. [20]

II. PERSONAL CONTRIBUTION

Introduction

In this paper we aim to evaluate and rehabilitate treatment associated with neuromuscular electrostimulation or Botulinum Toxin Type A injections by ultrasound guidance of patients with a change in gait pattern due to post-stroke genus recurvatum of spastic or non-spastic cause, study conducted in the Neurological Recovery Department of the Elias University Emergency Hospital. For this purpose, we enrolled a number of 40 participants, patients admitted to the Neurological Recovery Department of the Elias University Emergency Hospital, patients with gait disorder due to genu recurvatum post stroke.

Evaluation, administration of local treatment with TxB-A (Dysport) and monitoring of patients being performed during one or more treatment sessions.

In the prospective-observational study, the evaluation of the gait pattern, the spasticity of the lower limb, the functionality of the lower limb using the existing clinical data in the medical documents (general clinical observation sheets), as well as the evaluation sheets made by the doctoral student for each patient in part.

The evaluation stages were from T0 to T2, during 3 months in the case of patients with genus recurvatum associating spasticity in the lower limb and 2 months in the case of non-spastic ones. The intervention consisting of:

- Carrying out the rehabilitation treatment of the gait pattern, for 3 weeks
- Establishing with the help of musculoskeletal ultrasonography the areas of choice for the placement of local injections at the level of the target muscles
- Each patient will receive 1 or 2 vials of TxB-A, Dysport (abobotulinumtoxinA), 400 IU (800 IU in total), in the spastic muscles of the lower limb.

International assessment scales were used as assessment methods in the assessment of spasticity such as Modified Ashwort Scale (MAS), fall risk assessment such as Timed Up and Go (TUG), lower limb function assessment Lower Limb Functional Scale (SFMI) and walking parameters using the G-WALK device.

The objectives of this paper are statistically verified using comparative tests on a single batch type

• paired groups - the same patients evaluated at different times, from T0 to T2

The participants enrolled in the study were evaluated by the doctoral student, who performed the administration of TxB-A by ultrasound guidance at the level of the lower limb in the presence of spasticity at this level.

The 40 patients were included in the study following the fulfillment of the inclusion criteria, in the order of hospitalization in the Neurological Recovery Clinic of SUU Elias, in the period 01.04.2018-01.04.2020, and were divided into several subgroups, according to :

• the presence of spasticity in the lower limb muscles (20), patients who underwent 3 sessions of ultrasound-guided TxB-A injections, one in the extensor muscles of the knee (quadriceps muscle), one in the flexor muscles of the plant (sural triceps muscle) and one in both muscle groups and who underwent rehabilitation treatment for 3 weeks.

• absence of spasticity in the lower limb (20), patients who underwent rehabilitation treatment for 3 weeks associated with neuromuscular electrostimulation.

At the end of the paper are presented the discussions and conclusions derived from the study of the 40 patients.

4.STUDY ON THE EFFECTIVENESS OF THE REHABILITATION TREATMENT OF PATIENTS WITH GAIT DISORDER DUE TO POST STROKE GENU RECURVATUM WITOUH THE PRESENCE OF LOWER LIMB SPASTICITY

4.1 Introduction

Regarding gait disorder due to post stroke genu recurvatum that does not associate the presence of lower limb spasticity, numerous studies have described multiple therapeutic approaches, but without establishing a link between them and the mechanism of genu recurvatum.

4.2 Study hypothesis

Given previous studies on post-stroke genu recurvatum that do not associate the presence of lower limb spasticity (neuromuscular electrostimulation, functional electrical stimulation, and orthosis) - we want to demonstrate the effectiveness of the association between gait rehabilitation program and neuromuscular electrostimulation on gait asymmetry. in the case of these patients.

4.3 Motivation of the study

Rehabilitation of gait or improvement of gait is one of the main goals in post-stroke patients, whether associated with genu recurvatum or not. Changing the gait pattern can have repercussions on patients after stroke, such as increased energy consumption, limiting the performance of certain daily activities, which in some cases can lead to an increased risk of falling.

4.4 Objectives of the study

• Establishing the effectiveness of the rehabilitation program associated with neuromuscular electrostimulation on improving the gait pattern of patients with genu recurvatum after stroke that does not associate the presence of spasticity

• Establishing the impact that genu recurvatum has on the functionality and quality of life of patients after stroke

• Establishing the pathogenic mechanisms that lead to the emergence of non-spastic genu recurvatum

• Establishing therapeutic recommendations of the complex rehabilitation program that can help the Physician of Physical Medicine and Rehabilitation regarding the treatment of the genu recurvatum.

4.5 Material and method

participant

A number of 20 patients (7 women, 13 men) aged between 41 and 78 years, the average age was 61.6 years, and the average onset of stroke was 15.8 months, of which 11 suffered ischemic stroke and 9 hemorrhagic.

Inclusion criteria

• The patient is admitted to the U.S. Neurological Recovery Clinic. Elijah

• The patient has a genital recurvatum gait disorder after a stroke

Exclusion criteria

• The presence of spasticity in the lower limb associated with the genus recurvatum

• Recent orthopedic interventions <6 months on the hip, knee and ankle

• Presence of a prosthesis at the hip or knee joints

• Presence of degenerative pathology in the middle-advanced stages of the hip and knee

• Decompensation of underlying pathologies

• Inability to walk a distance of at least 10 meters

Study design

The study used a single batch of patients diagnosed with post-stroke genital recurvatum and was prospective, analyzing the effects of therapy at the beginning and end of the protocol.

Study method

Patients who agreed to be enrolled in the study were examined from the first day (T0) of hospitalization in terms of clinical, functional, risk of falling and gait, and these were assessed using quantification scales. approved international organizations.

Rehabilitation treatment was started on the first day after the assessments. After 3 weeks (Q1) the patients were re-evaluated using the same evaluation scale and the results of both evaluations were entered in the database to be compared, the patients being subsequently discharged.

The last evaluation (T2) was performed 1 month after discharge to determine the degree of remanence of therapeutic effects.

The evaluation of patients from T0 to T2 was as follows

Clinical-functional evaluation of the affected lower limb to determine the presence of the genus recurvatum. Assessment of the functionality of the affected lower limb using the Lower Functional Scale (SFMI) questionnaire. Assessment of mobility, balance, gait and fall risk using the Timed Up and Go (TUG) test. Evaluation of walking parameters using the G-WALK device.

4.6 Treatment protocol

In the case of the physiotherapy program on improving the ability and gait scheme in post-stroke patients associated with genus recurvatum, it was applied using the following objectives such as stretching the muscular-tendon tissue structures, stimulating the muscular activity of the affected lower limb, training muscle strength. of the affected lower limb, increased effort capacity, above-ground walking training without the use of assistive devices.

4.7 Evaluation tools

Lower limb functionality scale (SFMI), Timed Up and Go Test (TUG), G-WALK BTS.

4.8 Results

Regarding the values of gait speed, we observe at the moment T1 (at the end of the 3 weeks of the walking rehabilitation program associated with ESNM) an increase of significant values ($p < 0.001$) by 9 units in the case of walking speed, from 0.49 m / sec at 0.58 m / sec. At T2 (one month after discharge) the walking speed maintained its high values compared to the initial moment (T0) with a significant difference ($p < 0.05$) of 2.25 units of measurement, namely 0.51 m / sec.

Regarding the swing phase, although its values improved at the time of Q1, they did not have a statistical significance ($p > 0.05$), its values one month after the end of the rehabilitation program returning to the initial values. had statistical differences at both post-treatment T1 ($p < 0.001$) and T2 ($p < 0.05$). since its completion In the case of SFMI, it had a significant increase at 3 weeks after the rehabilitation program (T1) with 2 units of measurement ($p < 0.05$), an improvement that was not maintained 1 month after discharge (T2). being only 0.3 units of measure ($p > 0.05$).

4.9 Discussions

Walking speed and cadence Improving speed and cadence due to increased muscle strength in the treated muscle groups. In patients with post stroke genu recurvatum, due to the asymmetry of the gait pattern, this lack of correlation between the two values tends to be present.

Double step length

In the case of patients with non-spastic non-spastic recurvatum post-stroke, we notice an increase in it, its average value at time T0 being about 1.03 m. T1) and with 0.065 (T2) thus reveals the improvement of the asymmetry of gait.

The stance and swing phases

The spatiotemporal asymmetry of gait of the affected lower limb of post-stroke patients without the presence of genu recurvatum can also be observed in the support phase, which decreases in duration while the period of the swing phase increases, however opposite models may be present.

Phases of single and double stance

We notice that the single stance increased at T1 by 1.34 units and by 0.81 at Q2 compared to the initial time, and the double stance decreased to a lesser extent, namely 1.29 units at T1 and 0.8 units at T2, all these are not statistically significant and do not correlate with the improvement of walking speed. This lack of correlations between the 3 variables in patients with non-spastic genus recurvatum may be due to the significant degree of asymmetry of gait.

Timed up and Go score

In patients with non-spastic post-stroke recurvatum genu, no meta-analyzes were performed on the evolution of TUG in their case. However, for the TUG score to be relevant, the minimum detectable change must be 2.9 units, so patients with non-spastic genus recurvatum, although they had an improvement in the TUG score with the rehabilitation program, did not improve their balance and did not reduced the risk of falls in patients with non-spastic post-stroke genu recurvatum.

Functional scale of the lower limb

Similar to the evolution of the TUG test, SFMI had statistical improvements ($p < 0.05$) at both times, with 2.25 units at T1 and 0.3 at T2. These improvements are closely related to walking speed. However, the improvement of the SFMI score by only 2 (T1) and 0.3 (T2) units, respectively, did not improve the functionality of the lower limb.

4.10 Conclusions

The rehabilitation program increases the speed and cadence of post-stroke patients with genus recurvatum that does not associate the presence of spasmodic. , decrease the period of support and increase the period of swing phase. does not associate the presence of spasticity did not lead to an improvement in the functionality of the lower limb. Impaired motor control and decreased muscle strength of all muscle groups (quadriceps, hamstrings, dorsiflexors and plantar flexors) associated with structural changes in periarticular components underlie the etiopathogenesis of post-stroke patients with genu recurvatum not associated with the presence of spasticity.

5. STUDY ON THE EFFECTIVENESS OF BOTULIN TOXIN INJECTION UNDER ULTRASOUND GUIDANCE ASSOCIATED WITH GAIT REHABILITATION TREATMENT OF PATIENTS WITH GAIT DISORDER DUE TO POST STROKE GENU RECURVATUM ASSOCIATED WITH THE PRESENCE OF SPASTICITY

5.1 Introduction

The presence of spasticity after stroke is one of the most common causes of disability, a presence that decreases the degree of functionality of the patient, especially when it is present in the lower limb. Spasticity of the lower limb muscles in stroke patients contributes to gait dysfunction due to impaired motor control, abnormal muscle activation, and reduced range of motion.

5.2 Study hypothesis

Given previous studies of TxB treatment on lower limb spasticity in stroke patients, we would like to demonstrate the efficacy of treatment with TxB injections by ultrasound guidance associated with a gait rehabilitation program for post-stroke patients with stroke. genus recurvatum type walking that combines spasticity of the extensor muscles (quadriceps) and plantar flexor (sural triceps) of the lower limb.

5.3 Motivation of the study

In post-stroke patients with genital recurvatum-associated gait associated with spasticity of the extensor knee and flexor muscles of the plant, no studies have been performed on the efficacy of focal TxB-A in combination with the rehabilitation program to improve gait. of these patients.

5.4 Objectives of the study

• Establishing the efficacy of ultrasound-guided TxB-A therapy associated with the rehabilitation program in reducing MI spasticity located at the knee extensors and plantar flexors, on the Modified Ashworth Scale (MAS).

• Establishing the efficacy of ultrasound-guided TxB-A therapy associated with the rehabilitation program on MI functionality of post-stroke patients with genus recurvatum associated with the presence of spasticity.

• Establishing the degree of involvement of the spastic muscles of the MI, the extensor muscles of the knee and the plantar flexors in the etiopathogenesis of the genus recurvatum.

Establishment of recommendations for TxB-A therapy under ultrasound guidance associated with the rehabilitation program to assist the Physician of Physical Medicine and Rehabilitation

5.5 Material and method

A number of 20 patients (11 women, 9 men) aged between 44 and 75 years, the average age was 62 years and the average period of onset of stroke was 14.15 months, of which 12 suffered ischemic stroke and 8 hemorrhagic. The patients enrolled in the study were those who went to the Neurological Recovery Clinic of Elias Hospital for hospitalization and rehabilitation treatment, with post-stroke, ischemic or hemorrhagic status, which were evaluated and diagnosed with spastic hemiparesis and the presence of recurvatum.

Inclusion criteria

• The patient is admitted to the U.S. Neurological Recovery Clinic. Elijah

• The patient has a walking disorder type gen recurvatum after stroke that associates the presence of focal spasticity of the lower limb

Exclusion criteria

• Absence of spasticity in the lower limb associated with the genus recurvatum

• Recent orthopedic interventions <6 months on the hip, knee and ankle

• Presence of a prosthesis at the hip or knee joints

• Presence of degenerative pathology in the middle-advanced stages of the hip and knee

• The presence of oral antispasmodic medication in the last 3 months in the treatment schedule.

• Performing local intramuscular infiltrations with phenol, alcohol in the last 3 months.

• Hypersensitivity to TXB-A or to any of the other components of Dysport.

• Decompensation of underlying pathologies

• Inability to walk a distance of at least 10 meters

Study design

The study used a single batch of patients diagnosed with post-stroke genuinely recurvatum-like gait associated with spasticity and was prospective, analyzing the effects of therapy at the beginning and end of the protocol.

Study method

Patients who agreed to be enrolled in the study were examined from the first day (T0) of hospitalization in terms of clinical, ultrasound, degree of spasticity, risk of falling, functional and of the flow chart, these being evaluated using the approved international quantification scales. Evaluation of patients from T0 to T2 At T0 - initial time:

• Clinical-functional assessment of the affected lower limb to determine the presence of the genus recurvatum and the degree of spasticity • Assessment of the degree of spasticity using the international MAS scale (Modified Ashworth Scale)
• Ultrasound evaluation of spastic muscles in order to perform ultrasound-guided infiltration.
• Assessment of the functionality of the affected lower limb using the questionnaire (SFMI).
• Assessment of mobility, balance, walking ability and risk of falling using the test (TUG).
• Evaluation of walking parameters using the G-WALK device.

5.6 Treatment protocol

The intervention (infiltration itself) will consist of:

Performing musculoskeletal ultrasound on the spastic lower limb to determine the areas to be injected. Each patient will be given TxB-A (Dyspor) under the following schedule:

• First session - 400 IU (1 vial) TxB-A, diluted in 4 ml saline, will be administered to the quadriceps muscle (right femur, medial, lateral and intermediate vessels), 100 IU for each muscle.
• Second session - 400 IU (1 vial) TxB-A will be administered, diluted in 4 ml saline, at the level of the sural triceps muscle (lateral and medial gastrocnemius, soler), 100 IU for each gastrocnemius and 200 IU in case solar muscle
• Third session - 800 IU (2 vials) TxB-A will be administered, diluted in 8 ml saline in both muscle groups, quadriceps and sural triceps, using doses similar to those of previous sessions

5.7 Evaluation tools

Ultrasound evaluation of the lower limb muscles

Modified Ashworth Scale (MAS).

Lower limb functionality scale. SFMI.

Timed Up and Go test. TUG

Instrumental analysis of walking parameters.

5.8 Results

Regarding the speed of the patients who had TxB-A at CV level, it had significant differences, increasing by an average of 0.1705 units from the initial time T0 to T1, a value that was maintained even at time T2 with a significant increase of 0.1025 units compared to T0. Walking speed, in the case of the group that received TxB-A in the sural triceps, at T1 recorded significant differences from the initial time, the increase being 0.18 units and at T2 0.12 units. The group (CV and TS) who received TxB-A in both muscle groups recorded a significant increase in walking speed from T0 to T1, averaging 0.24 units, this being a statistical difference even at time T2 compared to T0, its increase being 0.16 units.

The values of stance phase in the case of the CV group had statistically significant differences in both moments, compared to the initial one, the increase being by 2,535 units at the time of T1 and by 1,295 at T2. In the case of the TS group, we notice that the stance phase had significant differences, respectively increased by an average of 2.69 units at both times, T1 and T2 compared to the initial time.

Patients in the group receiving TxB-A injection in both muscle groups experienced a significant increase in the duration of the stance phase of approximately 15 units of measurement at T1, an increase that was maintained at T2 as well. value 8 units higher than the initial moment. The Timed Up & Go score in the CV group had statistical differences ($p < 0.001$), decreasing by 2.6 units at T1, a decrease that remained at T2 ($p < 0.001$), but with a lower value, 1.7 units. In the case of the TS group, the TUG score had statistical differences, different from the CV group, at T1 the TUG score decreased by 2.6 units ($p < 0.001$), a decrease that was maintained at the time of T2 ($p < 0.001$) compared to the time initial. The group of patients who were injected in both muscle groups recorded a significant decrease of 3.4 ($p < 0.001$) units at T1, which remained at

T2, with a value of 3.3 units ($p < 0.001$) . The SFMI score improved statistically in T1 in the case of the CV group with 3.7 units, a score which in T2 was 0.65 units higher than in T0. In the case of the TS group, the SFMI score increased significantly in T1 by 2.3 units compared to T0, whereas at T2 it had a value of 0.67 units. The group of patients who were injected with TxB-A in both muscle groups showed a significant increase in the SFMI score at T1 and T2, the values being relatively similar.

The degree of spasticity of patients receiving TxB-A injection at the quadriceps level was assessed using Modified Ashworth Scale (MAS), and had significant differences, decreasing by 0.675 units 3 weeks later (respectively at T1), $p < 0.05$ and by 0.45, $p < 0.001$ at time T2. Also, the group that benefited from the injection of TxB-A in the sural triceps recorded a decrease in spasticity, assessed on the MAS scale, at both times, the decrease being 0.689 units ($p < 0.001$) at T1 and 0.452 ($p < 0.001$). <0.001) at T2, statistically significant value. In the case of the TS + CV group, the MAS scale decreased by approximately 0.723 units at T1 and by 0.525 at T2

5.9 Discussions

TxB-A

The presence of spasticity in the lower limb of post-stroke patients reduces its degree of stability, affects the gait pattern increasing the need for patients to use assistive devices such as orthoses, sticks, wheelchairs and caregivers. In post-stroke patients, spasticity frequently affects the extensor muscles of the knee, leading to the appearance of the stiff-knee but also the muscles of the plantar flexors (especially the sural triceps muscle) with the appearance of the foot in the equine lime. [20]

TxB-A treatment of lower and upper limb spasticity is recommended as first-line treatment therapy in multiple European and North American practice guides. Injection of TxB-A into the spastic muscles of the lower limb is aimed at reducing the equinovarus but also at joint mobility disorders due to spasticity, one of the goals of this therapy is to provide the whole foot to be in contact with the ground during the support phase (acting similarly to a stabilizer) but also on the control voluntarily from the hip and knee muscles in order to obtain an effective controlled movement. [21] post-stroke patients who associate the presence of recurvatum as well as spasticity.

MAS scale

Previous studies have shown that the presence of lower limb spasticity in post-stroke patients decreases stability, reduces gait, affects gait, thus increasing the need for the use of assistive devices and help from caregivers.

Various randomized and clinical trials have evaluated the efficacy of TxB-A in reducing spasticity of the flexor muscles of the ankle after stroke, all of which demonstrate improved gait pattern and balance due to reduced spasticity of the sural triceps. [20]

Finally, the session in which 800 IU TxB-A was administered to both muscle groups, the doses and injection sites being similar to those used in the first two sessions, the reduction in the degree of spasticity quantified by the MAS scale was significant ($p < 0.001$) at both times, the MAS scale showing a decrease of approximately 0.723 units at T1 and 0.525 at T2.

Also, there were no statistical differences in the comparison between the 3 groups, $p > 0.05$.

Gait speed and cadence

Patients with post-stroke spastic recurvatum who benefited from TxB-A by ultrasound guidance only at the level of the quadriceps associated with the rehabilitation program had a significant increase, both times, walking speed by 0.17 m / s and cadence by 12 steps / min at T1 ($p < 0.001$), on the other hand, although the speed values were increased compared to T0, at T2 they were 0.1 m / s while the cadence values remained constant ($p < 0.001$). .

Double step length

In the case of patients who received TxB-A in both muscle groups associated with the rehabilitation program, the increase in the length of the double step is obvious compared to those who received TxB-A in either CV or TS, the increase having an average of 0.30 m ($p < 0.05$). these in improvements are most likely due to the increase in the degree of flexion of the knee and dorsiflexion of the ankle by reducing the spasticity of the 2 muscle groups.

Stance and swing phases

The decrease in the period of the balance phase is mainly due to the reduction of the degree of spasticity of the quadriceps and less of the TS in the case of patients with genu recurvatum.

Phases of single and double support

The phases of single and double support of patients with genus recurvatum that associate the presence of spasticity, had a linear evolution with that of gait speed, so increasing gait speed (due to reduced spasticity and improved gait asymmetry) led to decreased duration bipodal support, increasing that of single support.

Timed Up and Go score

Although the decrease in TUG score was present in all 3 injection sessions, the decrease being significant ($p < 0.001$), only the group that benefited from the administration of TxB-A in both muscle groups had a detectable improvement. the decrease being 3.4 units ($p < 0.001$) only at the time of Q1. The improvement of TUG is most likely due to the increase in gait speed due to the reduction of gait asymmetry by reducing the degree of spasticity of both muscle groups.

Lower limb Functionality Scale

The groups that received TxB-A at the TS and TS + CV levels had a high efficiency compared to the group that received TxB-A at the CV muscle level. However, this improvement did not have an impact on the reduction of the lower limb dysfunction as the SFMI score increased by an average of a maximum of 3.5 points, and it was necessary to increase it by at least 9 points to take into account a minimally detectable change.

5.10 Conclusions

The association of the rehabilitation program with the ultrasound-guided injection of TxB-A in the spastic muscles of the lower limb in post-stroke patients with genus recurvatum, either in the sural triceps muscle or in the quadriceps, or in both muscle groups, led to a decrease in the degree. spasticity, regardless of the injection of one or both muscle groups.

The association of the rehabilitation program with the ultrasound-guided injection of TxB-A in the spastic muscles of the lower limb in post-stroke patients with genus recurvatum, either in the sural triceps muscle or in the quadriceps, or in both muscle groups, reduced the degree of gait asymmetry. by decreasing the balance phase and increasing the support phase as well as decreasing the unipodal support phase and increasing the bipodal one. The improvement in gait asymmetry is obvious when injecting both muscle groups (quadriceps muscle and sural triceps).

The association of the rehabilitation program with ultrasound-guided injection of TxB-A into the spastic muscles of the lower limb in post-stroke patients with genus recurvatum, either in the sural triceps muscle or in the quadriceps or in both muscle groups did not reduce the risk of falling in the case of these patients.

The presence of spasticity of both muscle groups of the lower limb, quadriceps and sural triceps may lead to the appearance of the genus recurvatum, and the degree of involvement is largely due to the spasticity of the triceps surae.

Limits of the study

During the study performed on a number of 40 patients, we encountered several technical disadvantages, one of which was the lack of assessments of the kinetic parameters of the degrees of joint mobility of the hip, knee and ankle, the recording device used not having these features included. In addition, the lack of evaluation of the change of the soil reaction force vector depending on the approached therapy.

Another disadvantage is the lack of electromyographic recording of the activity of muscle groups involved in the appearance of the genus recurvatum while walking. The presence of these records being a very useful one in the much more accurate assessment of the degree of involvement of each muscle group in the etiopathogenesis of the genus recurvatum.

Also, the assessment of the degree of spasticity at the time of T2 on an outpatient basis may be influenced by multiple extrinsic factors that may influence it, thus modifying the data collected and statistical results.

In both studies, we could not assess the degree of involvement of the capsulo-ligamentous structures in the occurrence of the genus recurvatum, previous studies describing their involvement as a possible risk factor in its occurrence. be the diffusion of the solution at the level of the neighboring muscles as well as the injection of other muscle groups.

CONCLUSIONS AND PERSONAL CONTRIBUTIONS

Final conclusions

• The study developed in the thesis was performed on a number of 40 patients with post-stroke disorder associated with the presence of the genus recurvatum spastic or non-spastic.

• The mechanisms underlying the genus recurvatum are the following:

o Genu recurvatum non-spastic decrease in muscle strength of the lower limb such as the quadriceps, hamstrings, dorsiflexors and plantar flexors is one of its mechanisms of appearance, being most likely associated with an impairment of capsulo-ligament structures.

o Genuine spurvatum spastic is due to the spasticity of the extensor muscles of the knee (quadriceps muscle) but also of the plantar flexor muscles (sural triceps), the degree of involvement being much higher in the case of spasticity of the sural triceps muscle.

• Similarities of the spastic and non-spastic recurvatum genus

o Both forms of the genus Recurvatum, spastic and non-spastic, have relatively similar gait speeds, which affect the functionality of the lower limb and increase the risk of falling.

• Differences between spastic and non-spastic genu genu recurvatum

o These are most evident in the case of asymmetry of the gait pattern, the presence of the genus recurvatum non-spastic produces a significant increase in the duration of support of the lower limb compared to that of the genus recurvatum associated with the presence of spasticity.

• The efficacy of TxB-A and ESNM associated with the rehabilitation program on the management of spastic or non-spastic recurvatum of post-stroke people associated with this gait disorder was confirmed, results obtained during evaluations performed throughout the scientific study.

Genu recurvatum spastic or non-spastic has negative effects on gait, lower limb function, balance, quality of life, also increasing the risk of falling.

• Both therapeutic approaches used in the ESNM-associated gait rehabilitation program and in the ultrasound-guided injection of TxB-A improved patient gait asymmetry, increased gait and cadence, but did not improve lower limb functionality quantified by the SFMI scale. did not reduce the risk of falling quantified by the TUG scale.

• In order to maintain these improvements obtained by following the two therapeutic approaches on the non-spastic and spastic recurvatum genus but also by the differences in the asymmetry of gait between the two, we consider it appropriate to develop in later studies a removable orthotic device to recognize the appearance recurvatum during the support phase in post-stroke patients.

• This paper is of particular importance, being one of the few papers that have studied both the etiological mechanisms and the therapeutic approach of the post-stroke genu recurvatum, whether non-spastic or spastic. Also, the study of the effectiveness of the rehabilitation program associated with TxB-A on spastic muscles is one of the few studies in the national and international literature that aims to establish the degree of involvement of each spastic muscle group in spastic genu recurvatum.

• The paper is a national first in the management of focal spasticity of the lower limb by ultrasound guided administration of TxB-A to the extensor muscles of the knee joint and plantar flexors of the ankle joint, with the role of rehabilitating lower limb functionality quantified by commonly used international scales such as SFMI and TUG.

Regarding the administration of TxB-A by ultrasound guidance, we want to highlight its importance related to the information provided about the location of muscle structures, needle positioning but also the local diffusion of the substance used. The therapeutic approach by ultrasound guidance of the spastic muscle structures has been shown to be superior to the approach by anatomical landmarks and palpation as well as the one using electrostimulation.

• In view of the present study but also previous studies in the literature on the efficacy of TxB-A therapy associated with the rehabilitation program on the management of focal spasticity of the lower limb after stroke in patients with genu recurvatum, we consider that new studies are needed, placebo controlled and on a high number of patients who could determine the optimal doses for each spastic muscle involved in genu recurvatum.

• We also consider it necessary to perform new, randomized, placebo-controlled studies on the efficacy of the two therapies described above, studies that include evaluation of kinetic and muscle activation parameters quantifiable electromyographically both in patients with genus recurvatum associated with the presence of spasticity and in in the absence of this.

• Another aspect that needs to be studied is represented by the highlighting of new therapeutic modalities as well as the development of new assistive devices through which we could prevent the appearance of the recurvatum type after spastic or nonspastic stroke.

Personal contributions

Patients who associate the presence of a post-stroke genus recurvatum have a significant impairment of lower limb function and are at increased risk of falling, both of which affect the quality of life of these patients.

In the two subchapters of the first part of the paper "**Assessment of gait disorder of patients with post-stroke hemiparesis**" and "**Rehabilitation of gait in patients with post-stroke hemiparesis"** was a synthesis of the literature to help the Physician of Physical Medicine and Rehabilitation on the evaluation and therapeutic approach of post-stroke patients with gait disorder, with or without the presence of recurvatum.

In the presence of post-stroke gait disorder associated with the presence of the genus recurvatum, the presence or absence of lower limb spasticity should be highlighted initially because the therapeutic methods used to improve gait disorder differ. In the absence of spasticity, patients can follow the gait rehabilitation program, and in its presence the gait rehabilitation program will be associated with the injection of TxB-A under ultrasound guidance in the spastic muscles. This paper presenting in the chapter "Discussions" in the second part of the paper the way of therapeutic approach of the two therapies. The personal contribution of the doctoral student is represented by the following aspects, he developed the design of the study, performed the analysis of the gait and evaluations of the degree of spasticity and functionality of the lower limb at all 3 moments. at the level of the spastic muscles.

The personal contribution is represented by the national pioneering on the establishment of the etiopathogenesis of the non-spastic or spastic recurvatum genus of post-stroke patients as well as by the various therapeutic approach used, namely the ESNM associated gait rehabilitation program in case of absence of lower limb spasticity and association injection of TxB-A under ultrasound guidance in the presence of spasticity. The present study includes 40 patients who were admitted to the Neurological Recovery Clinic of Elias University Emergency Hospital and quantifies the effects of the rehabilitation program and the associated TxB-A administered under ultrasound guidance on gait disorder due to the presence of post-stroke recurvatum. , is a national premiere

The results obtained are published in articles in specialized journals with domestic and international prestige.

The results of the two studies are important both in daily medical practice and in scientific research, thus contributing to the consolidation of a clear evidence base to support the progress of the medical sciences.

List of published works

http://jhsrm.org/health-sports-rehabilitation-medicine-vol-22-no-3-july-september-2021/

http://jhsrm.org/health-sports-rehabilitation-medicine-vol-20-no-2-april-june-2019/

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