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Effectiveness of neuromuscular taping on upper limb functionality and pain in elderly patients pos stroke

Eficacia del vendaje neuromuscular sobre la funcionalidad y el dolor de las extremidades superiores en pacientes de edad avanzada después de un accidente cerebrovascular

Eficácia da bandagem neuromuscular na funcionalidade do membro superior e dor em pacientes idosos após acidente vascular cerebral

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ABSTRACT: This study aimed at verifying the use of the *taping* technique for upper limb function gain and pain reduction in elderly patients pos-stroke. Participants received neuromuscular taping on the deltoid muscle. There was no evidence of a significant improvement regarding functionality gain or pain reduction. The neuromuscular *taping* was not effective in improving the function and reducing pain in chronic pos-stroke survivors after five weeks treatment.

Keywords: Stroke; Physiotherapy; Taping.

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***RESUMEN**: Este estudio tuvo como objetivo verificar el uso de la técnica de vendaje para la ganancia de función de las extremidades superiores y la reducción del dolor en pacientes ancianos después de un accidente cerebrovascular. Método: Los participantes recibieron vendaje neuromuscular en el músculo deltoides. Resultados: No hubo evidencia de una mejora significativa con respecto a la ganancia de funcionalidad o la reducción del dolor. Conclusión: el vendaje neuromuscular no fue eficaz para mejorar la función y reducir el dolor en los supervivientes de un accidente cerebrovascular crónico después de cinco semanas de tratamiento.*

***Palabras clave**: Accidente cerebrovascular; Fisioterapia; Taping.*

***RESUMO**: O objetivo deste estudo foi verificar a utilização da técnica de bandagem para ganho de função de membro superior e redução da dor em pacientes idosos após o AVE. Os participantes receberam bandagem neuromuscular no músculo deltoide. Não houve evidência de melhora significativa em relação ao ganho de funcionalidade ou redução da dor. Concluiu-se que a bandagem neuromuscular não foi eficaz em melhorar a função e reduzir a dor em sobreviventes pós-AVC crônicos após cinco semanas de tratamento.*

***Palavras-chave**: Stroke; Fisioterapia; Taping.*

Introduction

Stroke is a leading cause of disability in the world becoming more incident in the elderly population (Appel, Mayston, & Perry, 2011; Brunnstrom, 1966); impairments such as muscle weakness, balance disorders and sensory changes may interfere with the functionality after a stroke. Approximately 40% of individuals who have suffered a stroke can be affected by some functional damages, and 15 to 30% of individuals may acquire a serious deficiency (Brunnstrom, 1966; Carmichael, 2003).

One of the most disabling residual deficiencies is related to the functioning of the upper limbs, which affects up to 66% of all stroke patients (Kwakkel, *et al.*, 2003; Nijland, *et al.*, 2010).

This becomes more critical when we consider that the upper limbs play a considerable role on functionality and motor skills for handling, grip and range, which are critical to achieving most of the activities of the daily living (ADLs) (Bac, *et al.*, 2020; Carlsson, *et al.*, 2018; Michielsen, *et al.*, 2011; Rand, 2018; Shinohara, & Usuda, 2010; Veerbeek, *et al.*, 2011; Wu, *et al.*, 2013).

These deficits can generate restrictions on movement and impairments in function, which may have a major impact on the ability to perform ADLs; this, in turn, can lead these subjects to the need of assistance of caregivers or institutionalization, making interventions to reduce upper limbs deficits a priority in rehabilitation (Dos Santos Silva, *et al.*, 2015; Mayo, *et al.*, 2002; Ozyemisci-Taskiran, *et al.*, 2019).

The treatment of individuals with stroke sequelae aims at the rehabilitation of motor control, as the functional movement minimizes energy expenditure, prevents the appearance of contractures and the development of deformities, and reduces pain.

Several physical therapy techniques have been used in the treatment of these patients; among them, there are the neuromuscular bandages. The clinical applicability of the neuromuscular bandage is broad since it can be used in the treatment of neuro-musculoskeletal disorders such as the stroke. The use of the neuromuscular bandage, along with the conventional therapy programs, can favorably influence the cutaneous, sensory, and motor receptors, resulting in control improvements and voluntary coordination of the upper limbs (Hochsprung, *et al.*, 2017; Huang, *et al.*, 2019; Kim, & Kim, 2015; Lee, *et al.*, 2015; Ortiz-Ramirez, & Perez-De la Cruz, 2017; Yasukawa, Patel, & Sisung, 2006).

The neuromuscular bandage can be used in a variety of forms, and, on the upper limbs of patients with stroke sequelae, it can help postural alignment and stability of the scapula. It can be applied alone or combined, in order to support weakened muscles, relax strained muscles, promote upper limb function (Jaraczewska, & Long, 2006) and reduce pain (Castro-Sánchez, *et al.*, 2012; Cubała, *et al.*, 2012; García-Muro, Rodríguez-Fernández, & Herrero-de-Lucas, 2010; Ghozy, *et al.*, 2020; González-Iglesias, *et al.*, 2009; İskelet, & Ağrıları, 2012; Ravichandran, *et al.*, 2019; Thelen, Dauber, & Stoneman, 2008).

Thus, this study aimed at evaluating the application of the neuromuscular bandage, associated with conventional therapeutic exercises, to assess its possible effectiveness in reducing pain and improving functional abilities of the upper limbs of elderly patients with hemiparesis after a stroke.

Materials and Methods

This research was arandomized, controlled trial which followed the experimental analytical model (Marques, & Peccin, 2005). The study was approved by the Ethics in Research Committee of the Pontifical Catholic University of Paraná through the regulamentation 1.012.004. All volunteers of the trial were informed about the study and signed an informed consent form according to the ethical principles for research involving human beings, according to the resolution 466/12 of the National Health Council.

The research was conducted at the Physical Therapy Clinic of the *Centro Hospitalar de Reabilitação Ana Carolina Moura Xavier* in Curitiba. The selection of the participants in this study was done following these inclusion criteria: (I) presenting clinical diagnosis of ischemic or hemorrhagic cerebrovascular accident; (II) presenting hemiparesis as a motor deficit; (III) having suffered the stroke twelve months prior to the study, at most; and (IV) under going physiotherapy rehabilitation at the center twice a week.

Furthermore, patients who presented the following criteria were excluded from the sample: (I) being in Brunnstrom stage I; (II) presenting spasticity ≥ 3 on the Modified Ashworth Scale (MAS); (III) presenting comprehension aphasia, and (IV)presenting mental confusion.

Participants

The sample consisted of ten (10) participants; five were allocated in G1 (two men and three women, with an average age of 62.0 ± 1 years), and five inG2 (two men and three women, with an average age of 65.6 ± 3 years). These groups were randomly fragmented into two new groups: the intervention group (IG), which encompassed the subjects recruited in the morning, and the control group (CG), which consisted of individuals recruited in the afternoon.

Assessment tools

At the early stages of the evaluation, data about the general identification of patients and of the pathology was collected. To investigate and quantify the presence of pain, motricity disorders and motor skills of the upper limbs, the following pre- and post-survey instruments were applied toboth groups — 1 (IG) and 2 (CG):

Fugl-Meyer Motor Scale – used to assess the sensory-motor impairment level, based on the concept that motor recovery after a stroke occurs in predictable sequential stages (Brunnstrom, S., 1966; Hernández, *et al.*, 2019). The scale has excellent reliability and validity with regard to the evaluation of the recovery of hemiplegic patients. This scale is divided into five domains: motor function, sensitivity, balance, range of motion and pain; in this study, evaluations were applied with regard to upper limbs and motor function.

The command of the motor functions of the upper limbs, as well as the coordination and the reflex activity of shoulders, elbows, wrists, and hands, add up to 66 points (of 100 existing points on the scale). Depending on the patient's score, he/she can be classified as having mild, moderate or severe impairment (Brunnstrom, 1966; Hernández, *et al.*, 2019).

Arm Motor Ability Test (AMAT) – aims at measuring quantitative and qualitative aspects of the activities of daily living (ADLs) involving the upper limbs of patients with stroke, through standardized daily living tasks (Gladstone, Danells, & Black, 2002; O'Dell, *et al.*, 2013).

It is composed by thirteen (13) tasks which reproduce daily activities, assessed by a scale ranging from 0 to 5 in the following items: (a) functional ability, in which 0 means none, 1 = very little, 2 = little, 3 = moderate, 4 = almost normal and 5 = normal; and (b) quality of movement, in which 0 means none, 1 = very poor, 2 = poor, 3 = moderate, 4 = almost normal and 5 = normal. The performance time of each task is clocked, and it may vary from 60 to 120 seconds (Morlin, *et al.*, 2006; Rand, 2018).

ShoulderQwith short SPIN– a structured questionnaire to assess the presence and severity of shoulder pain in hemiplegic or hemiparetic patients. This scale qualitatively assesses patients' pain in three questions in the following situations: at rest, in motion and at night (Turner-Stokes, & Jackson, 2006).

Intervention

In the intervention group, the neuromuscular bandage of Cure Tape® with five (5) centimetersof width was used; the length was defined according to the size of the upper limb of each participant. Initially, the measurement of the neuromuscular bandage used in the application of the deltoid muscle was taken; then, the neuromuscular bandage was cut individually for each participant, with rounded edges. The "Y" technique was used, since it is

the most common method of application, to facilitate and inhibit muscle stimulation (Kase, W. J., & Kase, T., 2003; Kase, K., *et al.*, 2017).

The anchor, i.e., the initial position of the base of the "Y", was placed five centimeters below the tuberosity of the deltoid (Mota, & Silva, 2014), fixating the anchor, with no tension from the insertion to the origin of the muscle. Regarding the applied tension, after measuring the size of the neuromuscular bandage, using a measuring tape, 100% tension was found and then 50% was subtracted, resulting in an applied tension of 50%.

For mechanical correction, moderate to severe tension (50-75%) of the available tension is commonly used, and the functional correction is used when the practitioner wishes sensory stimulation, which aids or limits the movement.

The first active band of the neuromuscular bandage was applied to the anterior portion of the deltoid with the muscle in the stretching position. To do so, the patient remained in a sitting position, with hips and knees at 90° degrees, elbows in 90° degrees of flexion and shoulders in neutral position; the shoulder extension was passively conducted.

The second active band was applied on the rear portion of the deltoid, in the same way as the first, with the muscle stretched, this time performing a passive shoulder flexion.

For the application, the skin integrity was checked, and thenit was hyginized using 70% rubbing alcohol. Patients remained with the neuromuscular bandage for two to three (2-3) days; it was applied twice a week by the researchers in charge, totaling ten (10) interventions. All participants were asked to remove the neuromuscular bandage with the help of a mineral oil should there be any allergic reaction.

Statistical analysis

The statistical analysis was performed using the SPSS software (v. 20.0); in all tests, a level of 0.05 was used to indicate statistical significance.

To investigate whether there was a significant difference in the ratings of AMAT, Fugl-Meyer and pain, between the pre- and post-intervention moments within each group, the non parametric Wilcoxon test was applied; the non parametric Mann-Whitney test was used to investigate if the evolution between the pre- and post-evaluation moments differed between the two groups (1, IG, and 2, CG).

The Spearman Correlation Coefficient was used to identify whether there was a correlation between injury time and the age to the evolution presented in Fugl-Meyer's A-D Domain, in each group, separately. A level of 0.05 was used to indicate statistical significance.

Results

As previously stated, the sample consisted of ten (10) participants; the average injury time among the participants of G1 was 3.8 ± 0.8 months; 80% of them had an impairment of the dominant side. In G2, the average injury time was 6.6 ± 3.9 months, and only 20% had an impairment in the dominant side.

Group 1 showed significant differences in the following tasks: 3 (in the assessment of functional ability (FA) and movement quality (MQ)); 4 (only for FA); 5 (in the time evaluation); 7 (FA and MQ); 10 (FA); and, finally, on task 11 (only in MQ). As for the other group (G2), statistically significant differences were found in tasks: 3 (MQ); 5 (time and FA); 9 (time and FA); 11 (FA and MQ); and 13 (time and MQ).

The only AMAT task that presented significant difference of evolution between groups 1 and 2, between the pre- and post-intervention moments, was task 9, exclusively in the time evaluation, which was significantly lower in group 2.

As presented in Table 3, only the A Domain (upper end) showed a statistically significant difference between pre- and post-intervention moments, in both groups 1 and 2. The D domain (Coordination/ Speed) remained the same in group 1 and showed regression of 3% in group 2. All other domains demonstrated improvement after the intervention in both groups. The correlation between the injury time and the evolution in A-D domain of Fugl-Meyer in G1 was statistically significant ($p = 0.014$), which indicates a strong negative correlation between the variables; i.e., the lower the injury time, the greater the developments in the A-D Domain. Statistical significance was also similarly observed in G2 ($p = 0.043$), which also indicates a strong negative correlation between variables.

Comparing the evolution of the domains of Fugl-Meyer between groups 1 and 2, we have not observed any statistically significant difference. We have noticed a higher evolution in G1, only in D and H domains. The other areas showed higher evolution in G2, despite the absence of statistical significance.

Regarding the pain, both groups showed regression in the three afore mentioned items (at rest, movement and at night) after the interventions, but this regression was only statistically significant in the item pain at night of group 2.

Comparing the groups, there was no statistically significant difference in any of the evaluated pain aspects. Nevertheless, it is verifiable in Table 6 that the regressions were higher in group 2 in all the items.

The results for each AMAT task in pre- and post-intervention moments are listed in Table 1 through the average ± standard deviation (SD) for each group, separately, as well as the respective *p* values.

Table 2 shows the comparison between groups 1 and 2 of the average percentages of evolution, between the pre- and post-intervention moments of each AMAT task, with the respective values of *p*.

Table 3 indicates the percentage of average values and SD obtained in each domain of Fugl-Meyer, in pre- and post-intervention moments, in each group, separately. The comparison between groups 1 and 2 of the difference between pre- and post-intervention moments, as well as of the percentage values obtained in each Fugl-Meyer domain, is presented in Table 4, with the respective *p* values.

Table 5 shows the comparison of the pain assessed inpre- and post-intervention moments, within each group. The comparison of the regression of the pain between groups after the application of interventions is presented on Table 6.

Table 1- Score of each AMAT task obtained in the pre- and post-intervention moments in each group

Group	Task	Time			Functional Ability			Movement Quality		
		Pre	Pos	*p*	Pre	Post	*p*	Pre	Post	*p*
1	1	95 ± 48	60 ± 45	0.068	2 ± 1	3 ± 1	0.038	2 ± 1	3 ± 1	0.046
	2	32 ± 49	12 ± 8	0.345	2 ± 1	3 ± 1	0.063	2 ± 1	3 ± 1	0.317
	3	71 ± 54	47 ± 47	0.068	1 ± 1	3 ± 1	0.038*	1 ± 1	3 ± 1	0.034*
	4	54 ± 60	15 ± 11	0.498	2 ± 0	3 ± 1	0.034*	2 ± 1	3 ± 1	0.063
	5	41 ± 28	21 ± 17	0.043*	2 ± 1	2 ± 1	0.317	2 ± 2	2 ± 1	0.564
	6	92 ± 50	58 ± 45	0.068	2 ± 2	3 ± 1	0.063	2 ± 1	3 ± 1	0.063
	7	79 ± 57	56 ± 58	0.285	1 ± 1	3 ± 2	0.038*	1 ± 2	3 ± 2	0.034*
	8	22 ± 11	23 ± 16	0.498	2 ± 2	3 ± 1	0.102	2 ± 2	3 ± 2	0.257
	9	43 ± 17	42 ± 25	0.498	2 ± 1	3 ± 1	0.157	2 ± 1	3 ± 1	0.180
	10	102 ± 26	103 ± 33	1.000	1 ± 1	2 ± 1	0.038*	2 ± 1	2 ± 1	0.157
	11	102 ± 38	99 ± 41	0.180	1 ± 1	2 ± 2	0.066	1 ± 1	2 ± 1	0.034*
	12	38 ± 47	30 ± 51	0.345	2 ± 0	2 ± 2	0.785	2 ± 1	3 ± 2	0.492
	13	42 ± 45	24 ± 14	0.225	2 ± 1	3 ± 1	0.705	2 ± 1	3 ± 1	0.157
2	1	95 ± 41	40 ± 22	0.08	2 ± 1	3 ± 1	0.102	2 ± 1	3 ± 1	0.083
	2	39 ± 50	15 ± 15	0.144	2 ± 1	3 ± 1	0.109	2 ± 1	3 ± 1	0.194
	3	92 ± 39	42 ± 4	0.068	2 ± 1	3 ± 1	0.102	1 ± 1	3 ± 1	0.039*
	4	48 ± 45	19 ± 16	0.138	3 ± 2	3 ± 1	0.18	3 ± 2	3 ± 1	0.157
	5	40 ± 46	13 ± 15	0.043*	2 ±1	3 ± 1	0.039*	2 ± 1	3 ± 1	0.063
	6	48 ± 45	19 ± 16	0.08	3 ± 2	3 ± 1	0.063	3 ± 2	3 ± 1	0.102
	7	86 ± 49	50 ± 49	0.068	1 ± 1	3 ± 2	0.066	1 ± 1	3 ± 1	0.102
	8	50 ± 40	23 ± 17	0.223	2 ± 1	3 ± 1	0.109	2 ± 2	3 ± 1	0.102
	9	87 ± 35	35 ± 27	0.043*	2 ± 1	3 ± 1	0.038*	2 ± 1	3 ± 1	0.059
	10	124 ± 9	108 ± 27	0.317	1 ± 1	3 ± 1	0.063	2 ± 1	3 ± 1	0.102
	11	104 ± 37	105 ± 34	0.317	1 ± 1	3 ± 1	0.038*	1 ± 1	3 ± 1	0.038*
	12	38 ± 49	14 ± 13	0.109	2 ± 1	3 ± 1	0.066	2 ± 1	3 ± 1	0.066
	13	74 ± 50	22 ± 13	0.043*	2 ± 1	3 ± 2	0.109	2 ± 1	3 ± 1	0.041*

* Statistical significance

Table 2 - Comparison of evolution in AMAT between groups 1 and 2

Task	Time			Functinal Ability			Quality of Movement		
	Group 1	Group 2	*p*	Group 1	Group 2	*p*	Group 1	Group 2	*p*
1	-35 ± 39	-55 ± 54	0.548	1 ± 1	1 ± 1	0.310	1 ± 0	1 ± 1	0.690
2	-20 ± 49	-25 ± 44	1.000	1 ± 1	1 ± 1	1.000	0 ± 1	1 ± 1	0.548
3	-23 ± 33	-49 ± 40	0.310	1 ± 1	1 ± 1	0.310	1 ± 1	2 ± 1	0.222
4	-39 ± 56	-29 ± 45	1.000	1 ± 0	1 ± 1	0.222	1 ± 1	1 ± 1	0.548
5	-20 ± 21	-27 ± 46	0.421	0 ± 1	2 ± 1	0.095	0± 1	1 ± 1	0.151
6	-35 ± 39	-26 ± 38	0.690	1 ± 1	1 ± 1	1.000	1 ± 1	1 ± 1	0.841
7	-22 ± 48	-37 ± 44	0.310	1 ± 1	2 ± 1	0.548	1 ± 1	1 ± 1	1.000
8	0 ± 21	-27 ± 47	0.421	1 ± 1	1 ± 1	0.690	1 ± 1	1 ± 1	0.690
9	-2 ± 9	-52 ± 28	0.008*	1 ± 1	1 ± 1	0.421	1 ± 1	1 ± 1	0.222
10	1 ± 37	-16 ± 36	1.000	1 ± 1	1 ± 1	0.841	1 ± 1	1 ± 1	0.421
11	-3 ± 4	1 ± 3	0.222	1 ± 1	1 ± 1	1.000	1± 0	2 ± 1	0.310
12	-8 ± 72	-24 ± 39	1.000	0 ± 1	2 ± 1	0.151	0 ± 1	1 ± 1	0.548
13	-18 ± 35	-52 ± 49	0.151	0 ± 1	1 ± 1	0.310	1 ± 1	2 ± 1	0.222

* Statistical significance

Table 3 - Comparison of average percentage values obtained in the pre- and post-intervention moments of each Fugl-Meyer domain in each group, separately

Group	Domain	Pre (%)	Post (%)	*p*
1	A –Upper End	65 ± 28	73 ± 25	0.039*
	B – Wrist	44 ± 44	52 ± 43	0.157
	C – Hand	64 ± 27	70 ± 36	0.317
	D –Coordination/Speed	70 ± 18	70 ± 41	1.000
	A-D –Motor Function	62 ± 27	69 ± 30	0.345
	H – Sensitivity	68 ± 36	78 ± 20	0.317
	J –Passive Articular Movement	75 ± 8	78 ± 24	0.564
	J –Articular Pain	79 ± 11	93 ± 7	0.564
2	A – Upper End	49 ± 19	63 ± 25	0.043*
	B – Wrist	12 ± 16	32 ± 29	0.109
	C – Hand	34 ± 36	54 ± 41	0.317
	D – Coordination/Speed	63 ± 18	60 ± 28	1.000
	A-D – Motor Function	42 ± 20	56 ± 28	0.080
	H – Sensitivity	90 ± 9	97 ± 7	0.317
	J – Passive Articular Movement	76 ± 7	86 ± 12	0.157
	J – Articular Pain	72 ± 31	88 ± 21	0.317

* Statistical significance

Table 4 - Comparison of average percentage growth in each domain of Fugl-Meyer between groups 1 and 2

Domain	Group 1 (%)	Group 2 (%)	*p*
A – Upper End	8 ± 4	13 ± 9	0.222
B – Wrist	8 ± 11	20 ± 21	0.421
C – Hand	6 ± 15	20 ± 20	0.421
D – Coordination/Speed	0 ± 41	-3 ± 14	0.548
A-D – Motor Function	7 ± 7	14 ± 9	0.548
H – Sensitivity	10 ± 23	7 ± 9	0.841
J – Passive Articular Movement	3 ± 19	10 ± 9	0.690
J – Articular Pain	14 ± 15	16 ± 25	0.690

Table 5 – Comparison of average values of ShoulderQwith short SPIN obtained before and after the implementation of intervention in each group, separately, and the average difference between pain evaluated in the pre- and post-intervention moments between groups 1 and 2

Group	Pain	Pre	Post	*p*
1	At Rest	0 ± 0	0 ± 0	1.000
	In Motion	4 ± 4	3 ± 4	0.854
	At Night	4 ± 4	1 ± 3	0.109
2	At Rest	4 ± 5	0 ± 0	0.157
	In Motion	6 ± 4	2 ± 2	0.066
	At Night	8 ± 2	1 ± 2	0.039*

Table 6 - Average difference in the regression of pain between between groups 1 and 2

Pain	Pain Regression		
	Group 1	Group 2	*p*
At Rest	0 ± 0	-4 ± 5	0.310
In Motion	-1 ± 5	-4 ± 3	0.222
At Night	-3 ± 3	-7 ± 4	0.095

Source: Authors' research data

Discussion

As previously stated, the objective of this research was to determine the efficacy of the neuromuscular bandage technique, associated to kinesiotherapy, for function gain and reduction of upperlimb pain of elderly individuals with stroke sequelae.

In a study which discusses several therapeutic methods for the stroke treatment, aiming at the improvement of the functionality of upper limbs, some elastic neuromuscular bandage use techniques are described — including the deltoid muscle "Y" technique, which aims to seek additional support of the weakened muscles of the shoulder joint (Jaraczewska, & Long, 2006); (Kase, K., Wallis, & Kase, T., 2003; Yang, L., Yang, J., & He, 2018).

Unlike the technique used in this study, the direction of the application of the neuromuscular bandage proposed by those authors was from the origin to the insertion. Therefore, results can not be compared, due to the fact that no research that has used the neuromuscular bandage with the technique described above was cited by the authors.

In another (prospective) survey, five individuals with chronic stroke who took part in a physical therapy program, twice a week, had the associated use of the neuromuscular bandage, totaling twenty applications in the area of the wrist extensors and affected side of the elbow (Mota, & Silva, 2014). However, in this study, nothing was described regarding the neuromuscular bandage use technique. The assessment tools used in the study were: goniometry, the Medical ResearchCouncil (MRC) the scale for muscle power, the Modified Ashworth Scale (MAS), for the evaluation of spasticity, and ADLs, to check the functionality.

The authors reported that there was an increase in range of motion (ROM), a strength gain of the assessed muscle group, and a reduction of the degree of spasticity; as in our study, significant improvement from the upper limbs functionality gain was not observed.

The results presented in this study may be questionable, since there was no control group and the participants of this study were part of a standard physical therapy program; thus, it is not possible to say that the gains happened due to the application of the neuromuscular bandage or just due to the kinesiotherapy.

Studies which aimed at preventing pain in the shoulders of patients in the acute stroke phase used neuromuscular bandage in the deltoid region, applying it every three (3) days with protocols ranging from two to six (2-6) weeks of intervention (Hsieh, *et al.,* 2021); Huang, *et al.,* 2016; Griffin, & Bernhardt, 2006; Hanger, *et al.,* 2000; Kase, K., *et al*., 2003; Pandian, *et al.,* 2013). All patients of these studies, with samples ranging from 33 to 98 subjects, went through conventional therapy. Participants were divided into intervention and control groups, and/or sham. In addition to measuring pain, they have also evaluated the functionality and the ROM of upper limbs, with some variability between the assessment tools.

None of the studies was able to show significant improvement in relation to functionality and ROM in comparison to control groups, although in one of the surveys they have used rigid neuromuscular bandage instead of the elastic (Hanger, *et al.,* 2000).

Regarding the pain, only one study (Griffin, & Bernhardt, 2006) showed significant improvement in favor of the experimental group, in relation to the number of days which this group remained without reporting pain. The results presented in this study are similar to our findings, since, despite the intervention group'simprovement in some functional aspects, it was not significant when compared to the control group.

The same happened in relation to the pain aspect which was evaluated through the specific scale to shoulders: the intervention group showed a tendency of pain diminishment, mainly in the subitem of the scale related to night pain. However, there was no statistically significant improvement. And, even though a) the neuromuscular bandage was used on the same muscle group; b) the application technique and the assessment tools were not the same; and c) the participants were in the subacute phase, the findings were similar to ours.

In order to assess pain, active ROM and shoulder sub luxation of ten patients after stroke, ranging from one month to 2.5 years of injury time, another study evaluated the use of the neuromuscular bandage in the deltoid region for three (3) weeks, with three (3) applications per week (Hayner, 2021). Regarding this research, the applied method differs in injury time and technique: the California Tri-Pull Taping method was used, without the specification of the tape tension. The study identified a tendency of increased ROM of the shoulder flexion, which was compared only to the pre-assessment, and not to a control group.

Our research corroborates the results of this research regarding pain relief, since participants had an improvement in pain symptoms, even though there was no statistical significance. However, this study identified an improvement of upper limbs' functionality as well as the research (Appel, Mayston, & Perry, 2011), which discovered, through Fugl-Meyer,

Motor Assessment Scale and Nine Hole Peg Test assessment tools, that the neuromuscular bandage has a potential beneficial effect on functionality gain, but without significant results. The latter research (Appel, Mayston, & Perry, 2011) evaluated fourteen (14) participants with acute stroke and hemiparesis sequelae. These participants were divided into control and intervention groups.

The statistically insignificant difference in neuromuscular bandage application may be explained by biomechanical analysis; in a research (Turner-Stokes, & Jackson, 2002), authors discuss the hypothesis that the shoulder girdle is a region with muscle weakness, which causes unbalance, joint instability, and pain in the gleno humeral and scapula thoracic joint, which are involved in the essential muscle function for maintaining joint position.

Active motion is required to build the stability of the scapula on the chest wall, and the pelvis position in the anterior pelvic tilt has a direct effect on the biomechanics of the upper limbs, causing the external rotation of the humerus (Appel, Mayston, & Perry, 2011; Griffin, & Bernhardt, 2006; Hanger, *et al.*, 2000; Hayner, 2012; Murta, *et al.*, 2020; Pandian, *et al.*, 2013; Turner-Stokes, & Jackson, 2002). Complementing, the same authors point out a conflict between the evidence of the use of the neuromuscular bandage to reduce pain, function or even the upper limb range of motion (Griffin, & Bernhardt, 2006).

In a systematic review research on the use of the neuromuscular bandage post stroke, which screened papers in the PubMed, EMBASE, CINAHL and Web of Science databases, between the years of 1966 and 2013, a total of fifteen (15) studies that met the criteria of inclusion was selected, since they summarize the available evidence on the effectiveness of the implementation of the neuromuscular bandage after stroke (Grampurohit, Pradhan, & Kartin, 2015).

The results of this review indicate that, currently, there is preliminary evidence in the domain of body structure and function to the use of the rigid tape on shoulders to increase the number of days without post-stroke pain. There is inconclusive evidence for the improvement of pain intensity, ROM, strength, and muscle tone with the use of the neuromuscular bandage; the evidence related to the activity and participation is insufficient (Appel, Mayston, & Perry, 2011; Grampurohit, Pradhan, & Kartin, 2015); Griffin, & Bernhardt, 2006; Hanger, *et al.*, 2000; Hayner, *et al.*, 2012; Hsieh, *et al.*, 2021; Huang, *et al.*, 2016; Kase, *et al.*, 2003; Mota, & Silva, 2014; Murta, *et al.*, 2020; Pandian, *et al.*, 2013; Turner-Stokes, & Jackson, 2002; Yang, L., Yang, J., & He, 2018).

Pain was measured in two different manners in the included studies: through pain intensity and number of days without pain. Pain intensity was measured using a visual analogue scale; the number of days without pain was measured using the Ritchie Articular index. Although there is preliminary evidence to support the use of the neuromuscular bandage post stroke to increase the number of days without shoulder pain, the overall quality of available evidence is modest.

There were several methodological challenges with the revised studies; some of the main concerns were the limited sample size, the lack of sufficient follow-up and the lack of control group. Furthermore, some were reports of a single application of the neuromuscular bandage.

The authors cite that in several of the randomized clinical trials there was a lack of rigorous protocols of randomization. Many had no information on the sequence generation and allocation concealment, and comparisons between the neuromuscular bandage protocols, to establish the efficacy of the intervention, are also needed. Therapists who provide standard care to the groups should not be informed of the assignment of the group, to reduce any influence.

Moreover, as the neuromuscular bandage is mainly used as an adjunct, a detailed record of the type and intensity of other rehabilitation techniques is necessary (Grampurohit, Pradhan, & Kartin, 2015; Unger, *et al.*, 2018), since the neuromuscular bandage methods also seemed to vary between surveys.

Still regarding theresearch review, the authors point to questions such as clear tape description, its direction, the application of tension and images of reference which could help therapists to replicate the method of the neuromuscular bandage. Another important factor is the brand of the neuromuscular bandage, since it reflects on the quality of implementation and correct performance; there are several papers that do not mention anything about this. In summary, the studies point out to the necessity of a larger scale, with more rigorous control and longer follow-up to reinforce the current results.

Therefore, given the limited current literature, it is not possible to compare the effectiveness of the rigid neuromuscularbandage to the effectiveness of the elastic band (Unger, *et al.,* 2018).

One of the limitations of our study was the small number of participants and of studies regarding the use of the neuromuscular bandage on patients with stroke sequelae; the ones found show very different methodologies, and few were successful in demonstrating their effectiveness in this population.

Thus, the authors suggest extensive research with methodological rigor, especially regarding tension; direction and technique of use of the neuromuscular taping; muscle groups; number of participants, and time of injury (Ortiz-Ramirez, & Perez-De la Cruz, 2017; Unger, *et al.*, 2018).

Conclusion

In this research, we have observed that the neuromuscular taping was not effective from the therapeutic point of view, regarding the functionality gain and the reduction of pain in the upper limbs of elderly patients pos stroke, in comparison to the control group.

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