Original Article

Impact of Extension Splint on Upper Extremity motor components and Function in Chronic Stroke Patients

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Objectives: Spasticity and contracture in flexor muscles of the wrist may occur after stroke, especially in which early recovery did not appear. Splints are prescribed to reduce spasticity and to prevent contracture after stroke. Although there is a few research in this field. The aim of this study was to examine the impact of the Extension splint on function, spasticity, and range of motion of upper extremity in chronic stroke patients.

Methods: Fourteen patients with chronic cerebro-vascular accident according to inclusion criteria participated in this study, and after initial assessments they were given splints. Goniometry was the method of assessing range of motion, and Fugl-Meyer assessment was used to examine the function of upper extremity, and spasticity of upper limb was evaluated by Modified Ashworth Scale. Patients were instructed to wear the extension splints for 1 month and 2 hours a day and all night (6 to 8 hours). Assessments were repeated at the end of the first, third and fourth weeks.

Results: The difference of wrist`s spasticity level and passive range of motion of wrist were significant before and after 1 month ($P<0.001$, $P=0.01$). And other items did not significantly improve ($P>0.05$). Also a result indicates that there are improvements in all outcomes to some extent and these results were not significantly different in the outcomes.

Discussion: The results show that 1-month using of this splint with 30-degrees of wrist extension reduces spasticity and improves passive wrist range of motion. But changes in other outcomes were not significant.

Keywords: stroke, extension splint, spasticity, range of motion, function

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Introduction

Stroke is known as the third cause of death. Incidence rate of stroke in Iran is nearly two times higher than European societies and the average age of the disease is about 10 years Lower (1).

One of the complications after cerebro-vascular accident is spasticity or muscle hyper-tonicity. The patients are confronted to problems in motor control and these problems also lead to difficulties in activities of daily living and complications such as shortness and contracture (2). Spasticity and contracture in the flexor muscles of the wrist may occur after stroke, especially in which early recovery did not appear (3). Neurolysis, denervation with

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chemicals and casting techniques are considered as treatment methods to resolve these complications (2). Also, splints are prescribed to reduce spasticity and to prevent contracture after stroke (4, 5). There is the belief that the use of splints plays a role in improving mobility of shoulder and hand function. One of the goals of splinting is improving flexibility of the muscle, so it is important to determine the degree of stretch in the splint. Some therapists believe that placing the muscle at the end range of stretch can result the greatest impact on spasticity and contracture (6,8)

Gossman showed that placing the muscle in a passive stretched position, changes it biomechanically, anatomically and physiologically (8). In this study we used a type of splint called Extension splint that works through application of serial static force (2). This study is based on the theory that muscle immobilizing in each position can affect the level of spasticity. For example placing the muscle in a special stretched position reduces the activity of motor neurons and can inhibit the spasticity and placing it in a shortened position may increase hypertonicity(9). Lannin et al. reported that using Extension splint for a month doesn`t decrease contracture of wrist in acute stroke patients (10). So due to lack of knowledge in chronic patients we examined the efficacy of this splint with various and repeated assessments.

Methods

This interventional study was carried out in a pretest-posttest design and in occupational therapy clinics in Tehran. Fourteen patients with chronic stroke were selected by a non-randomized simple method and according to the inclusion criteria. 7 men and 7 women with a 23.6 mean score of mini mental status exam (MMSE) participated in the study after signing the consent forms. 3 patients were exited the research due to absence in the final evaluations. The inclusion criteria were: one year passed since stroke, MMSE score above 22, ability to sit at least 10 minutes independently at the edge of bed, age between 20-64, no more than 3 and at least 1+ spasticity level according to Modified Ashworth Scale (MAS), no other neurologic diseases, no simultaneous application of other upper extremity splints, and no Botulinum toxin injection table (1).

Table 1. Descriptive Statistics

variable	minimum	maximum	Standard deviation	mean
Age	39	62	7.86	54.87
Duration	13	30	5.68	21.88
MMSE	22	30	2.59	23.66

To prepare these splints first positives were made in two sizes for men and women and all the splints were made based on the positives. In positives wrist was put in 30 degrees of extension, Thumb in Hyper abduction and fingers were put in zero degrees, So the angles of splints were the same for all patients. Before the initiation of the interventions, active and passive range of motion of elbow, wrist and metacarpo-phalengeal joints were assessed. Other outcome measures were elbow and wrist spasticity and upper extremity function. Goniometery was the method to measure range of motion, and Modified Ashworth scale was used to examine the spasticity and the upper extremity function was scored based on Fugl-Meyer assessment. Initial data were fully recorded and then after giving the necessary explanations the Extension splints were given to patients. Assessments were repeated at the end of the first, third and fourth weeks. And the results were compared with previous ones. Patients were clarified to wear these splints 2 hours a day and all the night (6 to 8 hours) about 1 month. In this 1-month period patients were called and reminded to use the splint. It should be noted that all patients were also participating in a routine Occupational Therapy program three times a week during the study. We calculated the descriptive and analytic statistics using the software SPSS, version 16. Level of Significancy was set at 0.05.

Results

The data was analyzed with SPSS version 16. Kolmogorov Smirnov was used for normality test. The repeated measures test was used to determine changes in the weekend. And with the paired t-test determined the changes over a month. As indicated in table (2), there were some improvements in all outcomes although these changes were not significant week by week in any outcomes [P(v)>0.05].

Table 2. Results of the changes within weeks(repeated measure)

Variable	N	First assessment	End of first week	End of Third Week	End of fourth week(final assessment)	P
Elbow MAS	11	1.44±1.13	1.33±1	1.22±0.97	1.22±0.97	0.12
Wrist MAS	11	2.66±0.5	2.11±0.60	1.88±0.78	1.88±0.78	0.11
Elbow AROM	11	70.55±47.52	77.22±51.78	82.22± 52.08	82.77± 54.03	0.08
Elbow PROM	11	129.44± 5.83	131.66±55	132.77± 5.06	132.77± 5.06	0.18
Wrist AROM	11	13.88±14.31	21.11±22.44	18.88±29.45	26.11±32.47	0.11
Wrist PROM	11	132.22±22.23	144.44±20.83	151.11±17.28	150.55±19.91	0.35
MP AROM	11	30.00±42.42	37.50±53.03	30.00±42.42	30.00±42.42	0.5
MP AROM	11	87.77±8.33	88.88±4.16	89.44±8.45	91.11±6.50	0.53
UE Function	11	19.44±9.8	19.88±11.14	20.88±11.35	25.33±20.18	0.2

By analyzing the data, changes between the first and last assessment showed obvious improvements in spasticity of the wrist [P(v)=0.01], elbow`s active range of motion [P(v)=0.006] and wrist`s passive range of motion [P(v)=0.01] and the changes of other variables were not significant table (3).

Table 3.analatical figure during the one month (paired t-test)

variable	Mean Difference	SD	Statistical T	P
Elbow AROM	-1.22	10.03	-3.65	0.006
Elbow PROM	0.00	4.43	0	1
Wrist AROM	-1.11	3.33	-1.00	0.34
Wrist PROM	-1.72	16.97	-3.04	0.01
Elbow MAS	0.22	0.44	1.52	0.16
Wrist MAS	0.77	0.44	5.2	0.001
UE Function	-1.33	2.17	-1.83	0.10

Disscusion

Results shows that after one month wearing the extension splint the changes of spasticity in wrist muscles is significant. So our results can prove the theory that placing the muscle in each position would affect the level of spasticity (9) .Lannin et al. have reported different results to ours, that using Extension splint for a month doesn`t affect upper extremity of acute stroke patients (10). To explain the results of Lannin`s study perhaps it can be said that in the acute phase of stroke the spasticity is usually in an ascending trend and those results are probable. Results of table (2) shows that the trend of weekly changes in one month according to the repeated measure test was not significant in all outcome measures. But explains that in the first week of using splint, spasticity was more decreased compared to next weeks. Perhaps passive stretching of a muscle through application of splint decreases the spasticity to a limited extent and then the improvement would be stopped. Trend of Spasticity changes, in elbow and wrist assessed by MAS was not significant with repeated measure analysis. One of the reasons for this result may be low sample size, and to have better results we need more patients. Other reason perhaps is the low reliability and low sensitivity of the MAS (2). MAS beside spasticity, evaluates thixotropy and fixed muscle contracture and this issue may be an Incompetency for the test to evaluate spasticity. It seems electrophysiological tests such as Hmax/Mmaxare appropriate scales to evaluate spasticity solely and It is suggested to be used in other researches.

A study in 2005 by Pizzi and colleagues has showed that about 3 months using of a Volar splint reduces spasticity and this improvement was only seen with neuro-physiological tests and the MAS results were not significant (11). Application of extension splint with wrist at 30 degrees significantly increased the passive range of motion in this joint. Our study was based on results reported from animal researches that describes the adaptation of muscle`s length to the extent of stretch (12,14). Pizzi et al. in their work, reported that wrist`s passive range of motion had improved, and the improvement was more in the extension than the flexion. The reason for this

difference is referred to spasticity decrease in flexor muscles. Also passive range of motion in chronic patients was more improved than the sub-acute patients that might be as a result of more flexed fingers in the chronic patients. Passive range of motion in elbow had significantly improved just in sub acute patients (11). Application of extension splint with wrist at 30 degrees didn`t make significant increase in active/passive range of motion in other joints. In this study according to table (2), increase in range of motion seems to be more in first week than other weeks, And during the last weeks the increase has nearly stopped. This issue may be due to executing the previously discussed animal findings just in the first week and not continuing it for the rest. If we had increased the degree of extension in wrist based on the increase in the length of muscles we would have better results. Lannin et al. has concluded their results nearly as same as ours (10). Also results of this study shows that function of upper extremity didn't change significantly after one month using extension splint. Research in 2000 by Gracise and colleagues has shown that upper limb function will improve in certain tasks. Gracise explains this improvement with regard to better perception of the senses and reduced spasticity and increased range of motion in some joints of the affected hemiplegic side as an outcome of using of a Garment (15). In a study Kinghorn and his team reported that after using a Inhibitory Weight-Bearing splint spasticity had decreased to minimum level and arm-hand status had improved but changes in fine functional tasks had varied results (16). Katz and colleagues in a study showed a strong correlation between spasticity and hand function (9). In our study function of upper extremity did change but not significantly.

Conclusion: The results show that 1-month using of this splint with 30-degrees of wrist extension reduces spasticity and improves passive wrist range of motion. But changes in other outcomes were not significant. Finally it is proposed to do similar researches with control group and more samples and if applicable, through neuro-physiological evaluations with an increase in degree of the angle of splint week by week.

References

1. Azarpazhooh MR, Etemad MM, Donnan GA, Mokhber N, Majdi MR, Ghayour-Mobarhan M,et al. Excessive incidence of stroke in Iran: evidence from the Mashhad Stroke Incidence Study (MSIS), a population-based study of stroke in the Middle East. Stroke. 2010;41(1):e3-e10.
2. Andrew JS, MPT. Samir, G.Sangani, BS. John, R MC Guire, MD. et al. Reliability of Biomechanical Spasticity Measurements at the Elbow of People post Stoke. Arch Phys Med Rehabil. 2005;86:1648-54.
3. Pandyan AD, Cameron M, Powell J, Stott DJ. Contractures in the post-stroke wrist: a pilot study of its time course of development and its association with upper limp recovery. Clin Rehabil. 2003;17:88-95.
4. Duncan RM. Basic principle of splinting the hand. Phys Ther. 1989;69:1116-40.
5. Lowell CT.Construction of hand splints. 4th ed. CA T, editor: Williams & Wilkins; 1995. 583-97.
6. Milazzo S, Gillen G. Splinting applications. Gillen G BA, editor: St Louis; Mosby; 1998.
7. Ada L, Goddard E, McCully J. Thirty minutes of positioning reduces the development of shoulder external rotation contracture after stroke: a randomized trial control. Arch phys Med Rehabil. 2005;86:230-4.
8. Gossman MR, Sahrmann, S.A. Review of length-associated change in muscle. Physical Therapy. 1982;62:1799-808.
9. Katz RT, Raymer WZ. Spastic Hypertonia: Mechanisms and Measurement. Arch Phys Med Rehabil. 1980;70:144-55.
10. Lannin NA, Cusick A, McCluskey A. The effects of splinting on wrist contracture after stroke A randomized controlled trial. stroke. 2007;38:111-6.
11. Pizzi A, Carlucci G, Falsini C, Verdesca S, Grippo A. Application of a Volar static splint in Post stroke spastisity of upper limb. Arch phys Rehabil. 2005;86:1855-64.
12. Herbert R. How muscles respond to stretch. Science-based rehabilitation: theories into practice Butterworth Heinemann. 2005:107-30.
13. Herbert RD. The passive and mechanical properties of muscle and adaptations to alerted patterns of use. Aust J physiother. 1988;34:141-9.
14. Wiliams PE. Effect of intermittent stretch on immobilized muscles. Ann Rheum Dis. 1988;47:1014-6.
15. Gracies JM, Marosszeky JE, Renton R, Sandanam J, Gandevia SC, Burke D. Short term effect of dynamic LYCRA splints on upper limb in hemiplegic Patients. Arch Phys Med Rehabil. 2000;81:1547-55.
16. Kinghorn J, Robert G. The effect of on Inhibitive weight – bearing splint on tone and function: a single case study. Am J Occup Ther J. 1996;50:807-14.