

Influence of autonomic nervous system in muscle activity of individual with sequelae after stroke.

Influência do sistema nervoso autônomo na atividade muscular de indivíduo com sequelas após acidente vascular encefálico.

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Abstract

Introduction: The stroke is a lesion of the Central Nervous System inducing spasticity, caused by a lesion of the upper motor neuron. The presence of spasticity limits the patient in achieving the necessary adjustments for the execution of required functional movements, causing limitations in daily life activities, interfering in our quality of life. **Objective:** To analyze the influence of the Autonomic Nervous System (ANS) in spastic patient consequential of stroke and decrease spasticity resulting of stimulus in the ANS. **Method:** It is a case study, where the spasticity was analyzed by means of Electromyography record (RMS), Ashworth Scale modified and goniometry. The intervention consisted in 10 visits by performing Parasympathetic Laringe-Faringe Maneuvers, Plantar Arch and inhibition of Gastrocnemius. **Results:** The ANS has influence on the muscular activity, seen that there was a reduction of spasticity with decrease of the RMS values, increase in the amplitude of movement quantified by degrees and by means of the Modified Ashworth Scale. **Conclusion:** However, the mobilization of the autonomic nervous system through parasympathetic maneuvers are effective in decreasing spasticity due to stroke.

Keywords: Stroke, Spasticity, Autonomic Nervous System.

Resumo

Introdução: O acidente vascular encefálico é uma lesão do sistema nervoso central que tem como principal consequência a espasticidade, causada por lesão do neurônio motor superior. A presença da espasticidade limita o paciente na realização dos ajustes necessários para execução dos movimentos funcionais necessários, causando limitações nas atividades de vida diária, interferindo na qualidade de vida do paciente. **Objetivo:** Analisar a influencia do sistema nervoso autônomo em pacientes espásticos consequentes de acidente vascular encefálico e diminuir a espasticidade por meio de Mobilização do sistema nervoso autônomo. **Método:** Trata-se de um estudo de caso, onde a espasticidade foi analisada através de Eletromiografia (RMS), Escala de Ashworth Modificada e goniometria. A intervenção consistiu em 10 atendimentos realizando as Manobras Parassimpáticas Laringe-Faringe, Arco Plantar e Inibição dos Gastrocnêmicos. **Resultados:** O sistema nervoso autônomo tem influência sobre a atividade muscular, visto que houve uma diminuição da espasticidade com a diminuição dos valores de RMS, aumento da amplitude de movimento em graus e por meio da Escala de Ashworth Modificada. **Conclusão:** Portanto, a mobilização do sistema nervoso autônomo por meio de manobras parassimpáticas é eficaz na diminuição da espasticidade decorrente de acidente vascular encefálico. **Palavras-chave:** Acidente vascular encefálico, espasticidade, Sistema Nervoso Autônomo.

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INTRODUCTION

Stroke is defined as being a neurological disorder (transient or permanent) that occurs in an area of an injury resulting from central nervous system vascular motivated by ischemia or hemorrhage. ⁽¹⁾ Stroke has as consequence functional sequelae with primary neurological deficits that normally cause a pattern of life with various limitations to perform the simplest activities of daily life. The main failure that occurs is hemiplegia, ie the motor and sensory impairment, with or without impairment of the cognitive functions. ⁽²⁾

Therefore, some cases may manifest varying degrees of weakness of one or more members associated with spasticity, which may arise in hemiplegic as sequelae of stroke. ⁽³⁾ Spasticity can be characterized by difficulty performing movements passively in a joint, due to the intense contraction of the muscles that normally mobilizes, and also the tendency to immediately return to its original position when the force imposed is contained. ⁽⁴⁾

Spasticity is caused by upper motor neuron lesion involving the spinal-cortico-reticulo-bulb pathway. ^(4,5) This injury in the nervous system brings pain, contractions and deformities, which complicates the process of rehabilitation. The change in the characteristic nervous spasticity agonists leads to act simultaneously and with the same intensity as the antagonist muscles, causing a blockage of the movement. ⁽⁶⁾

The tone is not only a state of muscles, but of the whole neuromuscular system and is directly related to the coordination to the achievement of the movement. The presence of spasticity limits the patient in making the necessary adjustments to the movements, which generates a blocking move that ends up preventing the necessary functional gains, limiting the passive movements of the limbs, and still causing limitations in daily activities, interfering with quality of life of the patient. Spasticity can cause a decrease in range of motion that since committed, will be detrimental to the performance of functional skills. ⁽⁷⁾

The Modified Ashworth Scale and goniometry are assessment methods that are widely used to verify these changes in range of motion correlated to the degree of spasticity.

The Autonomic Nervous System (ANS) is responsible for the control of certain functions in the body, based on the control of blood vessels, viscera and glands, and can be seen as an integral part of the motor system. However, in place of skeletal muscles, the effectors of the autonomic nervous system are smooth muscle, cardiac muscle and glands in order to maintain body homeostasis. ⁽⁸⁾

Electromyography (EMG) is a graphical representation of the electrical activity of muscle, very used mainly for being a non-invasive method for evaluating behavior

in some neuromuscular diseases or injuries that affect this system, ⁽⁹⁾ the effect of disuse on the level of muscle activation and even the effects and characteristics of exercise/physical training on neuromuscular function. The EMG is of utmost importance in the understanding of muscle activity by facilitating the understanding of neuromuscular involvement in response to exercise and may also be understood as quantifying the electrical signals in skeletal muscle. ⁽¹⁰⁾

Thus, this research aims to analyze the influence of ANS resulting in spastic stroke patients through electromyography and goniometry Modified Ashworth Scale, thus enabling a better physiological understanding of pathology and its sequelae, to improve the standard of life of patients involved.

METHODS

Sample

The sample was recruited randomly, taking only the presence of spasticity into consideration. As a case study, one 46 year old male patient with 2 years of illness was recruited.

Protocol of the clinical trial

The intervention consisted of 10 weekly appointments. The following techniques were carried out:

1) Mobilization of the ANS pharynx larynx: the patient is in dorsal decubitus, with a fixed point on the jaw and a mobile point on the anterior region of the neck (cricoid cartilage); the technique is executed using three sets of two minutes, liberating the deep cervical fascia. Mobilization occurs through latero-lateral and cephalo-caudal movements of the cricoid cartilage, which directly stimulate the glossopharyngeal nerve and parts of the vagus nerve, increasing the parasympathetic tone.

2) Technique of releasing the plantar arch and inhibiting the gastrocnemius: the plantar arch must be positioned correctly and slight movements are used to increase the arch, making the foot flat, with 3 repetitions of 2 minutes. The inhibition of the gastrocnemius is generated by a fast tactile stimulus, from the distal to the proximal, with 3 repetitions.

3) Goniometry of the elbow and ankle joints on the impaired side: the range of motion was assessed by goniometry, in which the patient remains in dorsal decubitus for rapid stretching of the elbow joint in extension. Goniometry measures the degree of existing flexion. Similarly, with the ankle, the goniometer confirms the degree of dorsiflexion after the same resisted movement. These tests were performed before and after each appointment.

4) Assessment of the degree of spasticity using the Modified Ashworth Scale: this involved rapid stretching of the elbow and ankle joints on the impaired side. The

assessment is made from the point in which there is stiffness during the movement, causing a certain limitation. The degrees range from 0 to 4: 0 indicates normal tone; 1 is the increase in tone at the start and end of the movement; 1+ corresponds to the increase in tone by less than half of the arc of motion, manifested by abrupt tension and followed by minimal resistance; 2 is the increase in tone by more than half of the arc of motion; 3 indicates parts in flexion or extension that are moved with difficulty; 4 indicated stiff parts in flexion or extension.

Eletromiography (EMG)

Muscle activity in the compromised upper limb was assessed with the patient sitting at rest. Two electrodes were placed on the biceps brachii muscle at a distance of 2 centimeters from the motor point. The time allowed for electromyograph activity collection was 1 minute, before and after application of the techniques.

An electromyograph (EMG System Brasil Ltda.) with 8 channels and active, bipolar and differential surface electrodes was used to acquire the electromyographic signal, together with Windaq signal acquisition software. The signals were passed through a filter (20-500 Hz), amplified 1000 times and converted by an A/D board, with a sampling frequency of 2000 Hz for each channel and an entry variation of 5 mV.

Statistical Analysis

The data were analyzed in Excel. Descriptive and inferential statistics were acquired using Origin 8.0 and GraphPad 5.0 software, the student's t-test, the D'Agostino test and the Shapiro-Wilk test, with the level of significance set at $p \leq 0.05$.

RESULTS

The following figures display the variation of the RMS (root mean square) according to the speed of the electrical signal in the concentrations of the biceps brachii muscle, considering the following: motor units; the firing rate of electrical signals and the duration of electrical signals.

Figure 1 displays the general mean of the RMS before and after the performance of ANS mobilization, with a mean value of 3.456 ± 2.862 before mobilization and a mean value of 1.759 ± 1.817 afterwards. There was a significant decrease in spasticity after the appointments were completed ($p=0.0551$).

Figure 2 displays the results of all of the appointments. There were no changes on the first day, maintaining 100% contraction. On the second and third days, there was a 50% decrease in the contraction values, showing the efficacy of the techniques, similar to the sixth and seventh days. The values fell on the fourth and fifth days, probably due to the beginning of concomitant

treatment (walking in water exercises). This may also be reflected in the results of the last 3 appointments, since the mean RMS value after the appointments was higher than the initial value. The exemplified mean values were 7.845 ± 0.2051 before and 4.000 ± 1.160 afterwards, although no significant associations were recorded.

The following figures represent the values from the goniometry of the elbow joint in flexion and the ankle joint in dorsiflexion, unilaterally on the impaired side. Figure 3 displays the goniometry of the elbow and the mean values before and after the techniques were applied. There is a difference between these values. After

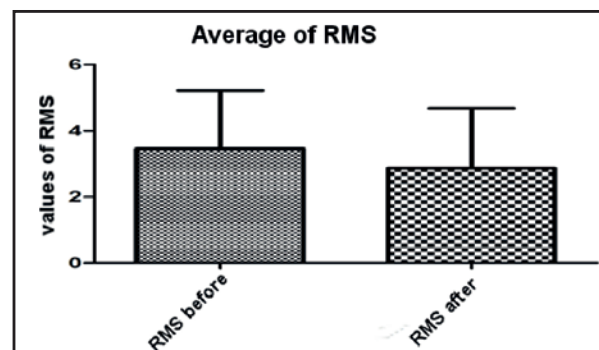


Figure 1. Mean value of the RMS (mean square) before and after the performance of the techniques.

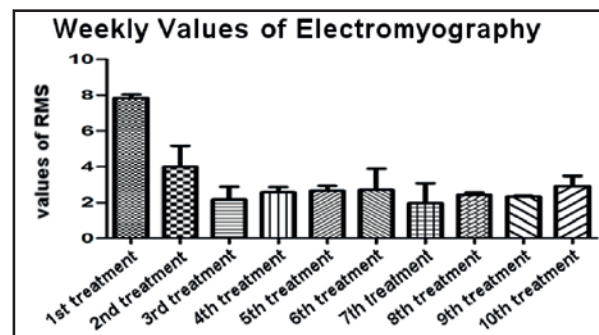


Figure 2. Mean value at each appointment.

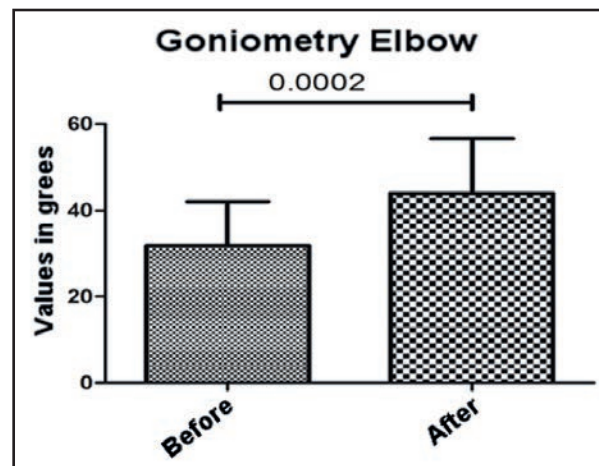


Figure 3. Mean goniometry value for the elbow.

the ANS mobilization techniques were employed, there was an increase in the degree of amplitude in the joint assessed. The mean value beforehand was 31.80 ± 10.27 and afterwards was 44.00 ± 12.61 , with a p-value of $p=0.0002$.

Figure 4 displays the goniometry values of the elbow at each appointment. No great change was recorded in the early appointments. From the third appointment, the degree of amplitude increased and, like the RMS values, altered in the final three appointments, due to the abovementioned concomitant treatment. However, the intervention still provided a positive result. The mean value before mobilization was 52.50 ± 10.61 . This figure was 55.00 ± 7.071 after treatment. The p-value revealed no statistical significance.

Figure 5 contains the goniometry data for the ankle joint in dorsiflexion, together with the mean values before and after the interventions: 3.700 ± 1.494 before and 6.000 ± 1.491 afterwards ($p=0.0001$). This can be considered as a significant result, since the increase in the amplitude implies a decrease in spasticity, which is associated with muscle activity.

Figure 6 displays the range of motion of the ankle joint at each appointment. The values remained stable in the first days. There was a clear increase in the goniometry degrees from the third or fourth appointment. Similar to the other results, the values in the final three appointments were affected by the other intervention, although not significantly for this particular joint, which exhibited a lower difference in the values of all of the appointments. It is believed that this was because the lower limb had better muscle tone. The mean value before and after the appointments was 5.500 ± 0.7071 , which explains the lower difference between the values.

Table 1 displays the values (degrees) of the Modified Ashworth Scale for the assessment of the degree of spasticity in the elbow and ankle joints in the proposed case study. It is notable that after the sixth appointment, both the elbow and the ankle exhibited decreased values on the scale, despite the fact that the values remained the same in the eighth, ninth and tenth appointments. During the seventh appointment, there was an increase in proportion compared to the other days, which could be explained by the new treatment started

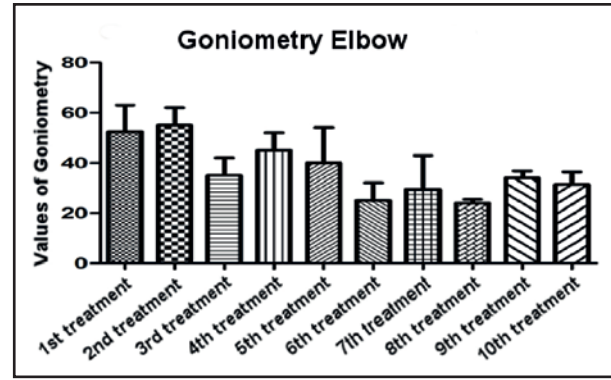


Figure 4. Goniometry at each appointment.

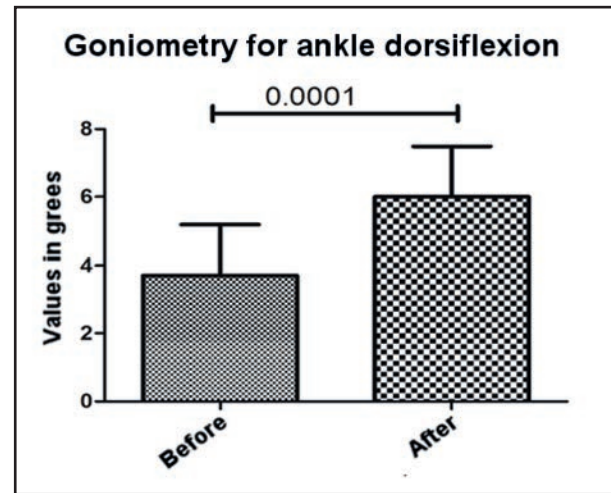


Figure 5. Mean goniometry value for the ankle.

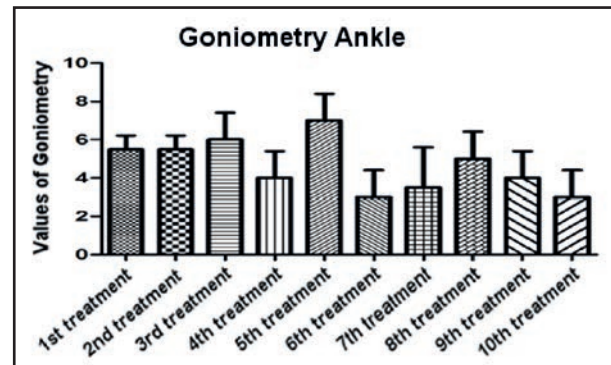


Figure 6. Goniometry at each appointment.

Table 1. Assessment of the degree of spasticity in the elbow and ankle joints - Modified Ashworth Scale Values

	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth	Ninth	Tenth
EAB	1+	2	2	2	2	1+	1+	1	1	1
EAA	1	1+	1+	1+	1+	1	1	1	1	1
AAB	3	3	3	3	3	2	3	2	2	2
AAA	2	2	2	2	2	1+	2	1+	1+	1+

Subtitle: EAB: elbow amplitude before; EAA: elbow amplitude after; AAB: ankle amplitude before; AAA: ankle amplitude after.

by the patient outside of the study. However, the difference of the scale values before and after the appointments, even in terms of the overall mean value, exhibited a decrease in spasticity.

DISCUSSION

The use of Mobilization Autonomic Nervous System Maneuvering reduced spasticity due to stroke, whereas the mean values of RMS, the range of motion by goniometry and evaluation of the spastic degree itself through Asworth Modified Scale had a positive result after the treatments, since there was a decrease in spasticity.

The autonomic nervous system plays a role in maintaining the quality of life, as the regulation of heart rate, emotional system, and hormonal.⁽¹²⁾ This control is essential for the maintenance of the degree of muscle contraction, for example, when changed from pathological way is called spasticity. In the muscle spindle are two major types of receptors. The muscarinic are responsible for the maintenance of normal muscle tone, and nicotinic regulators increased tone. Both are sympathicotonic and operate under stimulation of acetylcholine (ACh), a neurotransmitter in the cholinergic system widely distributed in the autonomic nervous system. When an injury occurs in the CNS, such as stroke, muscarinic receptors are blocked, losing control of the normal tone, nicotinic are then stimulated, which causes an increase in excess of muscle tone, spasticity. (13) Under these conditions the sympathicotonia is predominant, so the use of parasympathetic maneuvers has an important value in reducing the interfering signal in the state of muscle tone, as well as other systems.

Electromyographic activation occurs more significantly in stroke patients due to the greater degree of muscle contraction, characteristic of spasticity.⁽¹⁴⁾ The RMS used to obtain data about the speed of the signal, and its power in the interval of time analyzed, can analyze the quantity of motor units fired during muscle contraction.⁽¹⁵⁾ These values demonstrate the decrease in the degree of muscle contraction caused by the stimulation of parasympathetic techniques, which act directly on the receptors in the muscle spindles. This can be seen from the difference in the values before and after the intervention, which caused the muscles in spasm to relax.

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Spasticity is a motor disorder characterized by an increase in tonic stretch reflexes (muscle tone) and consequently, it prohibits the individual from performing the adjustments required to execute movements. When there is a decrease in the range of motion due to nervous abnormalities caused by the injury, the activity of the agonist muscles is affected, decreasing the range of motion and the functionality of the upper and lower limbs.⁽⁷⁾ As soon as muscle contraction is decreased, the agonists and antagonists return to normal, which facilitates the performance of movements and increases the range of motion.

Spasticity is one of the main health problems in patients with CNS problems. It limits their mobility and as a result, their independence in activities of daily living and work. It usually causes pain, decreases the range of motion and causes contractures and sleep disorders, as well as compromising ambulation.⁽¹⁶⁾

Joint mobilization stimulates movement of the synovial fluid, which maintains the extensibility and force of tension in articular and periarticular tissues. In order to maintain the range of motion, mobility and flexibility of soft tissues are essential, which are achieved by decreasing spasticity.⁽¹⁷⁾ The modified Ashworth scale can demonstrate the significant manner of change in the degrees of motion, as well as the improvement in the execution of movements in different activities of daily living.⁽¹⁸⁾ The increase in the degree of the range of motion demonstrates the efficacy of the techniques, since a decrease in spasticity favors the execution of movements and the greatest possible functional range.

After the application of these parasympathetic techniques, the nicotinic receptors were inhibited and the muscarinic receptors were restimulated, obtaining a greater control of tone and decreasing the degree of spasticity which improved the patient's physical and emotional quality of life.

CONCLUSION

The use of Mobilization Autonomic Nervous System Maneuvering reduced spasticity due to stroke, whereas the mean values of RMS, the range of motion by goniometry and evaluation of the spastic degree itself through Asworth Modified Scale had a positive result after the treatments, since there was a decrease in spasticity.

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